NAME OF CATEGORY- 'INNOVATIVE USE OF ICT BY CENTRAL GOVERNMENT PSUs'

1. **Coverage – Geographical and Demographic** :-

(i) Comprehensiveness of reach of delivery centres,

India is a vibrant market from communications point of view. The subscriber base in the wireless market in India, the world's fastest growing telecom market reached another milestone when it surpassed 200 million subscribers in Aug 2007. The country's mobile services market is forecast to grow by a compound annual rate of 28.3% in next five years. At present there are around 54000 cell sites operated by different GSM/CDMA operators. This number would further go up to 80.000 in next couple of years.

(ii) Number of delivery centres

2G/3G/Wimax/CDMA sites all over India

(iii) Geographical

(a)National level – Number of State covered: 1

(b) State/UT level- Number of District covered: 2

(c) District level- Number of Blocks covered: 345

Please give specific details:-

The coastal district Mangalore & Udupi of Karnataka state falls along the west coast of peninsular India and is Western Ghats in the east and Arabian sea in the west. The district lies between 12 04' and 13 59' North latitude and 74 35' and 76 00' East longitude covering an area of 7575 sq km.

(iv)Demographic spread (percentage of population covered)

5 lakh people covering Mangalore & Udupi District

2. Situation Before the Initiative (Bottlenecks, Challenges, constraints etc with specific details as to what triggered the Organization to conceptualize this project):

Deployment of 2G/3G and other wireless communication system, predictions of signal strength and propagation coverage area are vital aspects in the design of wireless communication networks. Wireless communication has developed into one of the most exciting technologies of the last century since its invention in 1897, as the radio telegram. In the recent past, mobile phones have become an integral part of people's lives. High expectations of mobile communications-faster roll out, improved line

quality and wider area coverage-have forced leading service providers to improve the quality of their service through better network planning. The quality of the service relies on the signal strength available at the user's location. The signal originates from a network of antennas situated at strategic locations across the landscape. However, to work out the best network of antennas over a large area is difficult and is dependent on numerous factors, which include land cover, terrain undulations, building heights, geology and geomorphology. There are a variety of models created by electrical engineers in the past decades to analyse telecom site deployment and design for cellular networks, but none of the models were considered a final solution because each technique has some particular limitation in its application. Cellular network design is becoming more and more important since the network quality is highly dependent on the distribution of base stations. To design a cellular network for a particular region efficiently and accurately, the site suitability is an important determination. The primary operations in the telecommunication network industry include network site identification and planning, signal strength measurements with coverage estimation for the expansion of system. The mathematical algorithms used for prediction are generally known as propagation models. Model tuning is a process in which a theoretical propagation model is trained with the help of measured data. The aim is to get the predicted field strength as close as possible to the measured field strength.

The current project evaluates the capabilities of satellite remote sensing technology for planning the locations of mobile communication infrastructure and estimating the signal strength with more accurate design of the coverage of modern cellular network systems. The methodology also comprises of developing suitable spatial modeling in a Geographic Information System (GIS) environment.

3. **Scope of Services/ Activities Covered** (Relevance of choice of application for clients/ PSU, extent of e-enablement in terms of number of processes/services, extent to which step in each service/process have been ICT- enabled #)

The use of RS and GIS in telecommunications started with applications for automated mapping and facilities management. Automated mapping produces digital maps and facility management provides digital inventories of facilities. The network complexity

together with non-availability of data does make life miserable for managers and engineers of telecom systems. Hence Remote sensing and GIS study will help in gaining visibility to the planning issues faced by the telecommunication infrastructure. Capability to access, manage, and analyze a large quantities of information can be critical to customer service as well as facilitating the future growth and competitiveness of the utility. The modern techniques like the remote sensing (RS), the geographical information system (GIS) and the global positioning system (GPS) offers a great hope for the research and development aspects of the industry. The importance of sound cellular network design is apparent to many engineers engaged in improving the quality of wireless communication services especially since mobile data services have entered the mass market. In addition, the assured stability of networks is of unprecedented value for these new services. To serve an increasing number of users, requires an increasing number of base stations. Thus, operators must carefully plan the deployment and configurations of radio base stations to support voice and data traffic at a level of quality expected by customers.

4. Strategy Adopted

(i) The details of base line study done,

This project work attempts to model the localized environmental features and then use them to tune the propagation model for optimal predictions. Propagation models have traditionally focused on predicting the received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in a close spatial proximity to a particular location. Radio transmission in a mobile communication system often takes place over irregular terrain. The terrain profile of a particular area needs to be taken into account for estimating the path loss. The terrain profile may vary from a simple curved earth profile to a highly curved mountainous profile. A number of propagation models are available to predict path loss over irregular terrain. While all these models aim to predict signal strength at a particular receiving point or in a specific location are called sector, the methods vary widely in their approach, complexity and accuracy. In this research work different path loss models for macro cells such as Hata Okumura model, Cost 231 model and ECC-33 model are analyzed

and compared. A propagation model is proposed by modifying Hata Okumura model and it is implemented and its parameters are compared with experimental values. Based on all these correction factors for each point of measurement, the Okumura-Hata model was modified to account for clutter and terrain using Satellite data and GIS technology. Comparative study with real time measurement obtained from the telecom service provider, Bharat Sanchar Nigam Limited (BSNL) for the deployment of rural wireless Broadband telecom services at Udupi District of Karnataka State, India has been implemented.

(ii) Problems identified,

High expectations of mobile communications-faster roll out, improved line quality and wider area coverage-have forced leading service providers to improve the quality of their service through better network planning. The quality of the service relies on the signal strength available at the user's location. The signal originates from a network of antennas situated at strategic locations across the landscape. However, to work out the best network of antennas over a large area is difficult and is dependent on numerous factors, which include land cover, terrain undulations, building heights, geology and geomorphology. There are a variety of models created by electrical engineers in the past decades to analyse telecom site deployment and design for cellular networks, but none of the models were considered a final solution because each technique has some particular limitation in its application. Cellular network design is becoming more and more important since the network quality is highly dependent on the distribution of base stations. To design a cellular network for a particular region efficiently and accurately, the site suitability is an important determination. The primary operations in the telecommunication network industry include network site identification and planning, signal strength measurements with coverage estimation for the expansion of system.

(iii) Roll out/implementation model,

The study mainly involves the applications of Remote Sensing and GIS techniques. A major part of the work has been carried out by making use of the satellite data (both hard copies and digital data), SOI topographical maps, Google maps and other maps.

Satellite provides a good source for deriving critical thematic information for the location of towers. High-resolution panchromatic data (PAN) of the Indian Remote Sensing satellite CARTOSAT-1 was used for this study. The PAN sensor was primarily chosen for its stereo capability. The stereo pair data were acquired on 24th November 2007, and selected due to good overlap and a fairly good base to height ratio of 0.68. These data were used to generate the DEM of the study area. The other data taken for this study are the multispectral Linear Imaging Self Scanning-3 (LISS-III) sensor data of the Indian Remote Sensing satellite IRS-1C acquired on 1st March 2000 (table 1). These data primarily has been used for clutter analysis and for data integration with PAN, and for the extraction of road networks. In the present study, a planning strategy for establishing a network of towers for the purpose of mobile communications using remote sensing and GIS is demonstrated. In particular, this study addresses how to develop a surface model using IRS-1C LISS III and CARTOSAT-1 stereo pair. This information derived from the satellite data was integrated with raster GIS modeling. The study clearly demonstrates that the satellite data could be utilized for planning a suitable network of towers for telecom applications.

(iv) Communication and dissemination strategy and approach used.):

Thematic map on the land use/land cover has been generated using satellite data and with SOI topographical map and sufficient field checks. Different categories of land use/land cover were demarcated by visual/digital interpretation techniques. Patterns of vegetation and other land features have been identified by visual analysis of remotely sensed data using mainly tonal variations, textural pattern, shapes and associations. Land-water interchange and different types of vegetations have been distinguished from the differences in contrast in FCC using digital image processing such as contrast stretching and filtering techniques. The land use/land cover classification upto level III for various categaries of the entire study area was done based on the National Remote Sensing Centre (NRSC) guidelines. In visual analyses, image interpretation keys indicating tone/colour, texture, pattern, shape, size, location and association for each category was used to identify the features. Basic information such as transportation network, tank, river etc were taken from Survey of India (SOI) topographical maps.

The GCPs obtained from GPS surveys were used for validating the maps. The various thematic maps prepared using conventional and remote sensing data were transferred to GIS environment. The secondary data collected from various departments have been used directly or indirectly. The secondary data like village, mobile sites, road infrastructure, relevant facts and figures of Udupi district were collected from the following departments:

- Public Works Department,
- Directorate of Economics & Statistics
- Revenue Department.
- Mines and Geology Department.
- Meteorological Department.
- BSNL etc.

Indian Remote Sensing satellite Cartosat-1 was launched on 5th May 2005. It has a payload consisting of two cameras - one near nadir looking (-5 deg) and the other forward looking (+26 deg) providing the real time stereo data along the track with spatial resolution of 2.5m. These cameras are mounted with a fixed geometry, which helps in collecting stereo coverage of the terrain at a fixed B/H ratio of 0.62. Hence Height Accuracy = 2.5/0.62= 4.0m. In the present study DEM was generated at 5 m grid interval although the theoretical value is 4m. Horizontal accuracy of raw image as supplied by NRSA is 250m. After georectification, using DGPS control points an accuracy of 5m has been achieved. The projection, Spheroid and Datum defined for the base map as Transverse Mercator, EGM 96 (Global) and World Geodetic 84, Zone 43 N respectively. The work for DEM generation and stereo processing is created using Lieca Photogrammetry Suite 9.1 (LPS) software. The methodology adopted for generating the DEM and base map with contours is discussed below. Orthorectification is a process of correcting the imagery into a planar, map-like form by accurately removing all sensor, camera and terrain related distortions based on camera/sensor models, terrain models and GCPs. The DGPS surveyed Ground control points of x, y, z information is fed and the corresponding image points are identified in AFT & FORE images. The image chips and the ground photos of the area corresponding to GCP

points are referred in the identification of image points in the Cartosat image. These GCPs are acquired using the Differential Global positioning system and the accuracy of these points is better than one meter. The projection of these GCPs is UTM with spheroid and datum of WGS84. Total of 10 DGPS GCPs are used and out of them 4 points are used as control points and the rest of the points (6) are used as check points. The details of the peaks and valleys in the terrain are better modeled with small grid spacing than when the grid intervals are very large. Elevations other than at the specific grid point locations are not contained in the file. The ground coordinates calculated from the RFs were refined using a polynomial correction in the object space. RF based triangulation was applied to calculate the ground coordinates (X, Y, Z). Since the correct coordinates (X', Y', Z') of the GCPs are known and these coordinates were used for adjustment to generate an ortho-image. Later on, the topographic contours with 5m interval are captured in different layers. The 1-meter contour generated from FORE image and interpolation work carried out using 5 meter contour already derived earlier and interpolation was carried out by using SuperGIS software extension 3D analyst. The assessment of the output was carried out by using the "raster to vector" approach, using bilinear interpolation to determine the elevation. Digital Surface Model (DSM) represents the MSL elevations of the reflective surfaces of trees, buildings, mobile sites and other features elevated above the "Bare Earth". A Digital Terrain Model (DTM) is the elevation model of the landscape that does not include above ground objects. On the other hand, a Digital Surface Model (DSM) includes the objects with their heights above the ground as well as the mean sea level (MSL). Manual stereo mode interpretation and on-screen 3D feature digitization methodologies are developed for 3D feature capture from CARTOSAT-1 satellite stereo data. For example, all the buildings captured in building layer and all the roads captured in road layer. All the image processing, GIS and CAD software packages provide the functions required for feature capturing from monocular images. Captured data layers are properly checked for node, line and polygon errors like dangle nodes, undershoot, overshoot and unclosed polygons. Finally, the captured data in Autocad-3D vector format is imported to GIS 3D-Analyst environment for further analysis. On the other hand, the height data appear to be an

important source for building extraction.

The research work for DEM generation and stereo processing was carried out using Lieca Photogrammetry Suite (LPS) S/W. As the first step, CARTOSAT-1 stereo images were imported. The interior orientation has been computed for both fore and aft camera images (Band-A & Band-F) using RPC. Fifteen GCPs have been identified on both the images for Exterior orientation computation. Image matching has been performed between the fore and aft images. Triangulation has been performed with RPC at 2nd order polynomial refinement. The regular DEM has been generated at 5m grid interval. Finally Ortho-image is generated and features have been extracted in 2D mode by on screen digitization. The same model has also been used for 3D feature extraction. All the man made structures (like buildings, mobile sites, fence etc.) and trees have been captured in 3D environment in stereo mode. Finally using SuperGIS 3D analyst, 3D modeling has been performed in a GIS environment by which various 3D analysis has been carried out.

5. **Technology Platform used-**

(i) Description,

ERDAS Imagine, ArcGIS, , Map Info, AutoCAD map, SuperGIS with its extensions like Spatial analyst, 3D Analyst are the important software's used for Digital Image processing and GIS analysis. SuperPad mobile software was used for field survey along with Hardware Getac GPS. In GIS and Remote sensing applications, a large number of software's are required for input, manipulation, processing, analysis and output of spatial data, both in vector and raster format.

(ii) Interoperability

The interoperability is composed of three dimensions:

- compatible communications paths (compatible frequencies, equipment and signaling),
- radio system coverage or adequate signal strength, and;
- Scalable capacity.

(iii) Security concerns

Powerful geographic information systems are now available that quickly render one to several layers of digital geospatial data into map-like products. These systems can facilitate near-real time performance of a wide range of relevant geospatial analyses. These systems can be used to access and process digital geospatial data virtually anywhere because it, unlike analog data, can be instantly transmitted from wherever it's maintained and stored to any place where its needed. These characteristics make geographic information technologies, combined with appropriate sets of geospatial information, an invaluable tool for the handling, display, and analysis of information involved in every aspect of Homeland Security.

For example:

Detection: Geospatial information provides the spatial and temporal backdrop upon which effective and efficient threat analysis is accomplished. By linking and analyzing temporally and spatially associated information in real time, patterns may be detected that lead to timely identification of likely modalities and targets.

Preparedness: Emergency planners and responders must often depend on geospatial information to accomplish their mission. Current, accurate information that is readily available is crucial to ensuring the readiness of teams to respond. Geospatial information access and interoperability standards are essential elements as they support the means for the Nation's response units to react to terrorist attacks, natural disasters, and other emergencies.

Prevention: Geospatial information provides a means to detect and analyze patterns regarding terrorist threats and possible attacks. This information, coupled with information about borders, waters, and airspace, in turn may lead to the disruption of their plans or the prevention or interdiction of their attacks.

Protection: Geospatial information is a very important component in the analysis of critical infrastructure vulnerabilities and in the use of decision support technologies such as visualization and simulation to anticipate and protect against cascading effects of an attack on one system as it relates to other interdependent systems.

Response and Recovery: Geospatial information has been used by many organizations in response to and recovery from natural disasters. Similarly, this

information is invaluable for emergency response services of all kinds, as well as for carrying out long-term recovery operations.

Any issue with the technology used

Nil

(iv) Service level Agreements(SLAs) (Give details about presence of SLA, whether documented, whether referred etc. #)

Nil, Works involved with internal staff only

6. **Enhancement of Productivity** (Give details about impact on volume of transactions handled per employee, Productivity of machines/ resources#)

In the present study, a planning strategy for establishing a network of towers for the purpose of mobile communications using remote sensing and GIS is demonstrated. The primary operations in the telecommunication network industry include network site identification and planning, signal strength measurements with coverage estimation for the expansion of system. The study clearly demonstrates that the satellite data could be utilised for planning a suitable network of towers for telecom applications. Predictions of signal strength and propagation coverage area are vital aspects in the design of wireless communication networks. The aim is to get the predicted field strength as close as possible to the measured field strength. This research work attempts to model the localized environmental features and then use them to tune the propagation model for optimal predictions. Radio transmission in a mobile communication system often takes place over irregular terrain. The terrain profile of a particular area needs to be taken into account for estimating the path loss. The terrain profile may vary from a simple curved earth profile to a highly curved mountainous profile. In this research work, different path loss models for macro cells such as Hata Okumura model, Cost 231 model and ECC-33 model are analyzed and compared. A propagation model is proposed by modifying Hata Okumura model and it is implemented and its parameters are compared with experimental values. Based on all these correction factors for each point of measurement, the Okumura-Hata model was modified to account for clutter and terrain using Satellite data and GIS technology.

The technological advancement in the filed of geoinformatics has helped to understand the terrain conditions in a better way for designing the mobile towers. To design a cellular network for a particular region efficiently and accurately, the site suitability analysis is an important factor which makes use of geology, soil resistivity, geomorphology, LU/LC information. The study has highlighted the importance and significance of remote sensing and GIS integration for facility management in the field of telecommunication. The 3D base map derived from the stereo satellite images can be used for further analysis of the urban areas for planning. It is found that RS/GIS oriented signal strength prediction can significantly improve prediction quality compared to the theoretical free space model, which does not take into account any local terrain feature effects. The study has suggested that future research in radio wave propagation modeling and analysis should be carried out in a more strategic way and field measurement should provide more even representation on land cover types in order to make the statistical analysis more efficient. The validated terrain model for measurement of signal strength and estimating coverage has proved its usefulness. The data on various geospatial analyses can be used to constitute a 'District Information System' by integrating them in a Web GIS environment. The field distribution inside building is therefore dependent on specific features of its internal structure (e.g., layout, construction materials). If the knowledge is available about these features, it is possible to predict the exact internal field distribution and high accuracy can be obtained. Further, accuracy can be improved by modeling with high resolution satellite MSS data and stereo images like WorldView-2 having spatial resolution of 0.5cm.

7. **Efficiency Enhancement** (Give specific details about the following #)

(i) Volume of transactions processed

Fundamentally, all face-to-face surveys require the hiring of field staff and the subsequent assignment of sample in advance of field interviewing. District-based field managers have traditionally been responsible for executing this process on their own. The manual exercise of traditional assignment-making has been challenged, however, by particular structural limitations. Such complications are due to the use of obsolete technology involving manually matching cases to appropriate interviewer by ZIP code.

It would thus be desirable to develop an automated method of case assignment that could consider distance and proximity within a database structure. This type of solution can be facilitated through the use of GIS technology. Geographic Information Systems or 'GIS' embodies a set of tools that permits the automatic linkage of data sets based on geographic variables, such as distance, adjacency, or the quality of being within given census or postal areas. Through the use of GIS, one can calculate distances and optimize sample allocation based on project-specific parameters. A necessary factor would then be to know a priori the addresses of potential field interviewers as well as sample address locations.

(ii) Coping with transaction volume growth

GIS is defined as a combination of spatial database management and spatial analytical tools, along with computerized cartography, used to facilitate the accumulation and manipulation of geocoded objects GIS has commonly been employed in social science research to link attribute information to spatial or geographic information, and has considerably increased the capacity for data processing in recent years. If GIS software could be programmed to ascertain the locations of interviewers and segments and then perform the necessary distance calculations, it could represent the necessary solution to automated case assignment. Essentially, we propose using distance as an analog or replacement for the traditional method.

(iii) Time taken to process transactions,

Database transactions represent a package of work that makes changes to databases. Most database transactions occur within a very short time period, often within seconds. A state is a unit of change (i.e., an edit) that is performed on data in the geodatabase. It represents a discrete snapshot of the database whenever a change is made.

Accuracy of output,

Enterprise GIS geodatabases provide support for many users creating and maintaining large amounts of GIS data in a central location. In many cases, multiple users need to edit the same data at the same time. In other words, they require concurrent multiuser geodatabase editing. The nature of the spatial relationships and connectivity that define geographic data requires that edit sessions for geospatial data typically span long periods of time (e.g., hours, days, or weeks). These long edit sessions can be thought of

as long transactions in the DBMS. Additional user requirements include the ability to undo or redo changes, the capability to develop alternative application design proposals without affecting the published geodatabase, and a mechanism to manage how the data and the geodatabase have changed over time.

(iv) Number of delays in service delivery

Database transactions represent a package of work that makes changes to databases. Most database transactions occur within a very short time period, often within seconds. A state is a unit of change (i.e., an edit) that is performed on data in the geodatabase. It represents a discrete snapshot of the database whenever a change is made. It contains all the datasets in the geodatabase and evolves over time. Users access data in an enterprise GIS geodatabase through a version. Behind the scenes, simple queries in the underlying DBMS are used to view and work with the referenced state for a particular point in time or to see an individual user's current edits.

8. **Service Delivery – Business/ Client Centricity** (Give details about improvement in interaction with clients and outcome for clients, relevance of access points, Length and Breadth of services provided online etc. #)

Business Application Services offer integrated business solutions that span the application and technology landscape, from enterprise applications and digital transformation to security and testing. It will help drive business innovation by integrating next generation technology into the enterprise IT landscape. The solutions streamline business processes, maximize and extend the value of package applications, and offer secure IT operations. It aggregate cutting-edge applications to drive collaboration and e-commerce with customers. GIS enables clients to deploy technology solutions across the globe on an integrated basis, while the traditional offerings include data center management, cloud services, managed network, managed security, end user computing and business advisory services.

9. Citizen/ Client Centricity (Give specific details on the following#)

(i) Impact on effort, time and cost incurred by user,

GIS allows Public authorities have been quick to recognise that in sharing information between departments and service actors the internal users have to deal with a huge amount of information, much of which is not directly required for their own service

tasks

(ii) Feedback/grievance redressal mechanism,

Public getting awareness about informations regarding signal strength, coverage using GIS mapping. Engage the community in your growth management plans, promote business diversity, attract talented citizens, and encourage quality places and environments.

(iii) Audit Trails,

Not applicable as service oriented to customers

(iv) Interactive platform for service delivery,

Department deploys a series of maps and apps that add value to your entire organization. Configure a harmonized information model that brings operations to life and connects silos of geographic information.

(v) Stakeholder consultation

Digital mapping constitutes an integral component of the process of managing land resources, and mapped information is the common product of analysis of remotely sensed data. High-resolution space-borne remote sensing image data show a high level of detail and provide opportunities to be integrated into mapping applications. The demand for accurate and up-to-date spatial information is increasing and its availability is becoming more important for a variety of tasks.

10. User convenience (Give specific details about the followings #)

(i) Service delivery channels (Web, email, SMS etc.)

GIS, or geographic information systems, is a computer application that allows the user to apply overlapping layers of data and information onto a single geographic map in order to demonstrate a relationship between that region and the data provided. The management tool is free to use and is considered especially helpful for customer

(ii) Completeness of information provided to the users,

The communities have the better knowledge about the local specific environmental needs that is their own needs. Hence, organising and taking the communities into confidence is possible and it is a strategic move.

(iii) Accessibility (Time Window),

To use innovative technology in order to sustain the project, programme as well as to implement the project in a most scientific way. SC, ST, OBC, and Other

Communities, Government Authorities, Municipal corporations, NGOs, CBOs, SHGs, Federations, Education Institutions, Universities, Research Groups, Employers unions, Urban and Rural People within the project implementation area. Significant population increase, migration, and accelerated socioeconomic activities have intensified these environmental changes over the last several years. Therefore, more scientific and engineering study is required in this area. Information concerning the characteristics of lightning strikes in different geographical regions is of interest and can augment research on the interaction between the radiative properties of the surface and the atmosphere. In order to create natural human interfaces with the environment through sensitising the communities to protect, preserve and sustain the environment.

(iv) Distance required to travel to Access Points

Not applicable as geospatial database available web based

(v) Facility for online/offline download and online submission of forms,

Web GIS technology used where clients no need of GIS software

(vi) status tracking

UsinG WebGIS and Datacommuincation, the facility can be extended to clients

11. **Innovation** (Give details on how the usage of technology is exemplary, any use of new and emerging technology, impact on number of steps required, identification and removal of bottlenecks/ Irrelevant steps etc. #)

The goal of this research was to introduce application of RS/GIS and geographical databases to the problems of propagation prediction and radio-network planning for cellular radio communications. Radio-network planners rely heavily on the display of a large number of intermediate and final results, such as maps of user requirements, coverage, carrier-to-interference ratio, completed calls, rejected calls, etc. The results are usually displayed as overlay for 2D or 3D geographical maps because the geographical locations of users and of offered services are of the utmost importance in the area of mobile communications. Theoretically it is possible to exactly predict the strength of the signal from any transmitter at any other location if all the elements of the propagation environment are correctly taken into account. In so called "free space"

(actually a vacuum), there are no elements in the propagation environment and the signal strength at some distance from the transmitter can be exactly calculated. It is found that RS and GIS oriented signal strength prediction can significantly improve prediction quality compared to the theoretical free space model which does not take into account any local terrain feature effects. The study also suggested that future research in radio wave propagation modeling and analysis should be carried out in a more strategic way and field measurement should provide more even representation of land cover types in order to make the statistical analysis more efficient. The multi spectral for spatial analysis and stereo satellite data for obtaining terrain height information in conjunction with GIS/GPS solution have helped to formulate and derive an algorithm for calculating signal strength and coverage estimation using various Geospatial analytical tools available in GIS environment.

12. **Defined and Achieved outcomes** (Give details about extent of improvement in terms of organizational objectives, output targeted in the beginning of the project and output achieved, extent to which the project is able to reach/ fulfill the requirements of planned beneficiaries etc. #)

The approach is cost-effective and practical measures which have been incorporated in the project design and which will be implemented during the construction and operation of the project to mitigate the potential environmental impacts. The EMP includes implementation schedule, monitoring program, estimated budget and institutional actions necessary to mitigate and monitor the performance of the management plan.

The EMP has identified institutional responsibilities for its implementation, institutional arrangements, training and environmental monitoring plans, equipment requirements, implementation schedule and budget needed to implement the proposed mitigation and monitoring measures. The approach to the environmental protection and development is through institutionalized intervention with community centered, community based and community owned processes with the involvement of people. The existing system of monitoring is based on the planned activities. With the participation of the community, local governance bodies and

government departments, monthly and quarterly meetings has been utilised to estimate the actual performance, to measure the deviations and precautionary and corrective actions to ensure the activities and whether the programmes and the implementation system is in line with the objectives of the project. The future monitoring system would be further improved with the collection of baseline data from the initial stage of the project would be used periodically to review the results and outcomes with respect to the implementation of project, programmes, impact, and working system of the people's organisation. The collection of base line data would help to measure the achievement against the time target and also process monitoring would be done to ensure the quality and impact of the project implementation. Indicators would be developed for this purpose. Both preventive and corrective action would be taken so as to satisfy the project objectives within the timeframe and budget. The mid-course corrective actions along with the continuous management feedback system would be the part of monitoring strategy. The qualitative and quantitative indicators would be used to measure and evaluate the efficiency, effectiveness and impact of the project implementation. Concurrent monitoring and evaluation process would be launched in collaboration with the external development experts. India is one of the fastest growing mobile telephony industries in the world. It is estimated that by 2013, 1 billion plus people will be having cell phone connection in India. With the growth of cell phone subscriber, it has also lead to growth of infrastructure in the form of mobile phone towers. Today, in absence of any policy on infrastructure development and location of cell phone towers, large number of mobile phone towers are being installed in a haphazard manner across urban and sub urban habitats in India. Along with the growth of phone towers and subscribers, India is also witnessing a rapid population growth. To feed and support this rapidly growing population the agricultural security and the factors influencing them should be of concern.

13. **Sustainability** (Give details about sustainability w.r.t. technology (technology used, user privacy, security of information shared- Digital Signature/

Encryption etc. #), Organization (hiring trained staff, training etc#), financial (Scope for revenue generation etc. #)

At the larger scale of state/province or country levels a system of systems approach comes into play. This Internet-based geospatial service provides online access to automated mapping and facility management information system to help citizens make responsible land-use decisions. Sustainable development is at the confluence of economic vitality, healthy communities and sustaining the environment. Sustainable development also must relate to meeting present needs with a great deal of forethought to future needs. There are a lot of metrics to follow and quantify at all scales of sustainable development, and there's a need to integrate information from disparate systems and sensors in order to understand the large picture. A robust data handling and visual communication system is the most efficient means to arrive at a consensus, and this is where GIS shines.

14. Adaptability Analysis

(i) Measures to ensure adaptability and scalability

Performance is a measure of the speed at which a computer system works. Scalability is the ability to grow in size or complexity without showing negative effects. Problems in either area may expose the enterprise to operating inefficiencies and potentially general failure of critical business components. Testing, monitoring, and tuning the environment will ensure optimal performance and user satisfaction. GIS products support a large number of data sources to pull data from including both relational database managed solutions and file server managed solutions. Based on feedback from our customers and internal testing of different data sources, this section provides relative differences in performance, scalability and availability. Note that there are always exceptions to relative rankings, but these are provided to give a starting point for helping select the appropriate technology for your environment and also identify suspect areas in your current solutions. Benchmarks utilizing particular data sources are listed in the table below as available.

(ii) Measures to ensure replicability

GIS is a strong tool, which stores spatial as well as non-spatial data digitally and establishes a link between the two. Resultantly it produces not just maps but an

information system, which can retrieve, analyse and represent the stored data in desired ways. It can be utilised in numerous applications like planning, rural development etc. A digital database also has the advantage of easy cost-effective updating, transparency, rationality and strength of complex analysis. Community GIS should be such an information system, which is totally for a community. Such a system ideally should be 'by, for and of' a community. In other words, such an exercise shall not only involve community through participatory methods in the database generation, assimilation and analysis but also essentially address the needs, problems and priorities of that particular community. More importantly, it is crucial to understand whether territorial communities do require a digital intervention rather than assuming that they necessarily do.

(iii) Restrictions, if any, in replication and or scalability

Scalability of mobile solutions is primarily dictated by the synchronization methods used by the mobile clients to a server infrastructure. Consider whether you want to support over-the-air synchronization, cradled synchronization, or both. Even though connection interruptions may occur gracefully, either by canceling the operation or by allowing it to resume when a connection becomes available, they cause additional overhead. Standard web application server scaling guidelines may be utilized to support your mobile synchronization needs. One key option to remember with mobile solutions is the ability to stagger times of when devices are synchronized.

(iv) Risk Analysis

The existing system of monitoring is based on the planned activities. With the participation of the community, local governance bodies and government departments, monthly and quarterly meetings has been utilised to estimate the actual performance, to measure the deviations and precautionary and corrective actions to ensure the activities and whether the programmes and the implementation system is in line with the objectives of the project. The future monitoring system would be further improved with the collection of baseline data from the initial stage of the project would be used periodically to review the results and outcomes with respect to the implementation of project, programmes, impact, and working system of the people's organisation. The collection of base line data

would help to measure the achievement against the time target and also process monitoring would be done to ensure the quality and impact of the project implementation.

15. Comparative Analysis of earlier Vs new system with respect to the BPR, Change Management, Outcome/benifit, Change in legal system, rules and regulations

The existing system of monitoring is based on the planned activities. With the participation of the community, local governance bodies and government departments, monthly and quarterly meetings will be organised to estimate the actual performance, to measure the deviations and precautionary and corrective actions to ensure the activities and whether the programmes and the implementation system is in line with the objectives of the project. The future monitoring system would be further improved with the collection of baseline data from the initial stage of the project would be used periodically to review the results and outcomes with respect to the implementation of project, programmes, impact, and working system of the people's organisation. The approach is cost-effective and practical measures which have been incorporated in the project design and which will be implemented during the construction and operation of the project to mitigate the potential environmental impacts. The EMP includes implementation schedule, monitoring program, estimated budget and institutional actions necessary to mitigate and monitor the performance of the management plan.

The EMP has identified institutional responsibilities for its implementation, institutional arrangements, training and environmental monitoring plans, equipment requirements, implementation schedule and budget needed to implement the proposed mitigation and monitoring measures. The approach to the environmental protection and development is through institutionalized intervention with community centered, community based and community owned processes with the involvement of people. The existing system of monitoring is based on the planned activities. With the participation of the community, local governance bodies and

government departments, monthly and quarterly meetings has been utilised to estimate the actual performance, to measure the deviations and precautionary and corrective actions to ensure the activities and whether the programmes and the implementation system is in line with the objectives of the project. The future monitoring system would be further improved with the collection of baseline data from the initial stage of the project would be used periodically to review the results and outcomes with respect to the implementation of project, programmes, impact, and working system of the people's organisation. The collection of base line data would help to measure the achievement against the time target and also process monitoring would be done to ensure the quality and impact of the project implementation. Indicators would be developed for this purpose. Both preventive and corrective action would be taken so as to satisfy the project objectives within the timeframe and budget. The mid-course corrective actions along with the continuous management feedback system would be the part of monitoring strategy. The qualitative and quantitative indicators would be used to measure and evaluate the efficiency, effectiveness and impact of the project implementation. Concurrent monitoring and evaluation process would be launched in collaboration with the external development experts. India is one of the fastest growing mobile telephony industries in the world. It is estimated that by 2013, 1 billion plus people will be having cell phone connection in India. With the growth of cell phone subscriber, it has also lead to growth of infrastructure in the form of mobile phone towers. Today, in absence of any policy on infrastructure development and location of cell phone towers, large number of mobile phone towers are being installed in a haphazard manner across urban and sub urban habitats in India. Along with the growth of phone towers and subscribers, India is also witnessing a rapid population growth. To feed and support this rapidly growing population the agricultural security and the factors influencing them should be of concern.

16. Result Achieved/ Value Delivered to the beneficiary of the project-(share the results, matrices, key learning's, feedback and stakeholders statements that show a positive difference is being made etc):

(i) To organization

The technological advancement in the filed of geoinformatics has helped to understand the terrain conditions in a better way for designing the mobile towers. To design a cellular network for a particular region efficiently and accurately, the site suitability analysis is an important factor which makes use of geology, soil resistivity, geomorphology, LU/LC information. The study has highlighted the importance and significance of remote sensing and GIS integration for facility management in the field of telecommunication. The 3D base map derived from the stereo satellite images can be used for further analysis of the urban areas for planning. It is found that RS/GIS oriented signal strength prediction can significantly improve prediction quality compared to the theoretical free space model, which does not take into account any local terrain feature effects. The study has suggested that future research in radio wave propagation modeling and analysis should be carried out in a more strategic way and field measurement should provide more even representation on land cover types in order to make the statistical analysis more efficient. The validated terrain model for measurement of signal strength and estimating coverage has proved its usefulness. The data on various geospatial analyses can be used to constitute a 'District Information System' by integrating them in a Web GIS environment. The field distribution inside building is therefore dependent on specific features of its internal structure (e.g., layout, construction materials). If the knowledge is available about these features, it is possible to predict the exact internal field distribution and high accuracy can be obtained. Further, accuracy can be improved by modeling with high resolution satellite MSS data and stereo images like WorldView-2 having spatial resolution of 0.5cm.

(ii) To citizen

1. GIS mapping of all telecom sites with geospatial database will be obtained on web Environment.
2. The technical feasibility for the 2G/3G/Wimax/CDMA or Consumer fixed access and transmission set up is getting within a short span of time.
3. The knowledge of tariff, plans, and standards of the department will be easily

accessible to consumers.

(iii) Other stakeholders

With the advent of GIS technology, many limitations have been overcome and dynamic loss studies can now be performed. With the rapid urbanization that is taking place in Udupi district, vulnerability studies have become a necessity. Enabling the poor and underprivileged to get opened to the realities of life; and, discovering their own inherent potentials and exploring the avenues and opportunities to optimize these abilities and potentials. To create natural human interfaces with the environment through sensitizing the communities to protect, preserve and sustain the environment. Equipping them to apply their critical consciousness and strive to take charge of their own development along with the protection, preservation, regeneration and defending the natural resources and to make impact on global warming and climate change. To involve multi-stakeholders like PRIs (local governance bodies), local institutions, NGOs, CBOs, CSOs, Youth Clubs, Education Institutions, government departments and agencies, universities, and community in the process right from the beginning of the project, encouraging voluntarism in environmental protection and eventually making them to own the process.

To use innovative technology in order to sustain the project, programme as well as to implement the project in a most scientific way. SC, ST, OBC, and Other Communities, Government Authorities, Municipal corporations, NGOs, CBOs, SHGs, Federations, Education Institutions, Universities, Research Groups, Employers unions, Urban and Rural People within the project implementation area. Significant population increase, migration, and accelerated socioeconomic activities have intensified these environmental changes over the last several years. Therefore, more scientific and engineering study is required in this area. Information concerning the characteristics of lightning strikes in different geographical regions is of interest and can augment research on the interaction between the radiative properties of the surface and the atmosphere. In order to create natural human interfaces with the environment through sensitising the

communities to protect, preserve and sustain the environment.

17. Extent to which the Objective of the Project is fulfilled-(benefit to the target audience i.e.G2G, G2C, G2B, G2E or any other, size and category of population/stakeholder benefited etc):

The main objectives of the study are to;

- Generate geospatial databases using topographic maps, satellite images, digital elevation models (DEM), and varieties of land use & land cover data.
- Understand the dynamic changes in land use and land cover pattern and its impact on the telecom network. To create 3D simulations of existing and proposed networks by generating and designing the wireless coverage networks to select cellular tower placement by development action plan for the study area.
- Generate the 3D modelling for terrain analysis for Telecom planning using high resolution Cartosat-1 stereo images.
- GIS integration for analysis and modelling - to solve real world problems.
- GIS mapping of all telecom facilities and Utilities to get the feasibility of services to the customer end.

The project has highlighted the importance and significance of remote sensing and GIS integration for facility management in the field of telecommunication. Remote sensing data provides latest and accurate maps, when used in the GIS environment, which become an integrated static qualitative document. It is here that satellite Remote Sensing with its ability to provide reliable and accurate data offers excellent possibilities to map, monitor and measure the various facets of telecom development. The information thus generated helps to formulate suitable plans and strategies for an effective telecom planning and development. The multi spectral satellite data in conjunction with GIS desktop, 3D analyst and mobile GIS/GPS solution have helped to formulate suitable plans and strategies for an effective Telecom planning and development in Mangalore & Udupi district for the benefit of consumer access.

18. Other distinctive features/ accomplishments of the project:

1. **National Award of "Geospatial Excellence in Telecommunication" at India Geospatial Forum-2012 held at New Delhi. The award was honored by the India Geospatial Forum& GIS development and Communication, New Delhi for the best research project of the year entitled "Geospatial analysis for the deployment of rural broadband services using Geo-Information Technology".**
2. **Two research papers published in International Journal based upon the R & D works in this project.**

This is just an indicative list of indicators. Applicant can add on more information based on suitability of the project nominated.