DISCUSSION DOCUMENT
ISRO-NNRMS-SP-75-2001

NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

STRATEGY AND ACTION PLAN

TASK FORCE ON NSDI
DEPARTMENT OF SCIENCE & TECHNOLOGY
GOVERNMENT OF INDIA

JANUARY 2001

ISRO-NNRMS-SP-75-2001
DISCUSSION DOCUMENT

NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)– STRATEGY AND ACTION PLAN

PREPARED BY:
INDIAN SPACE RESEARCH ORGANISATION

FOR
TASK FORCE ON NSDI
DEPARTMENT OF SCIENCE & TECHNOLOGY
GOVERNMENT OF INDIA
JANUARY 2001

CONTENTS

भारत सरकार
अन्तरिक्ष विभाग
अन्तरिक्ष भवन, न्यू बी ई एल रोड
बेंगलूर - 560 094 भारत
तार : स्पेस : फैक्स : 3415328
दूरभाष : 3415241
ई - मेल : केरंगन @ इसरो . एरनेट . इन .

सत्यमेव जयते

GOVERNMENT OF INDIA
DEPARTMENT OF SPACE
ANTARIKSH BHAVAN, NEW BEL ROAD
BANGALORE - 560 094 INDIA
GRAMS : SPACE - FAX : 3415328
TELEPHONE : 3415241
E MAIL : krangan @ isro.ernet.in

FOREWORD

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of geographical and spatial information about Society and a wide variety of environmental and cultural phenomena. Much of this information is “spatial” - that is, it refers to a coordinate system and is representable in map form. Current and accurate spatial data must be readily available to contribute to local, state and national development and contribute to economic growth, environmental quality and stability, and social progress.

The nation has, over the past years, produced a rich “base” of map information through systematic topographic surveys, geological surveys, soil surveys, cadastral surveys, various natural resources inventory programmes and the use of the remote sensing images. Further, with the availability of precision, high-resolution satellite images, data enabling the organisation of GIS, combined with the Global Positioning System (GPS), the accuracy and information content of these spatial datasets or maps is extremely high.

Encapsulating these maps and images into a National Spatial Data Infrastructure (NSDI) is the need of the hour and the emphasis has to be on information transparency and sharing, with the recognition that spatial information is a national resource and citizens, society, private enterprise and government have a right to access it, appropriately. Only through common conventions and technical agreements, standards, metadata definitions, network and access protocols will it be easily possible for the NSDI to come into existence.

With ISRO having championed the use of satellite images and the derived thematic maps in support of developmental activities in the country, we have also been at the forefront of envisioning a NSDI and I am happy that the “NSDI Strategy and Action Plan” report has been prepared and is being opened up to a national debate. The first steps have been taken but the end-goal is farther away but in sight now. While Government must provide the lead, private enterprise, NGOs and academia have a major role to play in making the NSDI a reality. NSDI will require for coming together of various “groups” and harmonizing their efforts in making this national endeavor a success. I urge one and all, associated with satellite images, maps and GIS, to help in finalizing the NSDI strategy so that the next steps for its establishment can be initiated.

I also take this opportunity to record appreciation to the NSDI Task Force for a job well done and having outlined a pragmatic NSDI strategy. Congratulations!!!

January 31, 2001

(K Kasturirangan)

प्रो० व. सु. राममूर्ति
सचिव
PROFESSOR V. S. RAMAMURTHY
SECRETARY

भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
विज्ञान और प्रौद्योगिकी विभाग
टेक्नोलाजी भवन, नया महरौली मार्ग, नई दिल्ली-110 016

GOVERNMENT OF INDIA
MINISTRY OF SCIENCE & TECHNOLOGY
DEPARTMENT OF SCIENCE & TECHNOLOGY
Technology Bhavan, New Mehrauli Road, New Delhi-110 016

FOREWORD

In the emerging information market-place, geographic or geo-spatial information occupies a pre-eminent position. In fact, the use of high quality, reliable, geo-spatial information is critical to virtually every sphere of socio-economic activity - disaster management, forestry, urban planning, land management, agriculture, infrastructure development, business geographics, etc., Much of geo-spatial data is scattered across a large number of organizations, largely in the public sector, following different standards and is not sufficiently integrated and networked to make it really useful to a large community of users.

There is a widespread consensus, internationally, that spatial data sets need to be integrated to create what is called a geo-spatial data infrastructure. Such infrastructures have been likened to information high-ways, linking a variety of databases and providing for the flow of information from local to national levels and eventually to the global community.

The foundation of any Geo-Spatial Data Infrastructure is the topographic map. The custodian of all topographic data in India has been the Survey of India, which established 233 years ago is probably the oldest scientific institution in the country.

I am happy that at the initiative of the Survey of India and the Indian Space Research Organisation, the Task Force established for preparing a Vision and Strategy for the creation of a National Geospatial Data Infrastrucutre by integrating and networking the data assets of the Survey of India, National Remote Sensing Agency, the National Atlas & Thematic Mapping Organisation, the Geological Survey of India, the Forest Survey of India, the National Bureau of Soil Survey and Land Use Planning and a host of other Government agencies has achieved the task of preparing a strategy and framework document in such a short span of time. The creation of such an infrastructure will be a landmark development of enormous significance for a knowledge-enabled society.

January 31, 2001

(V.S. Ramamurthy)

Telegram : SCIENCTECH • Telephone : 6510068/6511439
Fax : 0091-11-6863847, 0091-11-6862418 • E-mail : dstsec@alpha.nic.in

THE NSDI VISION

NATIONAL INFRASTRUCTURE FOR THE AVAILABILITY OF AND ACCESS TO ORGANISED SPATIAL DATA

USE OF THE INFRASTRUCTURE AT COMMUNITY, LOCAL, STATE, REGIONAL AND NATIONAL LEVELS FOR SUSTAINED ECONOMIC GROWTH

1.0 INTRODUCTION

1.0 India is fast moving into being an information and knowledge society – especially with the emphasis on Information Technology and "transparent" e-governance. The next decade will see further large-scale investment in communications technology as India moves to exploit the full potential of the information age. Recent initiatives by the Government, including the IT Act, as well as announced plans for private and public investment, make it clear that within a few years an unprecedented capability will exist for sharing of data along "electronic superhighways."

2.0 Amongst the variety of datasets that would be involved, spatial (or map) information will be a major "content". These Spatial information sets are vital to make sound decisions at the local, regional, state and central level planning, implementation of action plans, infrastructure development, disaster management support, and business development. Natural Resources management, flood mitigation, environmental restoration, land use assessments and disaster recovery are just a few examples of areas in which decision-makers are benefiting from spatial information.

3.0 Until recently, maps (usually in paper form) have been a mainstay for a wide variety of applications and decision-making. This is changing as more spatially referenced data and information on a wider variety of topics or themes (e.g., population, land use, economic transactions, hydrology, agriculture, climate, soils) are being produced, stored, transferred, manipulated, and analyzed in digital form.

4.0 A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of map information about our country (and the Earth) and a wide variety of environmental and cultural phenomena. Much of this information will be " spatially referenced" - that is, it will refer to some specific geographic place or have 2/3-dimension coordinates to depict its location. With the availability of satellite-based remote sensing data and the organisation of spatial databases around a Geographical Information Systems (GIS), combined with the Global Positioning System (GPS), the process of semantic spatial information systems has now became a reality. The advent of GIS technology has transformed spatial data handling capabilities and made it necessary for re-examining the roles of government with respect to the supply and

availability of geographic information. Using GIS technology, users are now able to process maps - both individually and along with tabular data and "crunch" them together to provide a new perception - the spatial visualization of information.

5.0 With the current emphasis on digital spatial information, new products (representing the conversion of paper map information, the enhancement of that information, and the collection of new data) are appearing with greater frequency and with greater ease. Several factors have contributed to the advancement of digital technology for collecting, handling, and processing spatial data. Perhaps the most important are the relative ease with which digital spatial data can be edited and updated (no more handwritten notes on paper maps); improved integration of operations between administrative departments within agencies (departments share and contribute to spatial data as a common resource); data management and storage; more effective analysis and decision making (manual analysis of paper maps is exceedingly tedious and costly); and faster access to current data (changes are available to all users in near real time).

6.0 With this increased production comes the potential for substantial duplication of effort, as virtually identical digital products appear from different agencies to satisfy their often very specific needs. The cost of creating and maintaining digital spatial data is high, so it is particularly important that data created at considerable cost and effort be shareable, that costly data collection not be duplicated, and that the collected data be fully utilized to realize all of their potential benefits.

7.0 In India, Government continues to play a major role in inventory and mapping of major national resources and establishing a map information base in the country. Thus, Government has a major stake in managing the spatial information as government agencies are not only the main external providers of spatial information for most operational applications of GIS but also because they exert a profound influence on national developments as a result of "a cocktail of laws, policies, conventions and precedents which determine the availability and price of spatial data". A major challenge over the next decade will be to increase the use of spatially referenced data to support a wide variety of decisions at all levels of society. Using an effective, efficient, and widely accessible infrastructure, spatial data could be readily transported and easily integrated both thematically(e.g., across environmental, economic, and institutional data bases) and hierarchically

(e.g., from local to national and eventually to global levels). Transparent access to myriad databases could provide the information for countless applications, e.g., facility management, real estate transactions, taxation, land-use planning, transportation, emergency services, environmental assessment and monitoring, and research. Work on these applications could take place in schools, offices, and homes across the nation. In addition, these activities will lead to new value- added services and market opportunities in emerging spatial information industries.

8.0 In the above context, the establishment of National Spatial Data Infrastructure (NSDI) would be the right direction for the country. The NSDI must aim to promote and establish an infrastructure, at the national level for the availability of organized spatial (and non-spatial) data and multi-level information networking to contribute to local, national and global needs of sustained economic growth, environmental quality and stability and social progress.

2.0 SPATIAL INFORMATION – INDIAN PERSPECTIVE

9.0 Decision-makers today sieve through a large amount of data. Perception of "spatial" information – information in map format, with proper scales, legend, symbolization, colors etc, enhance the understanding of "information inter-relationships" and thus contribute to a more appropriate locale-specific developmental strategy definition. Once in spatial format, achieved through the organization of a systematic Geographical Information System (GIS) database, merging and integrating layers of information and arriving at "decision alternatives" becomes easy – almost "collapsing" volumes of information layers into a set of understandable and meaningful action plan.

10.0 The awareness and utilization of the GIS technology and the power of spatial information systems – specially oriented towards decision-making or resource management is growing rapidly in the country. Over the past few years, Government and Private agencies have invested considerably in establishing GIS databases. The growth of applications around a GIS core has also been increasing and range from mundane mapping applications to integrated analysis for locale-specific development.

11.0 In a way, India has had a strong foundation of a spatial data infrastructure – though mainly analog and paper-map based. Traditionally, the central spatial information infrastructure has been managed as a set of discrete mapping responsibilities within several central agencies. The data management role of central agencies has been that of data "stewards" for large homogeneous data sets (more often in paper map form rather than digital data sets). As part of their mandates, these central agencies have collected and published data on maps that were then distributed to specific agencies on request. Relationships with states have been largely limited to ad hoc or cooperative projects with the states generally taking on the role of suppliers of data to the federal agencies.

12.0 This set of traditional arrangements is undergoing change, both obvious and subtle. The activities of the central agencies have been established largely as national survey charters, and although these may be initially tied to need, it has been difficult to keep up with changing technologies and changing requirements in the surveying and mapping technologies.

Costs are difficult to identify, quantify, or control, and the government finds it increasingly difficult to maintain established programs in the face of constantly increasing pressures on the federal budget. Finally, programs of spatial data creation have often been slow and inadequately funded for data maintenance. As a result, data are often so out of date that their value is seriously compromised. Further, the national agencies have yet to take on the process of format conversion of their data holdings in a digital format – that would make it amenable to better distribution and generation of commerce. The establishment of a NSDI would bring about a thrusted change of these traditional values and provide a new direction of contribution of each of these agencies to a "national resource".

13.0 Public access to spatial information is also a concern. Most government agencies do not have public access mandates. Developmental activities are no more the domain of government agencies. Private sector and NGOs are equally involved in developmental activities, specifically after the liberalization of the economy when large investments from private sector are being done for power, roads, communications, mining, petroleum etc. Further, as developmental activities are not to be considered as restricted to smaller areas and also cannot be "pinned" to locations, information for all areas must be accessible. The "non-access" of spatial information to the private sector is yet another major concern. Private companies see public access as a way to generate a revenue stream and also to generate a market for value-added products.

14.0 There are also major programmes of GIS databases that have been taken up and are a right step towards NSDI. Some of these efforts include:

14.1 **National (Natural) Resources Information System (NRIS)** of the National Natural Resources Management System (NNRMS) – for which the Department of Space (DOS) is the nodal agency. Establishment of National (Natural) Resources Information System (NRIS) is a critical element of the operationalisation of the National Natural Resources Management System (NNRMS). NNRMS aims to contribute to the optimal management of the nation's natural resources and support an environmentally benign sustainable development. Through NRIS, NNRMS enables the availability of a national inventory of natural resources information in spatial formats and with proper linkages to other socio-economic data within a framework of a smart information system to enable customized

retrieval and analysis of data for specific needs. The NRIS is visualized to be a network of GIS based Nodes covering data/information for districts, aggregated through states to the whole country. These Nodes will be the repositories of natural resource information and will assimilate other tabular socio-economic data, thus providing vital inputs to decision making at district/state/central levels – specifically in spatial and tabular formats. NRIS would cover the entire country in a phased manner – building from districts, through states and the entire country. The use of NRIS has been made by district and state authorities for Watershed Development Planning; District Plan Generation; Amenities (schools, hospitals and so on) planning and Facilities location in districts; Environmental Impact Analysis; Land Capability and Land Irrigability Analysis; State Plan Generation; Landuse Change Analysis; Monitoring of Developmental Programmes; Spatial representation of non-spatial data of demography, occupation structure and Index Analysis of Development at village/taluk level. NRIS has been established in many districts and states already. Yet another major achievement of NRIS has been the "NRIS Standard" - a content and design Standards that has become a de-facto national GIS standard and including about 22 layers of spatial information and about 8 items of non-spatial attributes at village-level. NRIS is now available for 30 districts in 17 states on 1:50000 scale and for 4 states fully on 1:250000 scale. The NRIS is being expanded to cover all states in a phased manner. **ANNEXURE-I** shows in summary the concept and achievements of NRIS. NRIS will become a part of the NSDI by enabling a national network of GIS based information systems at local, states and national level on key parameters of natural resources management.

14.2 **Digital Cartographic Data Base (DCDB) of SOI:** Survey of India has completed the creation of DCDB with the maps on scale 1:250,000 as input. This data is also available in the National Standard Exchange Format for Digital Vector Data (DVD). SOI has presently engaged in the task of completing digitization of maps on scale 1:50,000. Recently, Ministry of Defence (MOD) has authorized DST to have a separate series of maps on WGS-84 for the civilian use. Once SOI completes the project of determining the transformation parameters between WGS-84 and Everest spheroids, it will be possibleto convert the digital map data on Everest to

WGS-84 easily. This initiative will help in users obtaining data pertaining to any part of the country with out any restriction.

14.3 **Natural Resources Data Management System (NRDMS)** is a multi-disciplinary and multi-institutional program launched by the Department of Science and Technology, Government of India, for developing a scientifically proven database approach for operationalising the concept of micro-level planning. Major objectives of the programme include development of integrated district level resource databases on natural resources and allied sectors, research and software support for spatial data management technology, modelling and operation research, demonstration of the utility and use of the databases and spatial data management tools in local level planning, and development of Spatial Decision Support Systems (SDSS) in different sectors of integrated rural development. Thirty-three district GIS Centres have been set up in different states in collaboration with concerned state governments. The state of Karnataka is being covered in entirety to demonstrate the efficacy of the methodology on a statewide scale with the establishment of one State center and thirteen district centers in the first phase. The databases contain data on natural resources, demography, socio-economy, agro-economy, and infrastructure with village as the unit. Preparation and updation of the databases by collating the available data sets from the different sources like Survey of India (SOI), National Atlas & Thematic Mapping Organization (NATMO), National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Geological Survey of India (GSI), Central Ground Water Board (CGWB), Census of India, India Meteorological Department (IMD), state and district level line departments are the main activities at the district GIS Centres. The databases are used to develop spatial decision support systems in selected sectors relevant to integrated rural development planning viz. water management, land use planning, energy budgeting, and infrastructure development. An indigenously developed GIS package, Geo Referenced Area Management (GRAM++) on Windows 95/NT platform has been developed under the programme for organising district level databases and subsequent information generation through spatial analysis and modelling. Application studies are supported under NRDMS in prioritized research areas like land & water system analysis, spatial data management technologies, micro wave remote

sensing, disaster mitigation, ground water modelling, ecological modelling to upgrade the methodology. To facilitate use and analysis of spatial data sets stored in the district level GIS databases, metadata standards have been defined.

15.0 Apart from the above, there have been initiatives by many government and private sector agencies – like GSI, NBSSLUP, CWC, and FSI etc., for establishing GIS-based information systems for their thematic requirements.

3.0 NEED FOR A NSDI

16.0 The nation today needs a NSDI much more than at any time. There are 2 major imperatives that drive the country towards establishing the NSDI:

16.1 Enable the establishment of a national repository of a digital "warehouse" of the national map data holdings

16.2 Facilitate Sharing and access to the digital spatial information

17.0 Use of spatial information for resource management and decision-making is limited only by the imagination on how to combine the different data sets. Many a times new ideas create the need for even more data so as to achieve the end goals. This has been matched by a significant increase in the information retrieval capabilities of the GIS. It is because of this fact that GIS's are now becoming widely popular and are being used for a wide range of applications - natural resources management, wasteland development, watershed development, urban management, coastal management, utilities management, infrastructure development, business development etc.

18.0 Current and accurate spatial data must be readily available to contribute to local, state and national development and contribute to economic growth, environmental quality and stability, and social progress. This would be best achieved by making accurate and timely spatial data readily available to support sound decisions over a geographic area and to do so with minimum duplication of effort and at a reasonable cost. Establishment of a NSDI to support efficient production, easy access to and shared use of accurate, high quality spatial data to meet national needs is an urgent national requirement. NSDI will ultimately emerge as a major driver for impetus to development activities and also enable the emergence of an information business sector that will promote economics and commerce activities.

19.0 As a national infrastructure, NSDI will have the potential to serve as a "one-stop" source of spatial information and the "mining" of these GIS layers from the NSDI would be the major source for all GIS activities in support of sustainable development and economic growth.

20.0 A NSDI would enable the following:

20.1 **Towards a Spatial Society - Synergy of information, technology and access**. In the near term, technology development will continue to have profound effects on spatial information activities, as we are seeing it today – the changing demand of computing technology to understanding processes around us and its representation as maps. In the longer term, information needs will drive further technological developments – creating stringent demands for technology solutions for spatial data capture, integration and representation. The emergence of Spatial Business from the highly volatile and dynamic synergy of information, technology and access will see a truly Spatial Society.

20.2 **Expanding information inter-dependence**. The nationalization of spatial information will be yet another imperative. Markets will define and drive the need and use of spatial information for individuals, society, nation and the world as a whole.

20.3 **Increasing emphasis on sustainability**. The fundamental aspect of sustainable development lies in the paradigm of scientific innovation and economic determinism within the physical limits imposed by ecological systems on economic activity. The need is for a full integration of environmental and developmental information for decision-making on economic, social, and fiscal, exploitation and regeneration of natural resources and other policies.

20.4 **Emergence of community based governance**. Greater people's involvement in developmental planning at local level and the emergence of participatory planning will demand access to spatial information – basically integrating information from disparate sources. To an increasing degree, the use of spatial information will become commonly used tools for developmental alternatives and societal choices for decision-making.

20.5 **Benefits to the individual**. Individuals demand for information – spatial and non-spatial will force the establishment of infrastructures, encompassing his immediate circle of family and society, the land that he tills, the water that he uses, the environment around him and to a larger extent the general awareness of the world.

21.0 What would be the "utilisation" drivers for the NSDI? Some of the major uses of the NSDI would be:

21.1 Support to planning and development activities – specially the management of natural resources, disaster management, watershed management/development, district planning, state planning, resources monitoring, rural development, Land capability Analysis; Optimal landuse Planning; Water Resources Development; Agricultural Development; Irrigation planning; Watershed Development; Wasteland Development settlement hierarchy, facilities planning etc. Government would find use of NSDI to prepare spatial plans for the whole country - annual plans, five-year plans, perspective plans; inventory of natural resources and changes; for quick assessment of damages during natural calamities and disasters and monitoring and evaluating the various governmental policies and programs.

21.2 Information bases for infrastructure development in the country – specially the road, telecom, water distribution, sewerage management and so on. The NSDI would provide the base information for addressing issues related to landuse, environment, land acquisition, visibility and line of sight, costs of projects etc.

21.3 Business GIS which will be towards supporting the use of GIS databases to further business opportunities and enable spatial data commerce.

21.4 Universities involved in GIS Research, Education and Training will utilize the NSDI for undertaking specific research of global and national issues; impart GIS education with case studies and practical hands-on training.

21.5 Info-Savvy Communities who would have spatial information access and bring in transparency in governance and insurance against discrimination and exploitation.

4.0 PROPOSED FRAMEWORK OF NSDI

22.0 The NSDI would aim to have a de-centralized approach to:

22.1 Develop and maintain Standard digital collections of spatial data

22.2 Develop common solutions for discovery, access, and use of spatial data in response to the needs of diverse user groups

22.3 Build relationships among organizations to support the continuing development of the NSDI

22.4 Increase the awareness and understanding of the vision, concepts, and benefits of the NSDI

23.0 The NSDI will be an over-arching framework over existing agency-efforts at spatial information generation and format conversion. However, NSDI will bring about standardization to the total process of format conversion, access and inter-operability. The NSDI should have the authority to mandate contributing agencies to commit their map data holdings to the NSDI. NSDI must also have the authority to bring about newer data generation, as and when need is felt, by the data generation agencies and make them committed to NSDI. This can be achieved only after attaining the consensus of all concerned.

4.1 NSDI CONTENTS

24.0 The urgent need is to encapsulate the national holdings of spatial data in digital format so that a national repository of the map information is available. The digital infrastructure would also enable greater sharing and better access to high quality spatial data and would also improve the well being of our communities. Responsible stewardship of our natural resources for sustainable development depends on making sound scientific information available to local decision makers. Quality of life in a free society is determined by the collective decisions of its individual citizens acting in the home, the workplace, and together as members of the community and these decisions requires the foundation of information, of which spatial information would be a major element. Collective decisions cannot be arrived at in a vacuum.

25.0 To start with, the rich collection of spatial data available in the country should form the foundation data for NSDI, as shown in **FIGURE- 4.1**

25.1 National coverage of topographical maps on scales of 1:250000, 1:50000 and 1:25000 and any other data of the Survey of India (SOI) toposheets

25.2 National coverage of geological maps on 1:50000 scale and other maps/ data of the Geological Survey of India (GSI)

25.3 National coverage of soil maps on 1:250000 and 1:50000 scales and other maps/data of the National Bureau of Soil Survey and Landuse Planning (NBSSLUP)

25.4 National coverage of forest maps on 1:50000 scale of the Forest Survey of India (FSI)

25.5 National coverage of the hydrology maps on all scales of the Central Ground Water Board (CGWB)

25.6 National coverage of landuse maps on 1:50000 scale; wasteland maps on 1:50000 scale; urban maps on 1:50000 scale; ground water potential maps on 1:50000 scale and other thematic maps of National Remote Sensing Agency (NRSA);

25.7 NRIS Nodes of the NNRMS Programme involving District and State Natural Resources databases on 1:50000 scales;

25.8 Command area maps of Central Water Commission (CWC)

25.9 National coverage of coastal landuse maps on 1:50000 and 1:25000 scale of Ministry of Environment and Forests (MoEnF)

25.10 Census maps and census data of the Census Department

25.11 NATMOs national atlases on 1:1000000 and other scales

25.12 National coverage of Satellite images of different resolutions

25.13 Hydrographic data of the National Hydrographic Department

25.14 To this set of basic data, addition of India Meteorological Department's weather information and Department of Ocean Development's Ocean information (at smaller scales) could also be added.

25.15 Non-spatial data of the Bureau of Economics and Statistics, National Council for Applied Economic Research etc – which could be linked to the spatial features and become a part of the NSDI.

26.0 The above is only illustrative and not exhaustive list of known agencies providing data of relevance to proposed NSDI. The NSDI would get augmented with organs of the State Governments and then in turn by non-governmental agencies – with which data may be available in various forms. Data resources of various agencies have to be studied in detail and mechanisms should be available for ensuring that this data, whenever relevant, becomes part of the NSDI.

27.0 The NSDI would evolve and expand with the participation of committing agencies and it is envisaged that SOI, NRSA, GSI, FSI, CGWB, NNRMS/ NRIS, CWC, MoEnF, NATMO, NBSSLUP, CGWB, Census department, IMD, DOD, BES, NCAER etc would be the first committed agencies to the NSDI. Each agency would commit to establish a GIS database server as a NSDI Node. The NSDI would enable development of new relationships that allow organizations and individuals from all sectors to work together to share spatial data. **FIGURE – 4.2** shows the overall framework of NSDI.

28.0 As brought out in the foregoing, there are now a large number of organizations engaged in collection and collation of data for development and planning who follow varying methods for tackling similar problems. The solutions that emerge are often confusing and at times quite contradictory. There is thus a need for standardization of an information system, which addresses major issues for sustainable development. The system should be able to handle the tasks of recording, managing designing and developing a central authority to collect and manage data and thus provide an information which is at once authoritative and reliable.

29.0 Data sets obtained from NSDI are tailored to meet the specific needs of users. It is necessary, therefore to enumerate clear-cut policies and devise strategies to implement these policies. Major constraints in developing such an infrastructure revolve around the initiative and ability of the Government to establish a platform for consideration of activities of different organizations, formulating policies and towards creation of a co-ordinating body. All the efforts of the Government in the field standardization will be meaningful in case it is made obligatory on private and semi-Government institutions to accept and use the same. At present due to absence of efforts in the desired direction, many organizations with minimum available wherewithal are in the process of creating their own data standards. This can only lead to a chaotic situation.

4.2 NSDI – DESIGN ELEMENTS

30.0 The NSDI elements, as illustrated in **FIGURE- 4.3**, would be:

30.1 A **NSDI Standard** – defined and agreed to national agencies and defining content and schemas, design and process, network protocols, exchange and transfer. Standards are the crux of the NSDI and would be of relevance to database standardization - formats, exchange and interoperability; Networks-gateways and protocols;

communication equipment, software standards, etc. Standards enable applications and technology to work together. Tools, applications, and data affect each other, and processes for developing standards must consider these interactions.

30.2 A **NSDI Metadata** of the NSDI content and information availability. The NSDI Metadata would get evolved from the NSDI Standard and as digital spatial information is populated. As a part of NSDI, one of the critical steps would be the development of a metadata standard and development of metadata files.

30.3 **NSDI Nodes** and GIS servers of the actual spatial information – in conformity of the NSDI Standard. The NSDI Nodes would be mainly GIS based spatial databases and development oriented information systems servers - all integrated and linked to basic spatial/ geographic units. The value of NSDI would be to aid as a decision-making tool and more in the context of assisting planning for developmental activities.

30.4 **NSDI Search and Access Protocols** that would enable search and location of spatial information. The protocols would provide the gateway for users to access NSDI. The basic issue in the operation of the NSDI is the backbone on which the information travels from one point to another. The backbone carrier will be high-speed carrier capable of providing bandwidth on demand to intermediate levels of the NSDI and to users of the NSDI.

30.5 **NSDI Electronic Clearinghouse**. The NSDI Clearinghouse would be the mechanism to provide access to the metadata and finally to the actual data sets. The clearinghouse has to have systems to authenticate data requests and requests spatial data volumes are usually large and download through networks may not be feasible. In such cases, the system should be able to generate media bearing the requested data for transmission by mail. The clearinghouse should also store information about the applications and availability of application specific modules that could be reused by other users. The clearinghouse would use the NSDI Search and access Protocols engines to look for and discover data and information.

30.6 **NSDI User Interface** that would be the front-end interface for user queries and access of spatial information. With regard to design of NSDI much depends upon the level of penetration and upper-end level of applications and services available on it. For a completely ubiquitous NSDI, the penetration will have to reach public domain and the capabilities will include online access of information applications.

30.7 **NSDI Outreach and Awareness** programme so as to increase the public and professional use of NSDI services and encourage e-governance concepts.

31.0 The NSDI will open up tremendous opportunities for development of Application Shells using NSDI data and will be a major value-addition activity – which though not visualized as part of NSDI is the "ultimate" goal of the NSDI. It is envisaged that a separate activity of value-added services would emerge with private sector having tremendous opportunities to contribute to this. These modules would use region specific models to generate scenarios for decision support. These models would, hopefully, cater to all clients who could range from government functionaries to individuals.

4.2.1 THE NSDI STANDARD

32.0 The NSDI requires a major effort at standardizing content and schemas, design and process, network protocols, exchange and transfer. The standardization has enabled "user transparency" to information access. The NSDI Standards will evolve and grow as more and more agencies commit and access the NSDI Nodes.

33.0 The definition of the spatial framework will be very crucial in the NSDI Standard and it is important that this be decided upon in the beginning. In its simplest form, it is a frame of latitudes and longitudes with intermediate tic marks aimed at providing an invariant reference for all spatial data sets. However, most users need some basic references. Thus, it also can include ortho-rectified imagery, elevation, bathymetry, geodetic control, transportation, administrative boundaries, etc. All data has to be registered to this framework so that they can be related to each other. The framework must meet the mapping accuracy desired by the applications. The choice of the geoid and the projection systems has a bearing on the accuracy. Further, the accuracy is also a function of the scale of mapping. In India, we have the advantage of having an excellent cartographic database in

the Survey of India topographic sheets. These are based on the Everest spheroid and Polyconic and Lambert Conformal Conical projections. The framework of this system is ideally suited for providing the structure for a spatial database. In addition, the large-scale databases at 1:10,000 or larger scales will be on a cadastral map base – which uses using local projections. Interlinkage of these maps with the spatial framework is an involved task and no standardized procedures exist. With the increased use of Remote Sensing for thematic mapping, such inter-linkages are essential and hence this is an area in need of urgent attention.

34.0 The NSDI Standard would have to be developed and should cover:

34.1 Content standardization – the layers, attributes and schemas that will populate a NSDI Node.

34.1.1 Each NSDI-Node agency will have to develop its own thematic content standard – GSI for geology maps; FSI for forest maps; NRSA for satellite images and thematic maps; SOI for topographical maps and so on.

34.2 Design and Process standardization – the GIS database design encompassing issues of co-ordinate systems, projections, accuracies of databases, attribute schema forms etc. Further the database creation process standardization – the process and mechanics of actual database creation through manual digitization, scanning, keyboard entry of attributes and attribute file assimilation will also have to be developed.

34.3 Network Protocols Standards – for linking the NSDI Node servers and their inter-server communications.

34.4 Exchange and Transfer Standard – file formats for the exchange of spatial information from and to NSDI Nodes and defining output formats for user access.

34.5 NSDI Quality Standards – the quality evaluation parameters and procedures for verification and quality certification of the NSDI content.

35.0 In India, we have two standards: the NRIS Standards and the SOI DVD standard. The former is a content-based specification while the latter

addresses the data exchange issues. An attempt has been made to merge the two to form a single content cum transfer specification. These are the first steps in the direction of evolving a national standard for India.

36.0 NSDI will work with different agencies, national and international, towards establishing systematic procedures that will enable each agency to undertake standard quality audits on their spatial data. Each committing agency must declare a "Quality Certification" of their spatial data and may adopt a self-certification and quality-audit process according to the NSDI-Quality Standards. It is only after certification and audit reports are made available that the spatial data form a part of NSDI.

4.2.2 THE NSDI SERVERS

37.0 The NSDI will be a set of GIS database servers – one NSDI Node for each participating agency. Thus, the NSDI will have Nodes for GSI for geological data; SOI for topographical data: NRSA for satellite images and thematic data; NRIS for natural resources management and development data; NBSSLUP for soil data and so on. Each NSDI agency will maintain its own Node as part of an Intranet and link to the "master" NSDI server.

38.0 The NSDI organization needs to ensure the following:

38.1 A flexibility in the design to adapt to the needs of different users.

38.2 A system of validation checks to maintain the integrity and consistency of the data elements.

38.3 A level of security for minimizing damage to the data.

38.4 Minimizing redundancy in data storage.

39.0 The NSDI design would also define a comprehensive framework of the database and allow the database to be viewed in its entirety so that interaction and linkages between elements can be pre-defined and evaluated. The design would also permit identification of potential bottlenecks and problem areas so that design alternatives can be considered. The design would also help in identification of the essential and correct data elements to be incorporated into the database and filter out irrelevant data. The specification of the NSDI database, in terms of

the content, tolerances and accuracies, procedure for creation etc. This design sets out the logical structure of the database elements and is also independent of the commercial GIS packages. Hopefully, the commercial GIS packages would provide gateway solutions for interfacing their packages to NSDI Standards and NSDI would work with the GIS vendors to enable this.

40.0 It is also necessary to look into aspects of Data Warehousing and related Data Mining technologies to fully utilize the enormous amount of data that is likely to be part of the NSDI. While the granularity of the data can be quite high, the data volumes would also be very high. One could use the concepts of Data Marts and Data Warehouses.

41.0 Definition of updation procedures could also be a part of the design activity so that newer data can be incorporated in future and the database is "active".

4.2.3 THE NSDI GATEWAY AND INTRANET

42.0 Each of the NSDI Node will be on an Intranet – ensuring full security and "closed-user" access. The NSDI nodes would be linked to the master NSDI Server – which will serve as the Gateway on the Internet for the NSDI Intranet Nodes and will host the NSDI Metadata. The NSDI Master Server will also perform the role of the NSDI Electronic Clearinghouse and will "direct" access to appropriate NSDI Nodes based on access protocols.

43.0 The NSDI Gateway would be a web domain name (maybe, www.nsdi.gov.in) with individual Nodes linked to the NSDI domain.

44.0 Traffic on the NSDI is expected to be "asynchronous" with user queries of low-density and return "service" from the Nodes to the user being high-density spatial information. The NSDI Gateway on the wide area protocol and the NSDI Intranet would require sufficient bandwidth of a communication backbone. Traffic-hits on the NSDI would grow slowly and would require design of network architecture using both terrestrial and VSAT links.

4.2.4 NSDI SEARCH AND ACCESS PROTOCOLS

45.0 Support of discovery and access service for spatial information in NSDI would depend upon development of a "Search service". The search engines

to look for and discover data and information could adopt the Z39.90 standard (internationally adopted by spatial data infrastructures) that allows software and system independent search. Further integration of these services with web mapping, live access to spatial information, and additional services can lead to exciting user environments in which data can be discovered, evaluated, fused, and used in problem-solving. The Catalog Gateway and its user interface allow a user to query distributed collections of spatial information through their metadata descriptions. **FIGURE- 4.4** shows the possible framework for NSDI Search and Access.

46.0 A user interested in locating spatial information uses a search user interface, fills out a search form, specifying queries for data with certain properties. The search request is passed to the Catalog Gateway and poses the query of one or more registered catalog servers. Each catalog server manages a collection of metadata entries. Within the metadata entries there are instructions on how to access the spatial data being described. There are a variety of user interfaces available in this type of Catalog search in various national and regional SDIs around the world. Interoperable search across international Catalogs can be achieved through use of a common descriptive vocabulary (metadata), a common search and retrieval protocol, and a registration system for servers of metadata collections.

47.0 NSDI must adopt the web browser for display and interface of queries. NSDI mapping on the Web will include the presentation of general purpose maps to display locations and geographic backdrops, as well as more sophisticated interactive and customizable mapping tools. The intention of online or Web Mapping is to portray spatial information quickly and easily for most users, requiring only map reading skills. Web mapping services can be discovered through online directories that serve both spatial data (through metadata) and services information. In fact, web mapping services are often used to assist users in spatial search systems, showing geographic context and extent of relevant data against base map reference data.

48.0 Web based mapping would provide the functionality to NSDI to help discover and visualize spatial information referenced from Catalog Servers. A Catalog Service System is implemented through Internet-based software that allows users to inventory, advertise, and access metadata and associated spatial information within a global framework of servers and also to discover data and web mapping services and then requesting and displaying maps from different servers.

49.0 Access rules will define the restrictions and categorization of users to spatial information. In addition, the access rules could also define pricing rules and ember e-commerce protocols for users to access the NSDI nodes.

50.0 Access to NSDI spatial data from the users point of view is a part of a process of that goes from discovery to evaluation, to access and finally to exploitation. Access involves the order, packaging and delivery, offline or online, of the data (coordinate and attributes according to the form of the data) specified.

4.2.5 NSDI ELECTRONIC CLEARINGHOUSE

51.0 Implementations of NSDI access services will be through the NSDI Electronic Clearinghouse. The clearinghouse has to have systems to authenticate data requests and requesters. Where the data is priced, the clearinghouse must provide the necessary order forms or secure transaction gateways. Spatial data volumes are usually large and download through Internet may not be feasible. In such cases, the system should be able to generate media bearing the requested data for transmission by mail. The clearinghouse should also store information about the applications and availability of application specific modules that could be reused by other users. Metadata engines which allow the user to query the data set and select records from the actual data is an area of research. Such engines are present in the background of any DBMS but they do not have the capability of distributed processing over the Web.

52.0 The sub-elements of the Clearinghouse activities would have to include the following:

52.1 Offline (e.g. packaging and physical delivery of data sets in either hardcopy or softcopy)

52.2 Direct to datastore (e.g. soft goods delivery via ftp, specified via e-commerce order request)

52.3 Brokered - provide specification of data access request to secondary (online or offline) access service

52.4 Online data service (e.g. state request/response access protocol to data warehouse) supporting online operations such as - Drill down; Aggregation; Generalization

4.2.6 THE NSDI METADATA

53.0 Metadata helps people who use spatial data find the data they need and determine how best to use it. Metadata benefit the data - producing organization as well. As personnel change in an organization, un documented data may lose their value. Later workers may have little understanding of the contents and uses for a digital database and may find they can't trust results generated from these data. Lack of knowledge about other organizations data can lead to duplication of effort. It may seem burdensome to add the cost of generating metadata to the cost of data collection, but in the long run the value of the data is dependent on its documentation.

54.0 It is advised not to invent one's own standard and to build upon an internationally accepted one. The NSDI Metadata Standard; the Comité Européen de Normalisation (CEN) Pre-Standard; ISO TC 211 Standards are examples. Subtle changes from an international standard such as collapse of compound elements may be costly in the long run – making it unable to use standard metadata tools and the metadata may not be directly exchangeable or parseable by software.

55.0 There are different levels that metadata may be used for:

55.1 Search and Location - What data sets hold the sort of data of interest? This enables organizations to know and publicize what data holdings they have.

55.2 Analysis metadata - Do the identified data sets contain sufficient information to enable a sensible analysis to be made for my purposes? This is documentation to be provided with the data to ensure that others use the data correctly and wisely.

55.3 Access metadata – What is the process of obtaining and using the data that are required? This helps end users and provider organizations to effectively store, reuse, maintain and archive their data holdings.

56.0 Each of these purposes, while complementary, requires different levels of information. As such NSDI Metadata should look at their overall needs and requirements before developing the metadata systems. The important aspect is for agencies to establish their business requirements first, the content specifications second and the technology and implementation methods third.

57.0 The major elements of Metadata includes parameters on:

57.1 Identification Information - basic information about the information set.

57.2 Data Quality Information - an assessment of the quality of the data set.

57.3 Spatial Data Organization Information - the mechanism used to represent spatial information in the data set.

57.4 Spatial Reference Information - description of the reference frame for, and means of encoding, coordinates in the data set.

57.5 Entity and Attribute Information - information about the content of the data set, including the entities types and their attributes and the domains from which attribute values may be assigned.

57.6 Distribution Information - information about obtaining the data set.

57.7 Metadata Reference Information - information on the currentness of the metadata information and the responsible party.

58.0 There is a general consensus that metadata should be exchanged in Extensible Markup Language (XML) conforming to a Document Type Declaration (DTD). In the World Wide Web Consortium, there is progress on developing successor to the DTD, known as XML-Schema. Support for XML in parsing and presentation solutions is widespread on the Web and is presumed in current draft standards of the ISO TC 211 and OpenGIS specifications.

FIGURE - 4.1 : NSDI FRAMEWORK

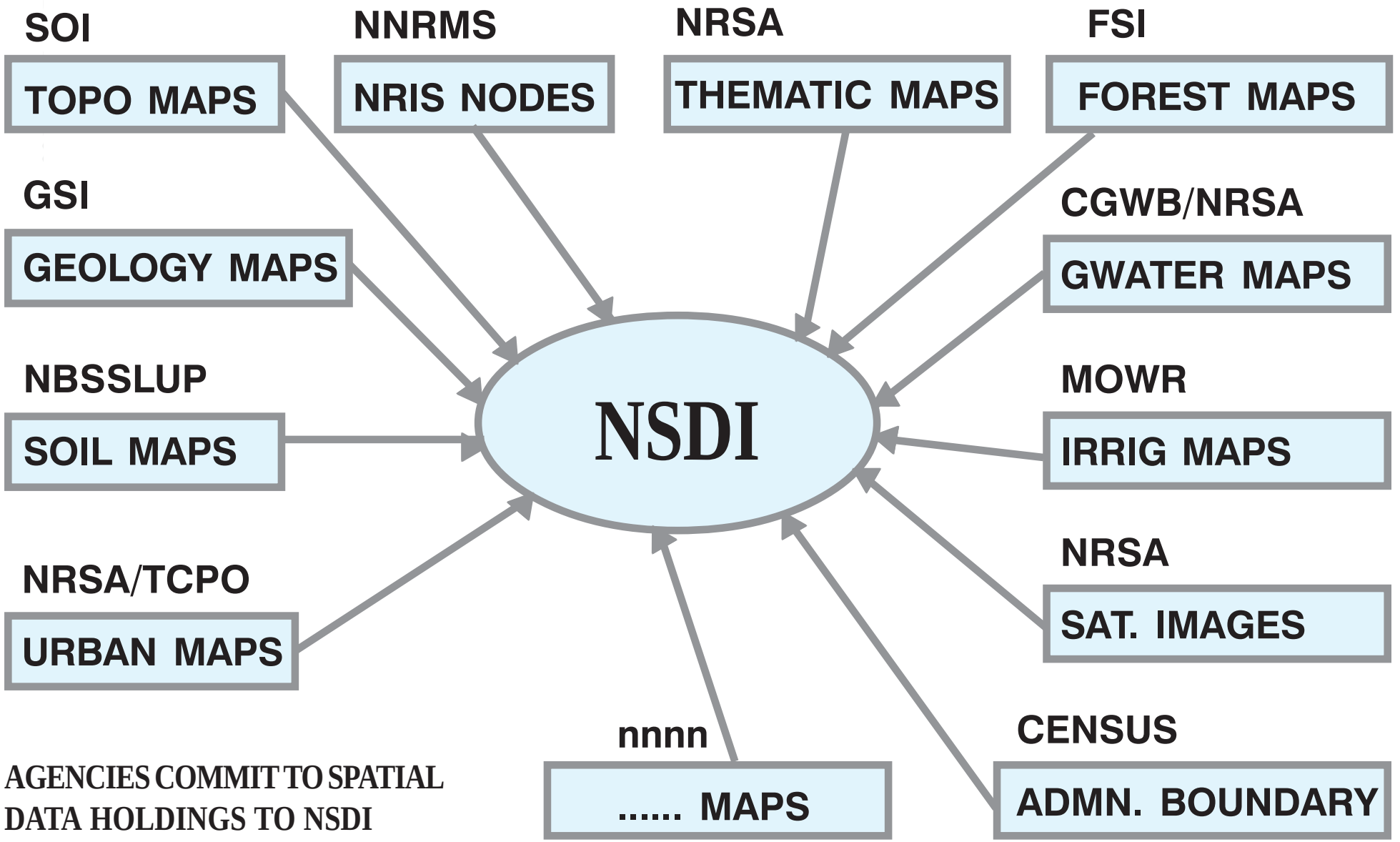
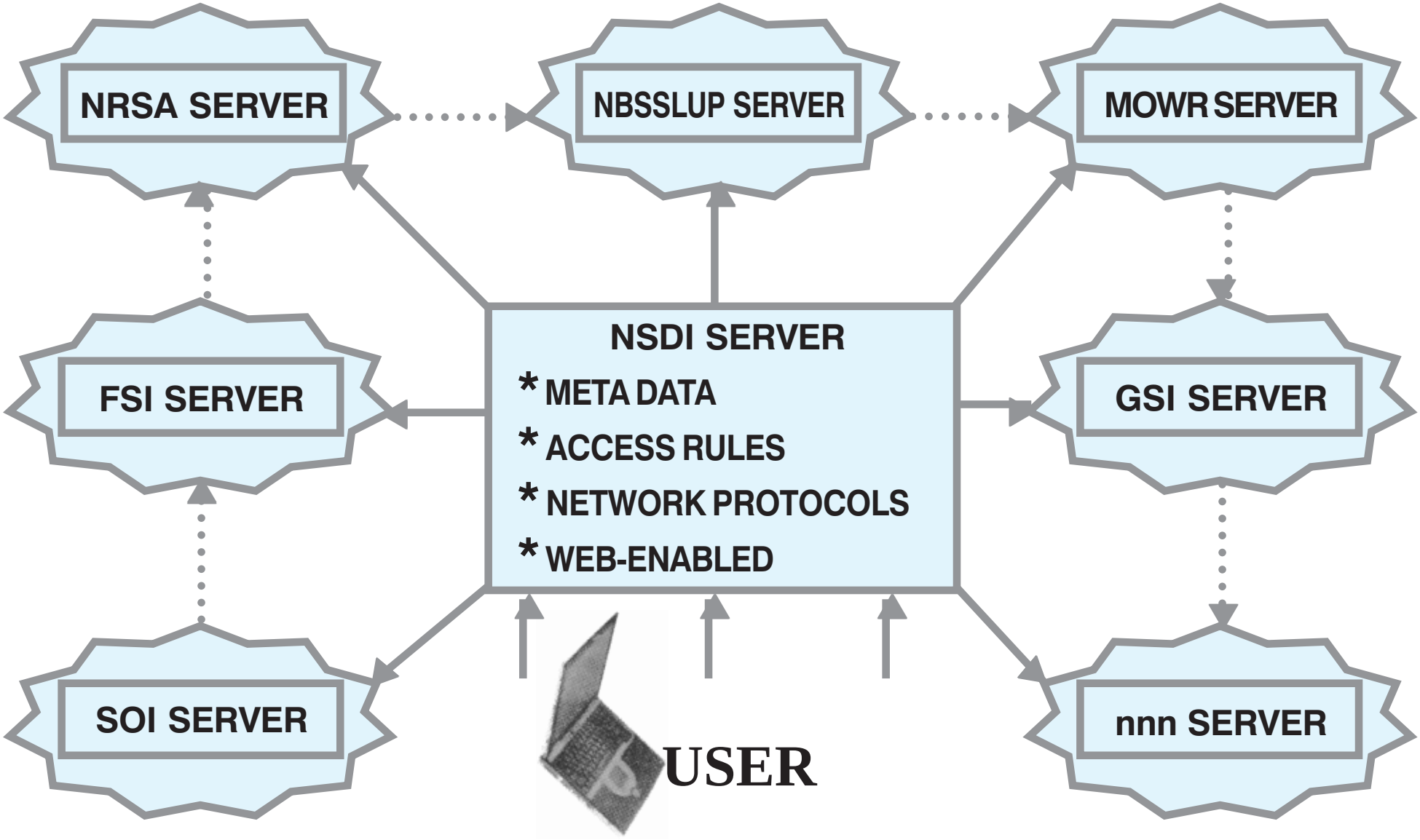


FIGURE - 4.2 : NSDI INTRANET



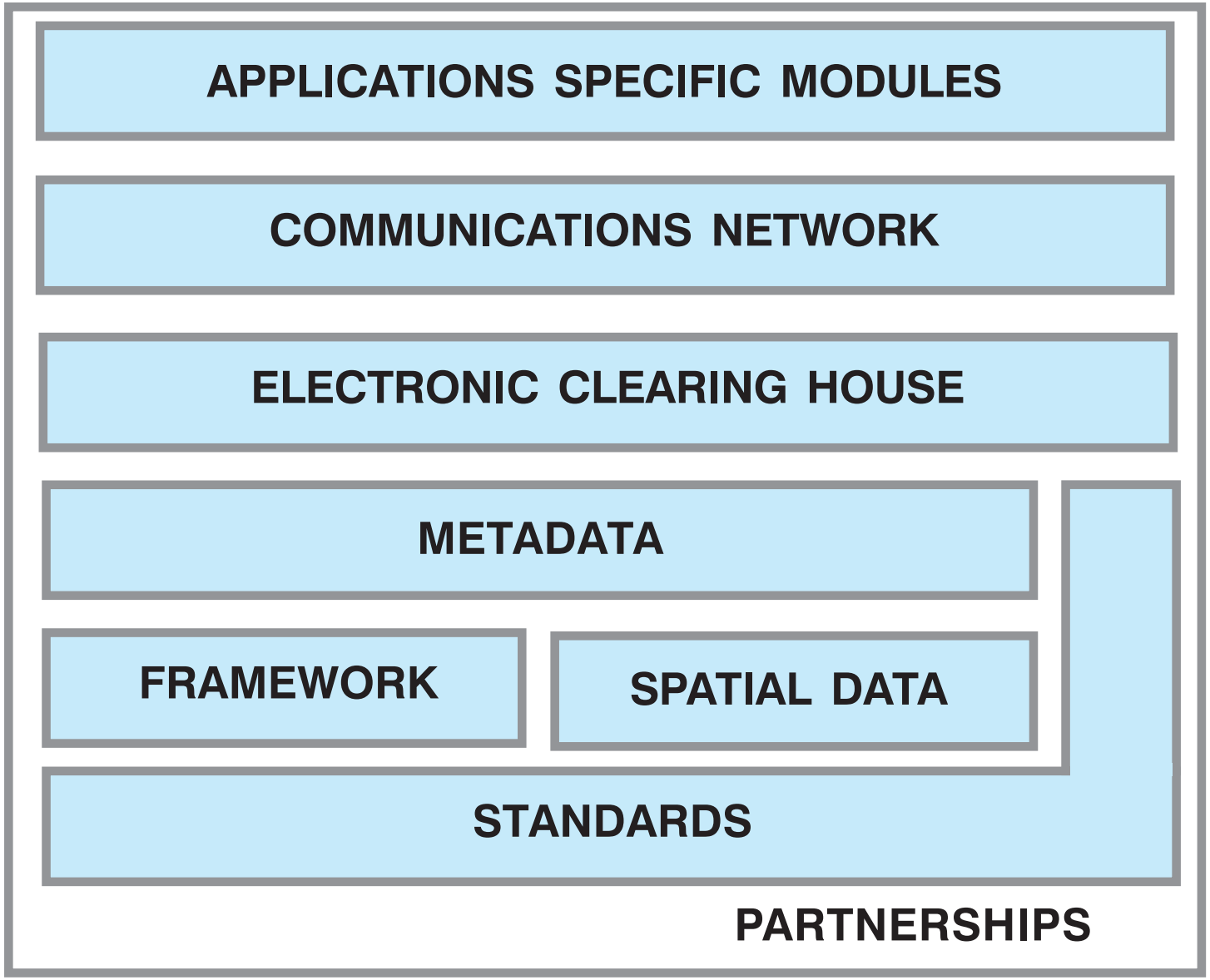
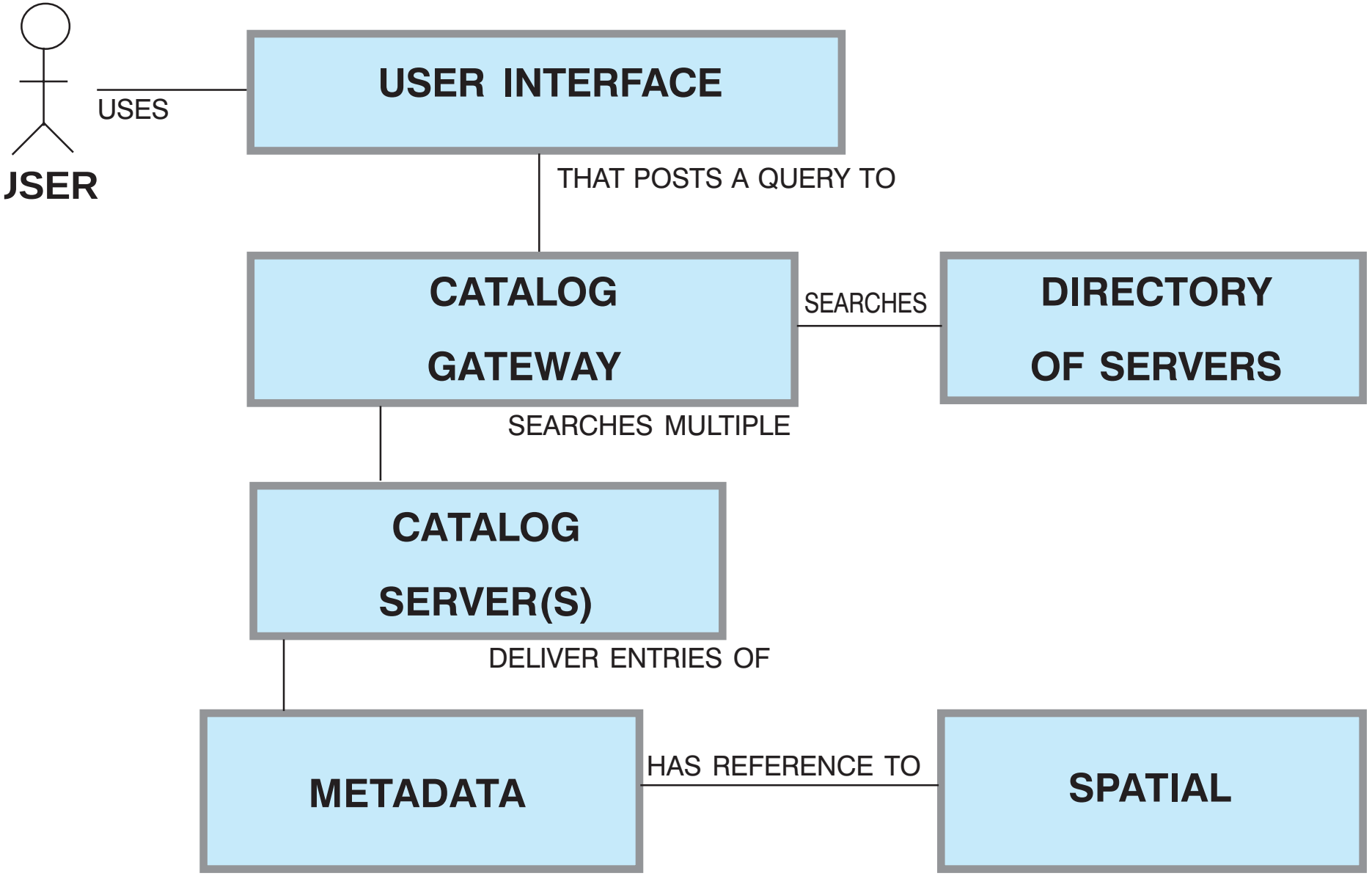


FIGURE - 4.3 : COMPONENTS OF NSDI

FIGURE - 4.4 : NSDI SEARCH AND ACCESS



5.0 ORGANISATIONAL FRAMEWORK

5.1 NSDI STAKEHOLDERS AND PARTICIPATION

59.0 The stakeholders in the NSDI will be, on one hand, the Government agencies or the spatial information generators and, on the other hand, the users of such spatial information – government, private or the public.

60.0 These are many and varied stakeholders to the NSDI and would include:

60.1 Government at local, state, national levels (as both users and data collectors/owners)
60.2 Non Government Organizations (NGOs)
60.3 Community groups
60.4 Aid/development organizations
60.5 Educational organizations and Academia
60.6 Science and environmental community
60.7 Private sector information/providers (including the value-added service providers) and end-users
60.8 Public sector agencies
60.9 Private citizens

61.0 Broadly, let us see how different stakeholder groups would participate in the NSDI:

61.1 **Government**, the major enabler, has to play the most important role for NSDI to come into existence. Aiming at transparency in Governance and conducive with the “Right to Information” tenet, Government will have to position policies and implement strategies at various levels. Government agencies will have to take the first step by enabling the NSDI Nodes to come into existence. Government will also be a major user of the NSDI – mainly for its multi-farious developmental activities and administration.

61.2 **Private Sector**, the other major Partner, will have a major role to play in contributing to the design, implementation and operations of NSDI. Not only as task-contracts for implementing NSDI and software development, the private sector will have to rise to the challenge of

"pooling resources" to make NSDI a reality. Private sector will also be major benefactors of NSDI for their own contribution to development "pooling resources" to make NSDI a reality. Private sector will also be major benefactors of NSDI for their own contribution to development and growth of business and also by generating information commerce.

61.3 **NGOs**, the outreach agencies, will be a major user community for ensuring that NSDI reaches the different rungs of Society and people access NSDI as an important information service. NGOs will also be users of NSDI for their community development programmes and societal development at grass-root levels.

61.4 **Academia and research community**, providing the research and technology development backbone for NSDI, will be yet another community participating in NSDI. Academia will also be major users of NSDI for imparting their education and training programmes and undertaking scientific research programmes.

61.5 **Individuals** will be the largest group of users of NSDI – satiating their need for accurate spatial information and also for obtaining necessary services for their activities.

5.2 NSDI ORGANISATION

62.0 As a result the NSDI structure should aspire to:

62.1 be inclusive of all stakeholders
62.2 add value
62.3 build on, facilitate and support existing initiatives
62.4 command respect and authority
62.5 support sustainable development
62.6 be flexible and adaptable to change
62.7 facilitate new initiatives especially those relating to the use and sharing of data
62.8 be as simple, transparent, open and democratic as possible
62.9 enhance decision making processes
62.10 engender partnerships

63.0 The vital enabling of the NSDI has to be done by the Government.

64.0 **FIGURE – 5.1** shows the broad organizational framework for NSDI, involving the various stakeholders.

65.0 The Government – clearly stating the possible benefits and role of different players, must adopt a **NSDI Act** – the broad statement of intent for the NSDI. The NSDI Act will also lay down guidelines for commitment by different spatial information generating agencies and cover issues of the Organizational framework, custodianship guidelines and liabilities for use etc.

66.0 As NSDI will involve various stakeholders. Considering that NSDI will be national endeavor towards transparency and e-governance, a high-level focus is essential for the NSDI activity. A **National Spatial Data Commission (NSDC)** with a senior Cabinet Minister as Chairperson, Secretaries/Senior Representatives of all committing Ministries/ Departments as Members, Representatives of different stakeholder groups and a senior Government official/eminent expert as Member Secretary be established to oversee and coordinate the inter-agency (within and outside Government) aspects of NSDI and also regulate NSDI actions within different Stakeholder groups. The NSDC will also address NSDI Policy issues and pave way for policy/guidelines positioning for NSDI to become a reality.

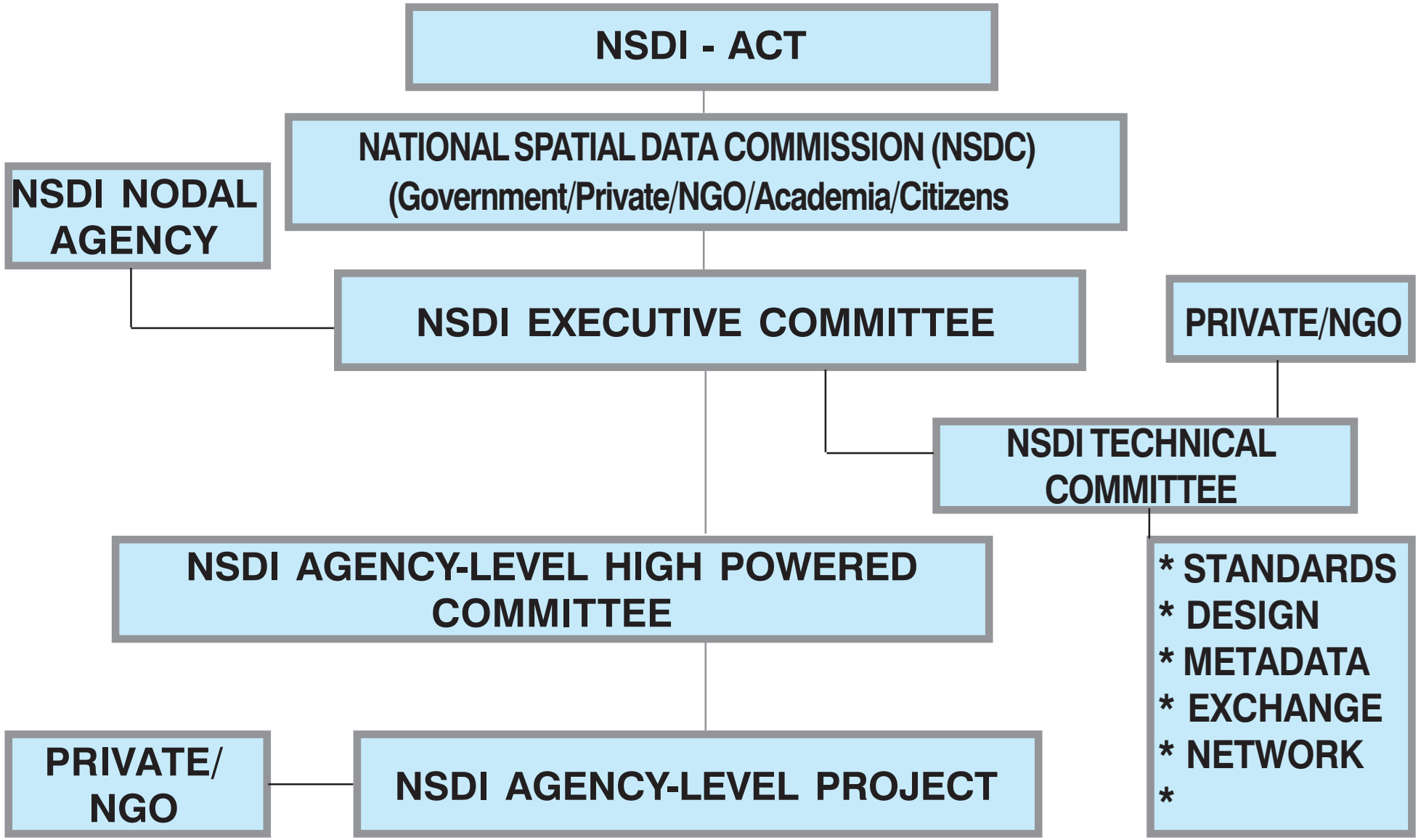
67.0 A **NSDI Executive Committee (EC)** is proposed - composed of participating Government agencies that generate spatial data and would include other stakeholder representatives. The NSDI-EC would be charged with coordinating the development of the NSDI and will be the overall technical body to oversee the implementation of the NSDI. The NSDI-EC would set up special sub-committees to address technical issues of NSDI Standard, NSDI Metadata, NSDI Intranet and so on. Government may identify a Senior Government Official/Expert to Chair the NSDI-EC.

68.0 An **NSDI-Nodal Agency (NA)** will have to be identified for the NSDI – mainly to coordinate the activities and also serve the NSDI-NGDC and NSDI-EC. The NSDI-NA would draw authority from the NSDI-Act and serve as a technical-secretariat for the NSDI, charged with the responsibility of overall coordination and operations. The NSDI-NA could be a small group of about 25 technical persons (with adequate support groups). While many national organizations like SOI, NRSA, GSI and others merit consideration to be the NSDI-NA, it is felt that the interests of the national endeavors of

NSDI would be best served if none of the "participating" agency is solely burdened with the role of the NSDI-NA. The NSDI-NA will have to have the flexibility of "authority" and must be a dynamic and IT savvy entity – having expertise in GIS and spatial data; IT and Networks; web-engines and networks and also be able to "steer" necessary policies, guidelines, standards, operations of electronic clearinghouse activities, operational procedures for NSDI stakeholders to benefit from. In view of the fact that the Department of Science and Technology has the mandate to coordinate all scientific and technological activities – especially those requiring inter-ministerial/departmental coordination, it is recommended that the DST have the nodal responsibility for NSDI. DST would establish an independent entity as the NSDI-NA. The NSDI-NA could draw experts from various stakeholders and emerge as the prime human-resource group for NSDI coordination, technologies and applications.

69.0 Each participating central agency, committing a NSDI Node, will have its own high-level **NSDI Node High Powered Committee** to address all technical and management aspects of NSDI implementation within the agency. A nodal person will be identified by the agency for the NSDI Node. Each agency will adopt its own internal finance and schedule procedures for its NSDI Node to be operational. The agency will coordinate its theme Content Standard, its NSDI Node development and NSDI Node Access rules and procedures.

FIGURE - 5.1 : NSDI - ORGANISATION



6.0 FUNDING MECHANISMS FOR NSDI

70.0 As envisaged, the implementation of NSDI (encapsulating mainly the existing spatial data holdings described earlier) would cost anywhere in the region of Rs 1000-2000 crore rupees. In addition, any new data generation and encapsulation would require additional funding – estimates of which have not been possible to make.

71.0 The NSDC will have to work out the mechanism of obtaining the finance for the NSDI – which could be a mix of options ranging from Government funding, Public-Private Partnership funding, public investments, international aid/loans etc. However, it is envisioned that Government will have to take the lead and provide the enabling mechanism for NSDC to generate the finances for NSDI. With a national commitment obtained for NSDI, each NSDI committing agency could build-up a NSDI fund base for its respective commitment.

72.0 It is also envisaged, that at an appropriate time after operationalisation of NSDI, access to NSDI could be driven by commerce. Cost recovery mechanisms could be built into the NSDI.

73.0 The NSDI-NA would have to be supported with an annual budget for its support operations to NSDI.

7.0 TOWARDS NSDI IMPLEMENTATION

.

74.0 **Positioning a pragmatic Map Policy that will address NSDI is critical and Government must enable this immediately**. The policy must also allow for digitization of maps and placing digital topographical maps on computer networks (NSDI Intranets). The Policy will have to cover access by various groups – individuals, society, private agencies, government agencies and so on.

75.0 The Task Force also noted that Government, through Ministry of Defence, Department of Space, is already considering changes in the existing Map Policy, Aerial Photographs and Satellite Images – which will enable a wider availability of these data to a wide cross-section of users. While Government after taking care of national security considerations is considering these decisions/changes, the Task Force recommends that the process be considerably accelerated to enable the positioning of NSDI at the earliest.

76.0 The Task Force would submit its report to the Government of India in February 2000 and would open the report to a larger debate and public perusal. Subsequent to this, the following actions will have to be taken for the NSDI:

76.1 Finalization of the NSDI Strategy and Action Plan. The Task Force on NSDI could do this within 6 months by involving public, private and Government debate on the NSDI.
76.2 Government approval for NSDI – with commitments from NSDI agencies
76.3 Formulation of NSDI Bill and its enactment through Parliamentary process
76.4 Constitution of NSDI-NSDC, NSDI-EC and NSDI-NA
76.5 Definition of NSDI Standards – Content, Design, Network, Exchange etc
76.6 Design and Organization of NSDI Metadata
76.7 Development of NSDI Search and Access Protocols
76.8 Establishment of NSDI Network (bandwidth and architecture)
76.9 Evolution of NSDI Nodes in phased manner by NSDI agencies. This could start with rapid conversion of legacy data (already available) as per the NSDI.

Hopefully, the development of Applications Services on NSDI would emerge parallely – with no limitation to its possible use except the visualization and imagination of the user.

77.0 At a broad estimate, it is envisaged that the NSDI would take anywhere between 5-7 years for becoming operational. But in a phased manner, the intermediate milestones could be established to showcase results.

ACKNOWLEDGEMENTS

Dr K Kasturirangan, Chairman, ISRO/Secretary, Space and Dr V Ramamurthy, Secretary, DST have been the visionary and guiding forces for the NSDI Task Force and we thank them for giving us this challenging task for defining the NSDI Strategy and also for the constant guidance.

The Task Force on NSDI would like to gratefully acknowledge the encouragement and support of a number of Government agencies, private sector agencies, NGOs and Academia experts - with whom the NSDI Task Force had detailed consultations in finalizing the NSDI Strategy and Action Plan.

The Task Force would like to place on record its deep sense of appreciation and gratitude to ISRO for leading the effort of conceptualizing, shaping and authoring the Strategy document and also for publishing the document.

The Task Force has referred to a wide variety of literature and materials on spatial data infrastructures - specially the strategy adopted by USA, Australia, Europe, the ISO documents and the Global Spatial Data Infrastructure Cookbook. Many other articles by renowned national and international experts have formed the reference materials.

The Task Force has also taken the liberty to refer to a large number of GIS project reports and documents produced by various agencies in India. These GIS reports have provided the Task Force a visualization of the GIS activities that have been taken up in India.

Though the Task Force would have liked to acknowledge all these efforts, it has had to limit this at this juncture with the schedule of opening up the Strategy document to debate in mind. Hopefully, the next version would include References, Bibliography and a List of Acronyms.

TASK FORCE ON NGDI

(Constituted by DST vide OM no. SM/31/001/2000 dated 30 Oct 2000)

Chairman
1. Lt Gen AK Ahuja, Surveyor General of India

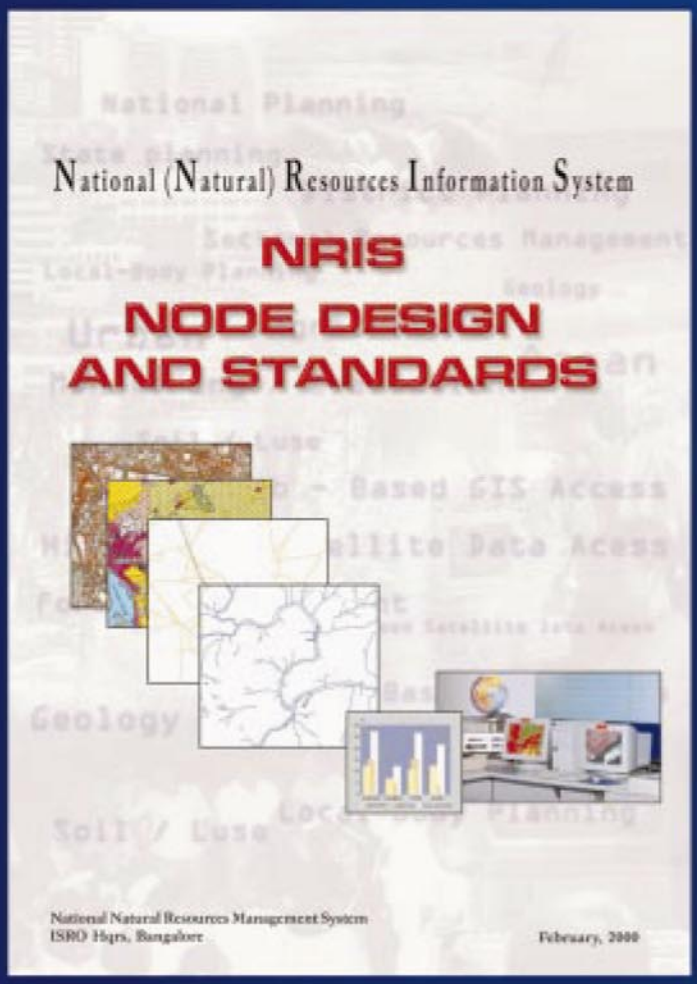
Members
2. Mr. Amitabha Pande, JS (A), DST
3. Mr. Mukund Rao, DD (T&S), EOS, ISRO HQ
4. Dr. P. Nag, Director NATMO
5. Dr. NS Virdi, Director, WIHG
6. Dr. M Velayutham, Director, NBSSLUP
7. Dr. EVR Parthasarathi, Director GSI
8. Dr JK Rawat, DG FSI
9. Dr. GD Gupta, Scientist 'G', DST
10. Mr. Sujith Haridas, EO, CII
11. Mr. Rakesh Srivastava, Director (G), MOD
12. Maj Gen AM Chaturvedi, ADG MO-GSGS, Army HQ
13. Mr. Vibhu Mushran, PSO, TIFAC
14. Brig VN Nerikar, DSG, SOI
15. Dr. Sujei M George, AGM, Tata Infotech
16. Mr. Avinash Dikshit, DS, DST
17. Dr. PS Acharya, PSO, NRDMS, DST
18. Dr. MP Narayanan, CSDMS

Member Secretary
19. Lt Col (Dr.) R Siva Kumar, Director Military Survey

Authoring Group for NSDI Strategy Document
1. Mr. Mukund Rao, DD (T&S), EOS, ISRO HQ
2. Mr. Amitabha Pande, JS (A), DST
3. Lt Col (Dr.) R Siva Kumar, Director Military Survey

Consultation Group:
1. Dr. Roddam Narasimha,Director, NIAS, Bangalore.
2. Dr. D.P. Rao, Director, NRSA
3. Mr. AKS Gopalan, Director, SAC
4. Shri K Krishnanunni, Director General, GSI
5. Shri AR Dasgupta, Deputy Director (SITA), SAC
6. Ms Manosi Lahiri, ML Infomap Private Ltd., CII Representative
7. Dr MK Munshi, Rolta India Ltd
8. Mr Rajesh Mathur, ESRI India
9. Mr. Chandrasekhar Nori, Speck Systems

National (Natural) Resources Information System



What it contains

SPATIAL DATA ON 1:50,000 SCALE

20 Primary Data

Landuse/cover map, Geomorphic units and landforms map,Rock group/lithological map, Soil map, Geological Structure map, Drainage Network map, Relief (Contour) map, Canal map, Watershed boundary map, District boundary map, Taluk boundary map, Village boundary map, Forest management/administrative boundary map, Well location map, Settlement map, Road Network map, Rail Network map, Rainfall/ temperature observation locations map, Mineral occurrence map, Lat.-Long. reference map.

17 Derived Data

Slope map, Groundwater prospects map, Composite Land development Unit map, Land capability map, Land resources development plan map, Water resources development plan map, Runoff potential map, Theissen polygon from meteorological observation points, Service Center hierarchy of settlements, Soil Irrigability map, Water quality (irrigation) map, Water quality (drinking) map, Land Irrigability map, Water body mask map, District mask map, Watershed priorities for soil conservation map, Habitation mask map.

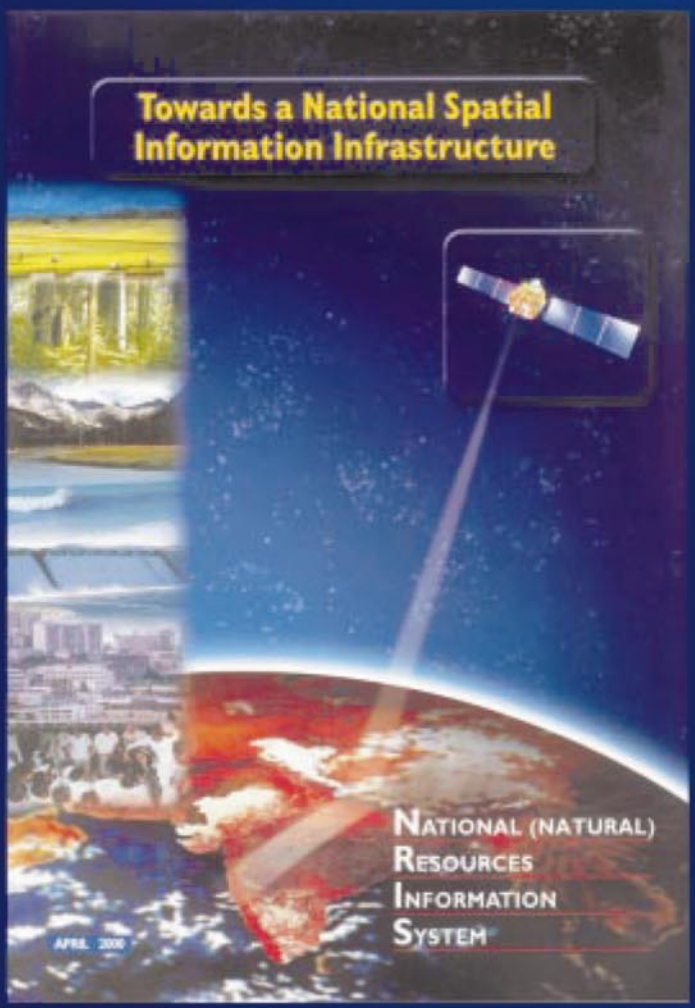
NON-SPATIAL DATA

8 Primary Data

Demography, Occupation structure, Education facilities, Medical facilities, Communication facilities, General facilities, Landuse data, Power availability data.

3 Derived Data

Composite functionality indices, Agriculture development indices, Village development indices.

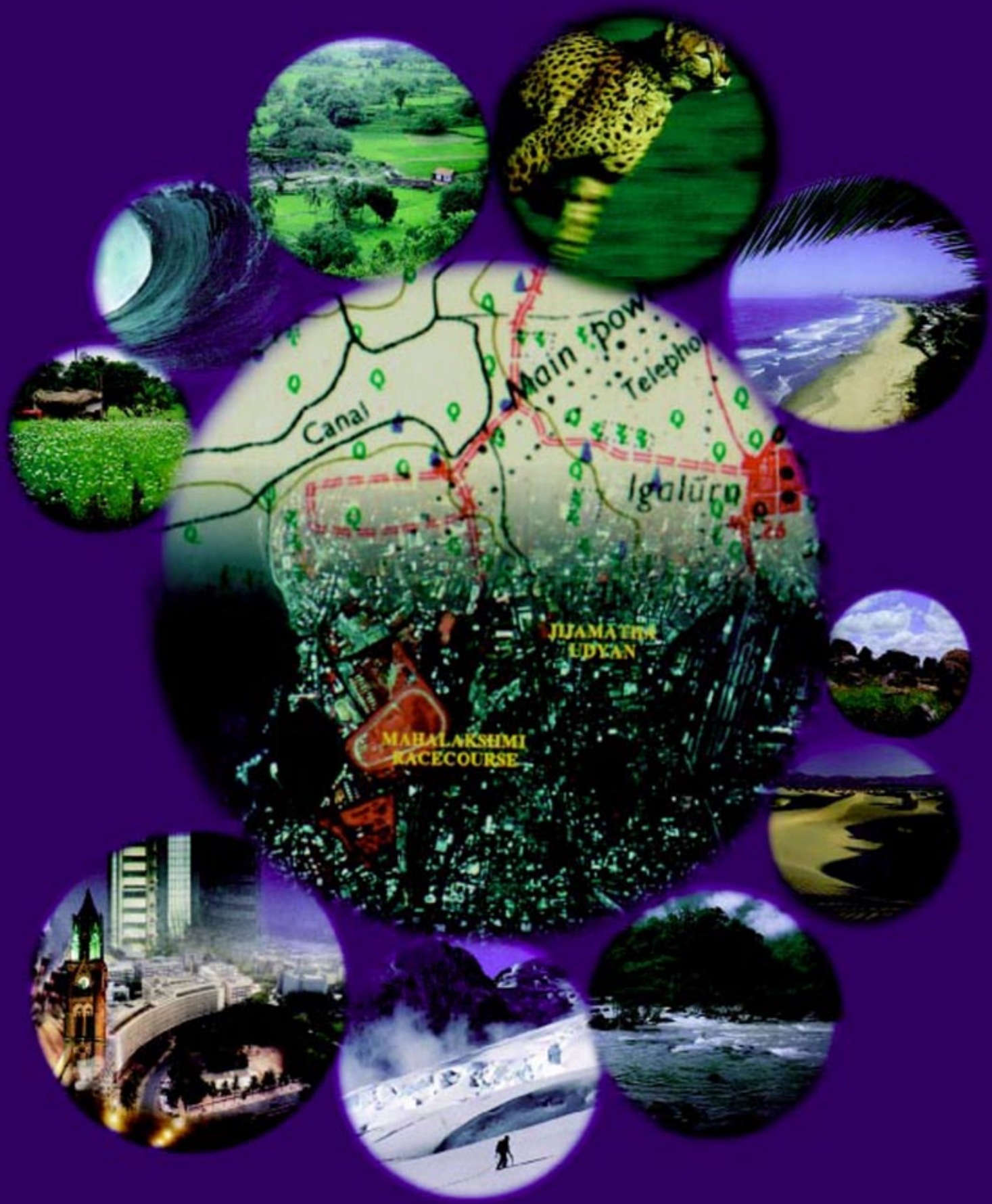


Where it is available

- Bhiwani, Gurgaon of Haryana
- Bathinda of Punjab
- Bharatpur, Dausa ,Nagaur of Rajasthan
- Panchmahals, Bhavnagar, Gandhinagar of Gujarat
- Chandrapur, Ahmednagar of Maharashtra
- Kalahandi of Orissa
- Ananthapur of Andhra Pradesh
- Bijapur of Karnataka
- Dharmapuri, Nilgiris of Tamilnadu
- Palakkad, Thrissur of Kerala
- Chamba of Himachal Pradesh
- Kamrup of Assam
- Aizwal of Mizoram
- Lalitpur, Bulandshahar of Uttar Pradesh
- Purulia, Bankura of West Bengal
- Jamui, Palamau of Bihar
- Datia, Sidhi, Jhabua of Madhya Pradesh

Also on 1:250,000 scale for the states of Gujarat, Orissa, Andhra Pradesh and Maharashtra

ANNEXURE-1



ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore - 560 094.
Website:www.isro.org