Abridged Version

INDIAN GEOSPATIAL ECONOMY REPORT

MAY 2018

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Indian Meteorological Department

Both Indian and International numbering systems have been used.
1 Crore = 10 Million = 100 Lakh

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INDIAN GEOSPATIAL ECONOMY OVERVIEW

Indian Geospatial Economy -18 is a unique exercise undertaken by Geospatial Media and Communications to address the demand for a coherent, robust and comprehensive analysis of the state of geospatial economy in India. The initiative engaged the public and private sector stakeholders across the country on various contexts and imperatives for enhanced adoption and integrated management of Geospatial information and technology solutions in their respective organization/ department and state level.

The Indian Geospatial Economy -18 aims to provide key stakeholders i.e. entrepreneurs, policy makers at state and centre, government, commercial and development users, and academia and research institutes with comparative assessment of current policies, geospatial technology and information management and governance structures, and adoption scenario at national, and state level.

The study also presents an estimate of current as well as near future (upto FY 2020-21) spread of Indian geospatial market opportunity, addressable market estimates and key action areas to enhance the overall geospatial economy size in the country. The market estimates have been presented for four technology segments, namely, earth observation (EO), GNSS and Positioning, GIS/Spatial Analytics and Scanning/Surveying. The study also presents the estimates and market opportunities in 10 application areas giving an overall perspective on directions and dimensions of the Indian geospatial sector. These 10 application areas are Rural Development and Land Administration, Infrastructure (rail, road, air, water), Urban Development, Water Resources and Irrigation, Retail and Logistics, Utilities (electricity, telecom, water, gas), Banking Financial Services and Insurance (BFSI and Taxation) and Taxation, Mining, Oil & Gas, National Geospatial Agencies (NGAs), and Education and Research.

The objective of the study is to drive the relevant stakeholders to take cognizance of the key role of geospatial policy framework in enabling appropriate structures to facilitate wider adoption and comercialization of geospatial solutions and information management for achieving the desired economic growth and developmental impacts. For the same purpose, there lies a critical need to develop an integrated approach on 'geospatial technology sector management' to harness its potential for entrepreneurship, innovative start-ups led employment and wealth creation, transforming governance and business process management and sustaining innovation led national competitiveness in the 4th industrial revolution (i.e. industry 4.0).

APPROACH AND METHODOLOGY

The research methodology for the report involved two distinct phases. **Phase-I** comprised of one day workshops, titled, 'Geospatial Strategy Forum', organized in the last quarter of 2017 in 11 states of India. The workshops provided an opportunity for the stakeholders to share and deliberate on critical need scenarios and socio-economic imperatives for planned and integrated adoption of geospatial information and technology management in context of the ongoing 4th industrial revolution.

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These workshops were delivered in partnership with the four IGE-18 study partners and technology/solution providers with complementary strengths: Trimble (devices and analytics), ESRI (GIS analytics), MapMyIndia (map content) and DigitalGlobe (satellite imagery and solutions). The four technology providers complemented the vision talk by presenting the range of examples and specific solutions on work flow level integration of geospatial information and solutions to derive organization level efficiencies and effective management gains. A total of 589 participants took part in these participatory and consensus building workshops, involving user government and industry stakeholders. The key discussion points centered on:

- → Understanding the onset of 4th industrial revolution and its constituent digital technology eco-systems such as Internet of Things (IoT), Big Data, Arificial Intelligence (AI) as key enablers of interconnected 'system of systems' in next decade and the role of geospatial technologies and information in it.
- → Critical need of fundamental maps and geodetic infrastructure in respective states to realize the vision of Digital, SMART and New-India initiatives on ground with effective integration of spatial data and information.

The research team utilized these workshops for a questionnaire-based survey, conducted pre-event and post event follow up meetings/interviews with stakeholders to elicit insights on the scale and scope of geospatial technology usage/adoption and factors affecting the overall geospatial sector development.

The **phase-II** of the study included a combination of exhaustive secondary research, e-surveys, and select one-on-one meetings with geospatial industry stakeholders, consultants and empaneled companies of various projects and application sectors, government department/initiative heads, and research institutes to know and estimate the geospatial economy size and validate the findings. These one-on-one interviews were also conducted in states where the strategy forum was not organized. Additionally, the government procurement data from FY 2014-15, FY 2015-16, FY 2016-17 and FY 2017-18* has been analyzed for estimating the geospatial adoption in India.

KEY CONTEXTS

The Indian government has undertaken a number of mission mode projects grouped under integrated initiatives like Digital India, Bharatmala, Sagarmala, Prime Minister Irrigation Scheme to achieve the 'New India Vision: 2020'. While this approach of integrated program with multiple cross cutting projects is highly commendable; a comprehensive, coordinated effort to enhance effective geospatial information technology integration into these programs is very much required. Despite, India's long history of topographic survey/mapping, globally acknowledged accomplishments in space and ICT technology domains with strong focus on social impact applications, the Indian geospatial sector suffers from lack of integrated approach cutting across the various technology segments, and governance structures at national and states level for the benefit of different use areas. The Indian geospatial sector ecosystem, at the very best, can be termed as 'below-par' or under delivering on its potential to add to the national growth and development objectives when compared to nations with similar or even smaller geo-political, economic and demographic heft. Some of the comparative assessments are as below:

Geospatial Readiness : The Countries Geospatial Readiness Index (CGRI)-2018, an assessment of the 'geospatial readiness' of 50 nations based on comprehensive evaluation of 5 core pillars of the geospatial ecosystem, namely geospatial data infrastructure, policy framework, user adoption, institutional readiness and geospatial industry fabric, ranked India at 26th place. India's ranking on these pillars and multiple sub-pillars which represents various sub components of the geospatial sector eco-system provides ample insights on the need for an integrated approach from government and national geospatial agencies for holistic development of the sector.

TABLE 1.1

Indian Geospatial Economy-18: India - Geospatial Readiness Index Rankings*

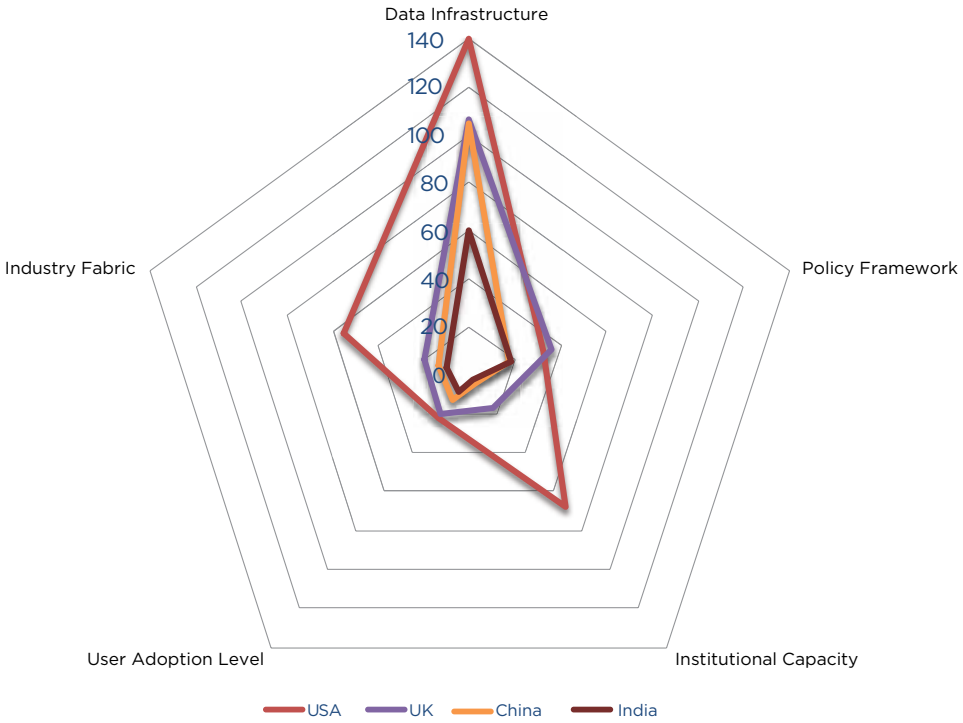
Assessment Pillars	Sub-Pillars	India's Ranking
Geospatial Data Infrastructure	Data Infrastructure, Positioning Infrastructure, Platforms and Portals and Standards	27
Policy Framework	Geospatial Policy Framework and Enabling Policy Framework	28
Institutional Capacity	Research and Post-Graduate courses and Graduate, Diploma and Certificate courses	17
User Adoption	Mapping or Service Level, Asset Management, Analytics and Workflow, System Integration Level and Enterprise Level	25
Industry Fabric	Industry Capacity, Innovation Promotion and Industry Networks	16

*GeoBuiz 2018 Report - download at www.goebuiz.com

The below infographic illustrates the 'geospatial readiness' of India vis-a-vis the countries which lead the 50 nation CGRI-18 index.

GRAPH 1.1

Indian Geospatial Economy-18: India - Geospatial Readiness Comparison



Source: GeoBuiz-18 Report; Geospatial Media Analysis

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Base maps availability: On a comparative analysis of scales of spatial thematic layers available in different countries given below reveals that barring Malayasia all other countries offer higher scale maps. Incidentally all these countries with higher scale maps happen to be ahead than India on their overall geospatial readiness as well.

High resolution base maps are prerequisite for town planning, navigation and engineering uses and services delivery.

TABLE 1.2

Indian Geospatial Economy-18: India - Base Maps Comparison

Country	Topography	Cadastral	Transport Infrastructure	Utility Network	Agriculture	Soil and Land Cover	Hydrology	Buildings Infrastructure	Disaster Zonation	Forest
Malaysia	1:60000	1:25000	1:60000	1:50000	1:50000	1:25000	NA	1:60000	1:50000	1:50000
USA	1:200	1:200	1:5000	1:500	1:5000	1:500	1:1000	1:500	1:200	1:500
Australia	1:25000	1:5000	1:25000	1:10000	1:25000	1:5000	1:10000	1:25000	1:25000	1:10000
India	1:50000	1:50000	1:50000	1:50000	1:50000	1:50000	1:50000	1:50000	1:50000	1:50000
UK	1:1250	1:1250	1:1250	1:1250	1:1250	1:1250	1:1250	1:1250	1:1250	1:1250
China	1:5000	1:1000	1:5000	1:5000	1:5000	1:5000	NA	NA	NA	NA

Source: GeoBuiz-18 Report; Geospatial Media Analysis

Positioning Infrastructure: India's comparative position vis-a-vis other countries on terrestrial positioning infrastructure is as below:

TABLE 1.3

Indian Geospatial Economy-18: India - Positioning Infrastructure Comparison

Country	Number of RTK base stations	Area (sqre km)	Area (sqre km) per RTK base station
UAE	1,410	83,600	59.29
Singapore	10	719	71.91
Japan	1,315	3,77,962	287.42
South Korea	224	1,00,210	447.37
Belgium	63	30,528	484.57
The Netherlands	40	41,543	1038.57
Italy	275	3,01,338	1095.77
Sweden	383	4,47,435	1168.24
Germany	260	3,57,376	1374.52
Switzerland	30	41,285	1376.17
India	2,000	32,87,000	1643.50

Source: GeoBuiz-18 Report; Geospatial Media Analysis

INDIAN GEOSPATIAL ECONOMY IN 2017-18

Geospatial Economy
INR 20,629 cr

International Trade
INR 7,933 cr

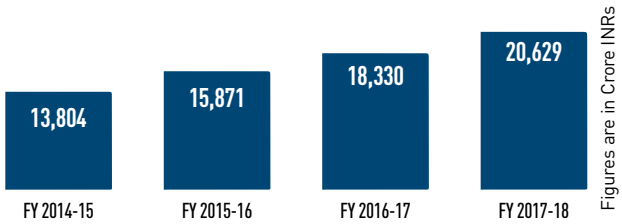
Employment
2,51,300

Government Expenditure
INR 12,509 cr

Geospatial Economy

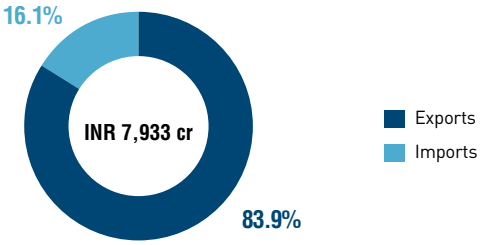
A geospatial economy comprises of the following components:

- Market size through commercial procurement of equipment, software, data, services
- Exports of geospatial equipment, software, data and services
- Public expenditure on creation and maintenance of geospatial data, infrastructure and institutions



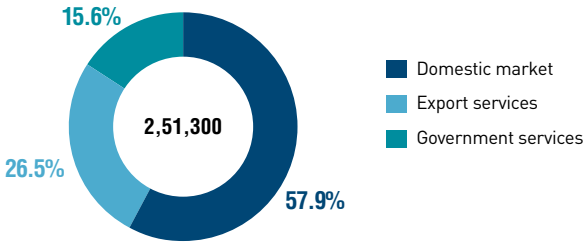
International Trade

- Geospatial industry in India has a significant trade surplus of nearly INR 5,385 Cr
- India relies heavily on imports for its geospatial hardware requirements. For 2017-18, estimated to be worth INR 1,274 Cr
- Export of services has seen consistent growth. India exported INR 6,659 worth of services during FY 2017-18



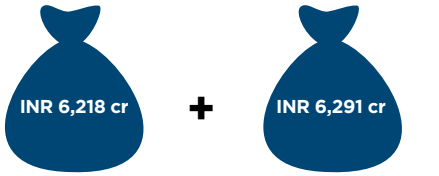
Employment

- At present, the Indian geospatial employs nearly 251,300 persons
- Of this total, nearly 67,000 are engaged in exports related services
- There are huge employment generation opportunities in India for basic services such as surveying, map digitization, content development, APIs, data analysis, etc.



Government Expenditure

- During 2017-18, the governments spent nearly INR 6,291 Cr through multiple national geospatial agencies through revenue and capital expenditure
- It spent another INR 6,218 Cr in procurement of the geospatial data, hardware, software and services for its various ongoing projects



Expenditure on Project Procurements

Expenditure on Geospatial Infrastructure and Institutions

Source: Geospatial Media Analysis

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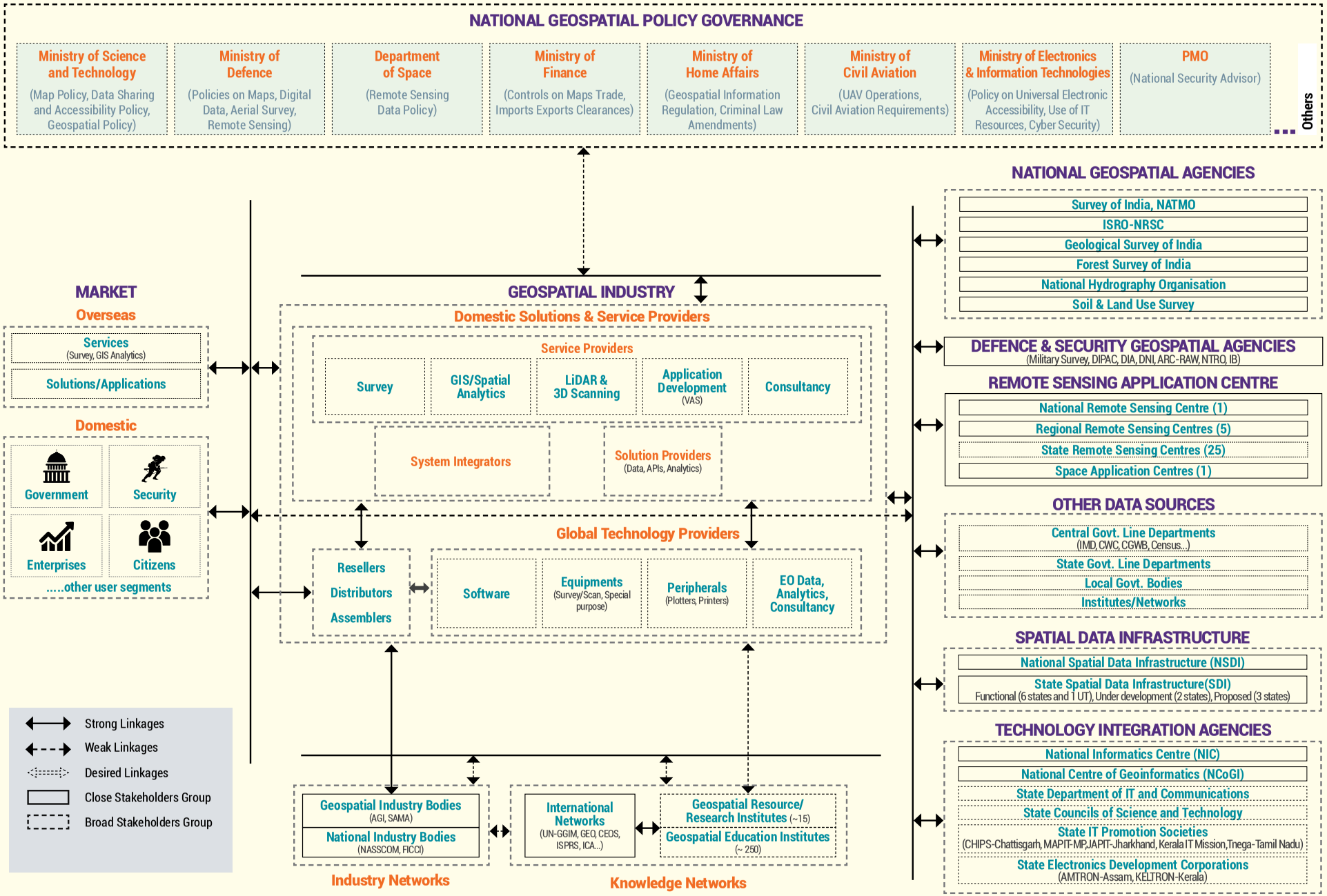
Indian Geospatial Sector Landscape



GOVERNANCE LANDSCAPE

National Geospatial Policy Environment: At national level, the regulatory landscape of Indian geospatial sector comprises of 15 national policies/acts/rules from 6 different ministries/departments to control the use/exchange of geospatial information of which 4 are in draft stage.

Ministry of Defence	• Restriction of Sale, Publication and Distribution of Maps (2017) • Policy on Digital Data of Topographic Maps (1967) • Policy of Aerial Photographic Survey Aircraft borne Remote Sensing (2006)
Ministry of Finance	• Rules prohibiting export of all maps of 1:250K and larger scales (2005) • Courier Imports and Exports (clearance) Amendment Regulations (2010)
Ministry of Science and Technology	• Restriction of Sale, Publication and Distribution of Maps (2017) • Policy on Digital Data of Topographic Maps (1967) • Policy of Aerial Photographic Survey Aircraft borne Remote Sensing (2006)
Department of Space	• National Map Policy (NMP) (2005) • National Data Sharing & Accessibility Policy (2012) • National Geospatial Policy (Draft 2016)
Ministry of Home Affairs	• The Criminal Law Amendments Act 1961, Act No. 23 • Geospatial Information Regulations Bill (Draft 2016)
DGCA, Ministry of Civil Aviation	• Civil Aviation Requirement (CAR) (2012) • Operations of UAVs-Air Transportation Circular 328 of 2016 • Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAs) 2017 (Draft)

State Geospatial Policy Environment: A detailed appraisal of Indian states and UTs for their explicit geospatial policy/strategy document and analysis of their ICT (or IT & ITeS) policy for geospatial information management and technology adoption finds only 3 states (one with a draft document) with GIS policy/strategy document. Further, only 11 states and 3 UTs are found to be having ICT policies mentioning the use of geographical information, GIS and remote sensing out of 29 states and 7 UTs which have ICT policy/notifications in place.

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TABLE 1.4

Indian Gespatial Economy-18: Geospatial Policies, Infrastructure and Schemes in States

	No.	States	Policy			Geo Portal**			State Remote Sensing Centre	GIS Based Schemes		
			GIS	ICT		State GIS	State Spatial Data Infrastructure(SSDI)*					
				With GIS	Without GIS		Functional/ under development	Proposed		>10	5-9	1-4
STATES	1	Rajasthan		✓		✓			✓		✓	
	2	Haryana		✓			✓		✓			✓
	3	Uttarakhand			✓	✓	✓		✓			✓
	4	Madhya Pradesh		✓		✓	✓		✓	✓		
	5	Karnataka	✓		✓	✓	✓		✓	✓		
	6	Andhra Pradesh	✓		✓	✓			✓	✓		
	7	Tamil Nadu	✓	✓		✓		✓	✓		✓	
	8	Goa			✓				✓			✓
	9	Maharashtra		✓		✓			✓		✓	
	10	West Bengal			✓		✓					✓
	11	Bihar		✓		✓	✓		✓			✓
	12	Punjab			✓	✓			✓			✓
	13	Odisha		✓		✓	✓		✓		✓	
	14	Jharkhand			✓	✓			✓		✓	
	15	Chhattisgarh			✓	✓			✓			✓
	16	Kerala		✓		✓			✓	✓		
	17	Assam		✓		✓			✓			✓
	18	Uttar Pradesh			✓	✓			✓		✓	
	19	Himachal Pradesh			✓				✓			✓
	20	Gujarat			✓	✓			✓		✓	
	21	Telangana			✓	✓			✓		✓	
	22	Mizoram		✓				✓	✓			✓
	23	Nagaland		✓				✓	✓			
	24	Jammu & Kashmir		✓			✓					✓
	25	Manipur		✓					✓			
	26	Meghalaya			✓							
	27	Tripura			✓				✓			
	28	Sikkim		✓					✓			✓
	29	Arunachal Pradesh				✓			✓			
UNION TERRITORIES	1	Chandigarh		✓								
	2	Puducherry		✓								✓
	3	Delhi		✓			✓			✓		
	4	Lakshadweep			✓	✓						
	5	Andaman and Nicobar Islands			✓							
	6	Dadra and Nagar Haveli										
	7	Daman and Diu										

(** This study treats both state GIS portal and SDI as geo portal, different nomenclature is more due to their genesis than anything else. SSDIs are funded by Department of Science & Technology (DST) i.e. a central government department while GIS portals are by states)

Observations:

- → In general, the spirit of governing rules and regulations is more restrictive than advancing geospatial adoption and commercialization.
- → An overarching strategic policy development and implementation framework is missing for holistic development of the geospatial sector in the country taking cognizance of emerging digital technology eco-systems, evolving business and governance paradigms for national competitiveness, innovation led wealth and employment generation and transforming governance delivery.
- → Five Indian states - Nagaland, Manipur, Meghalaya, Tripura, and Arunachal Pradesh and five union territories - Chandigarh, Lakshadweep, Dadra Nagar Haveli, Daman and Diu and Andaman Nicobar are found to be lacking schemes/initiatives with geospatial integration in our survey and secondary research.
- → There is no national geospatial technology policy (NPGT) in the country.
- → The national policy on information technology 2010 (NPIT 2012) mention GIS based IT services with reference to developing GIS platform for location based planning, service delivery, disaster management and enabling public spatial data access for value addition and innovation. However, it does not provide specific goals and frameworks on geospatial adoption.
- → Current governance structure lacks a national geospatial coordination mechanism between different agencies and stakeholders in the geospatial sector

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GEOSPATIAL AGENCIES LANDSCAPE

The National Geospatial Agencies are the key organizations which form the backbone of Indian geospatial sector. The designated national geospatial agencies are responsible for conducting survey and assessment of national resources, providing the base maps, specific geographical/ environmental information and data sets, representation, scrutiny and certification of national interests of geospatial domain, printing and publication of maps/data along with capacity building, technology adoption and R&D in their respective work areas.

Together with other key entities, these agencies play a crucial role in augmenting the usage of geospatial data and information for social and economic development planning.

Civil Geospatial Agencies

- → National Atlas and Thematic Mapping Organization (NATMO)
- → Survey of India (SoI)
- → NRDMS and NSDI Divison
- → National Remote Sensing Centre (NRSC)
- → ISRO Satellite Centre (ISAC)
- → Space Applications Centre (SAC)
- → National Hydrographic Office (NHO)
- → National Centre of Geoinformatics (NCoGI)
- → Geological Survey of India (GSI)
- → Forest Survey of India (FSI)

Defence and Security Geospatial Agencies

- → Military Survey
- → Defence Image Processing and Analysis Centre (DIPAC)
- → Directorate of Signals Intelligence (DSI)
- → Directorate of Air Intelligence (DAI)
- → Defence Intelligence Agency (DIA)
- → Directorate of Naval Intelligence (DNI)
- → Aviation Research Centre (ARC-RAW)
- → National Technical Research Organization (NTRO)
- → Intelligence Bureau (IB)
- → Defence Terrain Research Laboratory (DTRL-DRDO)
- → Centre for Artificial Intelligence and Robotics (CAIR-DRDO)

Observations:

- → Organizational mandates especially of the designated mapping agencies (i.e. SOI, FSI, GSI, NRSC,NHO etc.) do not lay specific focus on for enhanced commercialization of geospatial information and technologies through business incubation/MSME development programs.
- → Few international examples of dedicated geospatial technology business incubation programs either by national geospatial agency or as part of national/regional innovation programs are:
  - Geovation Hub by Ordnance Survey of Great Britain (OSGB), UK National Geospatial Agency
  - National Innovate UK with five catapult centres (centre of excellence) program which includes satellite applications among 6 focus technologies for business incubation.
  - 18 Space technology incubators in 15 member countries by European Space Agency (ESA)

- → Organizational mandates lack focus on skill certification/development initiatives such as of field surveyors, UAV pilots, and live labs to demonstrate use cases as well as to promote entrepreneurs/practitioners critical to enable employment and overall sector development.
- → For example, each of the 50 states of USA has formal professional surveyors networks which indicates pride, quality and standardization associated with the survey profession of geospatial industry segment).
- → On careful observation, it can be noted that national geospatial agencies are not uniformally empowered or represented despite having exclusive and complementary mandate areas. Also, there are visible instances of one department/agency crossing over to other's mandated areas. Taken together, these are few reasons for under-delivery of geospatial solutions as well as duplicity of initiatives/structures at state and national levels, knowledge synergy and resource pooling.
- → Survey of India (SoI) lacks capacities to deliver on demand for high-resolution maps from emerging use segments of Smart Cities, AMRUT cities, DILRMP, RuRban Planning, River Rejuvenation projects, water resource management (NHP) program, and country-wide transport infrastructure led by huge public sector investments. These capacities pertains to human resource and technical capabilities within the department as well as and lack of up-to-date geodetic infrastructure which includes datums and terrestrial augmentation systems.
- → The need of the time is to establish an overarching Department of Geospatial Science and Technology (DoGS&T) in the country with prime responsibility of formulation of national geospatial technology policy (NPGT), maintaining spatial data infrastructure, formulating spatial and non-spatial data access policy, coordinating various survey departments and data producing agencies to work in synergy, enabling interfaces to help user segment stakeholders in their geospatial integration initiatives proactively.

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REMOTE SENSING LANDSCAPE

The remote sensing centres are primarily responsible for remote sensing satellite data acquisition and processing, data dissemination, aerial remote sensing and development of demonstation/decision support applications using GIS at states. The space application centres are mainly dedicated to development of space borne and air borne instruments/payloads and their societal and scientific applications as part of overall national space research program under the Department of Space (DoS).

Remote sensing centres undertake development of GIS applications for various departments at states alongwith other projects assigned to them under national programs through NRSC and other agencies.

National Remote Sensing Centre:	→ Indian Space Research Organisation (ISRO), Department of Space (DOS) → Regional Remote Sensing Centres (5 regions): Karnataka (South), Rajasthan (West), West Bengal (East), Delhi (North), and Maharashtra (Central)
State Remote Sensing Centres (26 states):	→ Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura, Uttar Pradesh, Goa, Andhra Pradesh, Uttarakhand and Bihar → North Eastern Space Application Centre: Shillong, Meghalaya → Space Application Centre: Ahmedabad, Gujarat

Observations

→ State remote sensing centres are governed by Department of Planning in states like Kerala, Maharshtra, Telangana, Andhra Pradesh; by Department of Agriculture in Punjab and by Institute of Remote Sensing, Anna university in Tamil Nadu which is partially assisted by state Department of Agriculture. In other states these are governed by Department of Science and Technology.

→ In states where both spatial data infrastructures (SDIs) and state remote sensing centres are present, they exist as separate divisions in separate locations/offices seeking cohesion and synergy even in those states where both happens to be part of department of scienc and technology.

→ The annual turnover of the state remote sensing centres in various states, by way of budget supports and projects, is estimated to be approximately INR 400-500 crore. NRSC and its four regional space applications centres have an approximate annual income/allocation of approximately INR 1000 crore. These estimates are based on the data sourced from annual reports and budget grant figures as available on government web portals.

SPATIAL DATA INFRASTRUCTURE

The Spatial Data Infrastructures have been conceptualized to bring efficiencies as nodal point(s) for management of large volumes of different spatial and non spatial data sets through standardisation and interoperability, creation of meta data to avoid duplication and enhanced knowledge sharing in a networked environment. These were enabled by advances in ICT infrastructure and digital technologies, gains in computation and data storage capacities and growth in use of GIS.

In India, the concept of Spatial Data Infrastructures initiative at national and state level has evolved since 2000 and have been primarily led by Department of Science and Technology (DST). The current status and spread of SDIs in the country is as below:

National Spatial Data Infrastructure (NSDI)	→ Under Natural Resource Data Management System (NRDMS) & NSDI divison at Department of Science & Technology (DST).
State Spatial Data Infrastructure(SDI)* Functional (6 states and 1 UT)	→ Bihar, Karnataka, Madhya Pradesh, Odisha, Uttrakhand, Haryana (semi-functional), and Delhi → Under development (2 states): West Bengal, Jammu & Kashmir → Proposed (3 states): Mizoram, Nagaland and Tamil Nadu

*Compiled from Department of Science and Technology annual reports

Observations:

→ In states, Spatial Data Infrastructures (SDIs) have been implemented by respective state department of IT or science and technology through dedicated support by central government's Department of Science and Technology (DST) which established the Indian NSDI.

→ Development of geo-portals by designated geospatial agencies like 'Bhuvan' by the National Remote Sensing Centre (NRSC-ISRO); 'Bhukosh' by Geological Survey of India (GSI), various state GIS portals by respective governments showcases the presence of multiple entities. This is to say, geo-portals at different levels with limited integrating mechanisms in place, is a situation similar to fragmented policy environment above.

→ Effective implementation of SDI objectives, a standardized structure and time bound approach for implementation of state geo-portals with decision support systems and wider knowledge dissemination across Indian states and UTs is currently missing. Such an approach requires an integrated and consultative framework, administrative as well as technology integration and program management capacities involving private sector participation to deliver on ground.

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TECHNOLOGY INTEGRATION LANDSCAPE

The integration of digital technologies with geospatial information management is key to the overall adoption of technology solutions at national and state governance structures.

National

- National Informatics Centre (NIC)
- National Centre of Geoinformatics (NCoGI)

States

- State Department of IT and Communications
- State Councils of Science and Technology
- State IT promotion societies (such as CHIPS -Chattisgarh, MAPIT-Madhya Pradesh, JAPIT-Jharkhand, Kerla state IT Mission, Tnega-Tamil Nadu)
- State Electronics Development Corporation Limted (such as AMTRON-Assam, KELTRON-Kerala)

Observations:

- There is a critical need to analyze the technology integration structures at states (i.e. NIC, state IT and S&T departments) to identify successful models and frameworks on which other states can build or shape their integration technology governance structures. For example: DoIT&C, nodal agency for all technology integration in the state of Rajasthan with its ICT policy and technology project management partnership with Wipro technologies as implementation structure, can be a reference point.
- The rapid pace of advancments in digital technologies and increasing complexity of managing technology projects from concept to delivery requires agility, efficiency and effectiveness of private sector.
- These agencies need to be remodelled as nodal agencies responsible for developing frameworks for integrated adoption of geospatial and digital technology. Furthermore, partnership with the ecosystem stakeholders needs to be encouraged in the form of centres of excellences, innovation hubs and live labs for demonstrations/application development as per the user department needs. These should actively partner with institutes and private sector for technology project management.
- The annual budget support/turnover of National Informatic Centre (NIC) is approx. INR 1100 crore. The human resource strength of the agency is nearly 4000 with indirect engagement of about 40,000 or more at various departments and states. At states, the respective IT departments and technology integration agencies, have staff strength is in the range of 80,000 persons with there annual budgets totally approx INR 20,000 crore. It is estimated that only 2-3% of human and capital resource allocation of these agencies is dedicated on geospatial integration. This leaves a wide scope for holistic roadmap for strengthening geospatial information management and integration capacities by these technology integrators. While NIC has taken steps in establishing GIS technology integration and application development capabilities in house, at state agencies the progress is uneven among different states.

RESEARCH & EDUCATION LANDSCAPE

Key Geospatial Resource/ Research Institutes:

Geospatial domain entails a lot of research and development work both at scientific and applied levels in various application areas such as ecology and environment, forestry and wildlife, geology etc. The key geospatial resource centres/research institutes in the country have been established to advance knowledge base in designated functional and strategic areas by their respective ministries/departments. These are different from the academic institutes as under Ministry of Human Resource Development (HRD).

TABLE 1.5

Indian Geospatial Economy-18: Research/Resource Institutes[#]

Institute	Focus Areas
National Institute of Hydrography, Goa	• Topographical and hydrography survey courses; • Bachelor's degree/diploma in engineering; • Hydrographic software training
National Institute of Hydrology, Roorkee	• Study and research on key aspects of hydrology and water resources using remote sensing and GIS techniques.
Govind Ballabh Pant Institute of Himalayan Environment and Development	• Remote sensing and GIS Lab for watershed process, agriculture, socio-economic etc. • Specific research projects
Wadia Institute of Himalayan Geology, Dehradun	• Study of geology of Himalayas, geomorphology and environmental geology division, geophysics division, petrology and geochemistry division
Indian Institute of Geomagnetism (IIG), Navi Mumbai	• Scientific research in geomagnetism and allied areas • PG courses in earth and space sciences
National Academy of Sciences (NASI), Allahabad	• Research studies on thematic mapping, remote sensing and GIS
Indian Institute of Remote Sensing (IIRS)	Training and capacity building programs • M.Tech (RS&GIS) • M.Sc. Geoinformatics • Diploma programs
Indian Institute of Space Science and Technology (IIST)	• Developing future technologies and applications for space research. • M.Tech Digital Signal Processing; M.Tech in Geoinformatics; M.Tech in Earth System Sciences.
National Institute of Rock Mechanics	Autonomous research institute dealing with field and laboratory investigations, basic and applied research – use of GIS and remote sensing for surveying, 3D modelling, etc.
Central Mine Planning and Design Institute (CMPDI)	• Geomatics division for remote sensing, GIS, GPS, digital photogrammetry, LiDAR, etc. • Geological Studies – formulation of a project report or study report • Mine planning and designing – inclusive of field tests or laboratory analyses • Engineering planning and designing

[#] This is not an exhaustive list of reasearch institutes. Please refer to the full report for complete list.

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Observations:

→ The cumulative yearly budgetary support to these institutions (except CMPDI) is in excess of INR 550 crores* which have advanced GIS and remote sensing labs, automatic weather stations, and special measurement instruments and equipments for their respective research areas. Together these institutes (except CMPDI) are estimated to have technical and scientific human resource in excess of 1400 people.

→ CMPDI ltd. is the nodal agency in matters related to mineral exploration, co-ordination activities between related companies in India and research and development in the field of mineral mining. The agency employs more than 3000 people and has an annual turnover above INR 1000 crores.

*institution wise income statements/annual reports are not always available on institutes websites therefore broad approximation on the basis of available figures and through primary interactions.

Geospatial Education Institutes

Indian educational and research institutes offer a wide range of geospatial educational and research courses . The estimated throughput (seats) on compiled data base of educational and research institutes in India is given below. The compiled data reveals that undergraduate and certificate level courses are less than the post graduate and research courses both in number of courses offered as well as number of seats.

TABLE 1.6

Indian Geospatial Economy-18: Geospatial Education

Geospatial course types	Institutions*	Number of courses*	Estimated student output**
Research courses	40	62	186
Masters courses (MA/Msc.)	114	177	5310
Masters courses (M.Tech, M.E.)	77	100	2000
Bachelors courses (BA/Bsc.)	55	78	4680
Bachelors courses (B.Tech, B.E.)	8	10	300
Diploma courses	20	22	1100
Certificate courses	7	10	500
			14076

* Numbers of academic institutes and courses in geospatial domain present the broader understanding of educational through put in gospatial domain. While all efforts were undertaken to identify and list all institutes and courses offered in geospatial domain, the table cannot be taken as based on an exhaustive list of institutes and courses.

** Students throughput per course/stream has been estimated using the available data wherever available as reference. Indicative only.

Observations:

- → There is need for short term certification courses both for professionals and vocational education seekers in the geospatial domain.
- → There is strong need to introduce short term certificate courses across colleges/universities which are available to students of management and engineering, as well as to students of graduate and post graduate courses in science, commerce and humanities to promote wider understanding, cross learnings, instill interest and creative adoption of geospatial information management solutions.
- → Establishment of GIS labs in colleges in a programmed manner by national/state governments is a way forward. This will address the issue of lack of awareness, exposure of geospatial domain in larger public and working professsionals.
- → There is a need to revamp the current social studies (geography, history and civics) curriculum at schools with capacity building of teachers to use map-based visualization and various interlinking aspects of location information with modern digital technology enabled day to day uses to instill interest among students to know and explore on their own

International Networks:

***(a) OGC India Foundation**:* The foundation raises awareness and adoption of OGC Standards in India and supports the interests and needs of Indian organizations. The OGC India Foundation also facilitates the participation of Indian members in OGC international programs.

(b) International Society for Photogrammetry and Remote Sensing (ISPRS): Established in 1910 as the International Society for Photogrammetry (ISP), and rebranded as ISPRS in 1980. National Remote Sensing Centre (NRSC) is a sustaining member of ISPRS and contributes to the financial support of the society. Indian Institute of Remote Sensing has taken lead in Commission V of ISPRS for the term FY 2016-20 to support, promote and motivate capacity building at different levels of professionals, educators and students.

(c) International Cartographic Association (*ICA)*: Survey of India is the national member of ICA while National Hydrographic Organisation and Indian National Cartographic Association are affiliate members. There are 27 commissions, 2 working groups and 3 committees of the ICA, India is not represented in anyone of them.

(d) Group on Earth Observations (GEO): GEO champions global collaboration for improved application of Earth observations for the benefit of humankind. India is represented by ISRO in GEO as a member state while Association of Geospatial Industries (AGI) is a participating organisations in GEO.

(e) Committee on Earth Observation Satellites (CEOS): CEOS was established in 1984 under the aegis of the G7 Economic Summit of Industrial Nations Working Group on Growth, Technology, and Employment. ISRO is one of the 32 members of CEOS and Earth Systems Science Organisation (ESSO) is one of the 28 associate members. Besides, ISRO represents India in Ocean Surface Vector Wind Virtual Constellations, which is a coordinate space-based, ground-based, and/or data delivery systems to meet a common set of requirements within a specific domain.

(f) United Nations Committee of Experts on Global Geospatial Information Management (UNGGIM): UN-GGIM aims to address global challenges by using geospatial information, included in the development agenda, and to serve as a body for global policymaking in the field of geospatial information management. India is a member of UNGGIM by virtue of being a member of the UN. However, India has not been represented consistently in the past many years High Level Forums and Expert Group or Working Group meetings.

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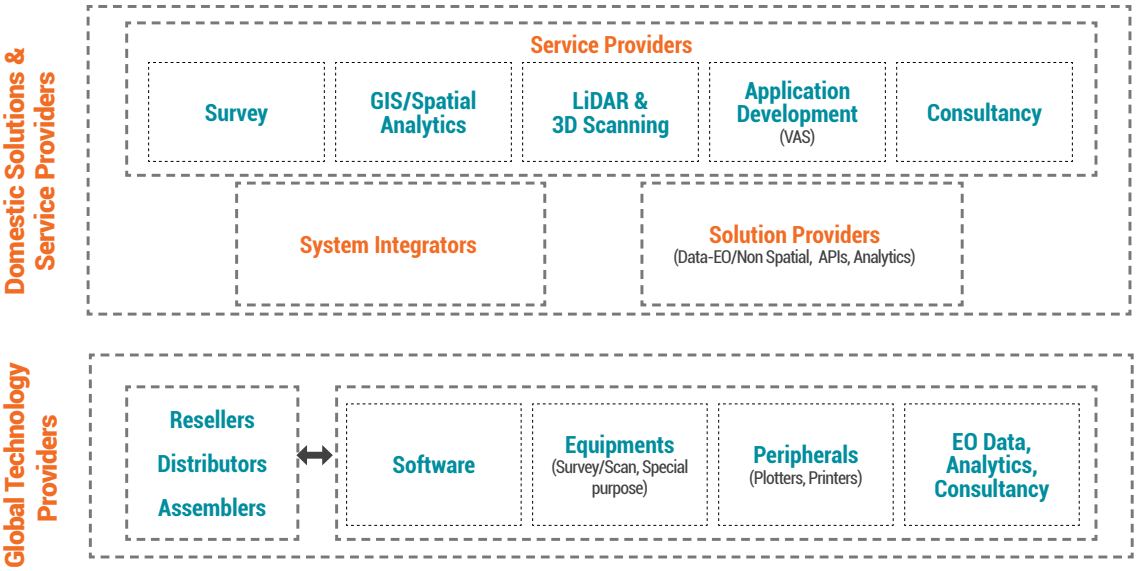
INDUSTRY LANDSCAPE



The **services segment** constitutes the largest part of the Indian geospatial market with 74.4% of market share in FY 2017-18. The major categories of services are land survey (GNSS and optical technology), GIS/Spatial Analytics, LiDAR and 3D scanning, aerial and satellite data/image processing, consultancy and R&D.

Land measurements and survey segment alone is estimated to have more than 5000 enterprises with most of them being micro enterprises (up to 20 personnel) as proprietorship and partnership firms. These small and unorganised players, more often than not, cater to the clients in their vicinity i.e. depending on local/regional geographic presence. Very few of these enterprises (fewer than 30 in numbers) are capable of providing end-to-end solutions to customers anywhere in the country and overseas markets looking for high end precision and special domain survey services and value-added analytics. Cumulatively, the land measurement and survey segment is estimated to provide employment to nearly 2,00,000 people. This industry segment requires mandatory skill certification for professional surveyors, clear guidelines on the type of technologies to be used for different job requirements, linking of certified professional survey to construction /insurance claims to bring at par with global best practices.

A sizeable section of Indian geospatial industry caters to overseas market, exporting a range of **services** in domains of survey and spatial analytics, data processing and GIS integration, R&D services etc. Similar to globally established Indian IT industry prowess in business process management (BPM) segment, the system integrators have capacities to deliver large projects in areas of map content, location information analytics, GIS and spatial analytics etc., both for overseas clients as well as to cater to domestic market requirements. While application development services hold promise; currently the domestic market happens to be underperforming on consumption of services in proportion to product (i.e. software) sales. The reasons behind are (i) most of the users are at a nascent stage of adoption, (ii) users are not engaging the private application developers due to strategic reasons or doing it inhouse (iii) poorly designed project plans- not focussing on applications and service requirements are limiting returns on investments, (iii) lack of solution centric approach by the industry which is more inclined to sell only software boxes/hardware, (iv) lack of data availability, and (v) low level of data sharing with SME/entrepreneurs to develop commercial applications,

etc. Therefore, the **services segment** which holds a great potential in Indian geospatial sector growth, needs focused interventions to strengthen it with carefully designed market support mechanisms.

Indian geospatial industry currently imports almost all of its **hardware** requirements for surveying and special purpose measurement/observation stations. There is limited assembling activity for imported GNSS modules/parts etc in equipment domain and these are sold through distributor channels. Similarly, import supply situation exist in the **software** segment as well, where almost all prominent platform software companies (GIS software) and specific vertical software segments (BIM, parcel logistics) have their local presence in India with solution development /training supports divisions for the Indian market.

Earth observation data procurement in India is routed through the National Remote Sensing Centre (NRSC). Whether it is NRSC's own data, or that of a private supplier, the procurement is done through NRSC only. International players in this segment are present in India through their direct offices or through resellers/distributers. There lies a big scope for opening up of commercialization opportunities for private sector entrepreneurs both in EO upstream (satellites, launch mechanisms, ground stations etc.) and EO downstream on VAS development in India, which is currently public sector controlled.

Indusrty Analysis*

Strengths	• Strong credentials of Indian knowledge workforce and service providers in catering to overseas market requirements along with cost efficiencies. • Well diversified presence of services and solutions providers across value chains catering to domestic users. • Local presence of global geospatial technology providers in Indian market both for outsourcing and local business development adds to industry ability to deliver and creating spill overs.
Weakness	• Missing domestic manufacturing in sensors & equipment (i.e. hardware). • Industry focus more on 'product sales' than delivering solutions to customers hampers market development, trust building, low returns to customer on capital deployed on software and hardware procurement. • Instances of Industry players adhering to cost cutting to win contracts leading to lack of trust among peers, under delivery, delays etc. • Heavy dependence on public sector procurements for business

*Detailed SWOT is available in the complete version of the Indian Geospatial Economy (IGE)-2018 Report

Geospatial Industry Representation

(a) Association of Geospatial Industries (AGI): Established in 2009, AGI works through a number of Special Interest Groups (SIGs) to build perspectives around the application of geospatial technologies in various sectors, or for policy formulation; MoUs with geospatial industry associations of other countries as well as with government agencies to build B2B and B2G collaborations and acts as an advisory body to several government projects.

(b) Surveying and Mapping Association (SAMA): Established in 2016, the main objective of SAMA is to work as an interface between Indian geospatial industry or more specifically survey and mapping industry and government to address the concerns of the industry as well as of the government departments/user organizations.

(c) Federation of Indian Chambers of Commerce and Industry (FICCI): Established in 1927, FICCI is the largest and oldest apex business organisation in India. In 2008, FICCI formed a Task Force on Geospatial Technologies which takes initiatives to mainstream the use of geospatial technologies in various sectors and applications in India.

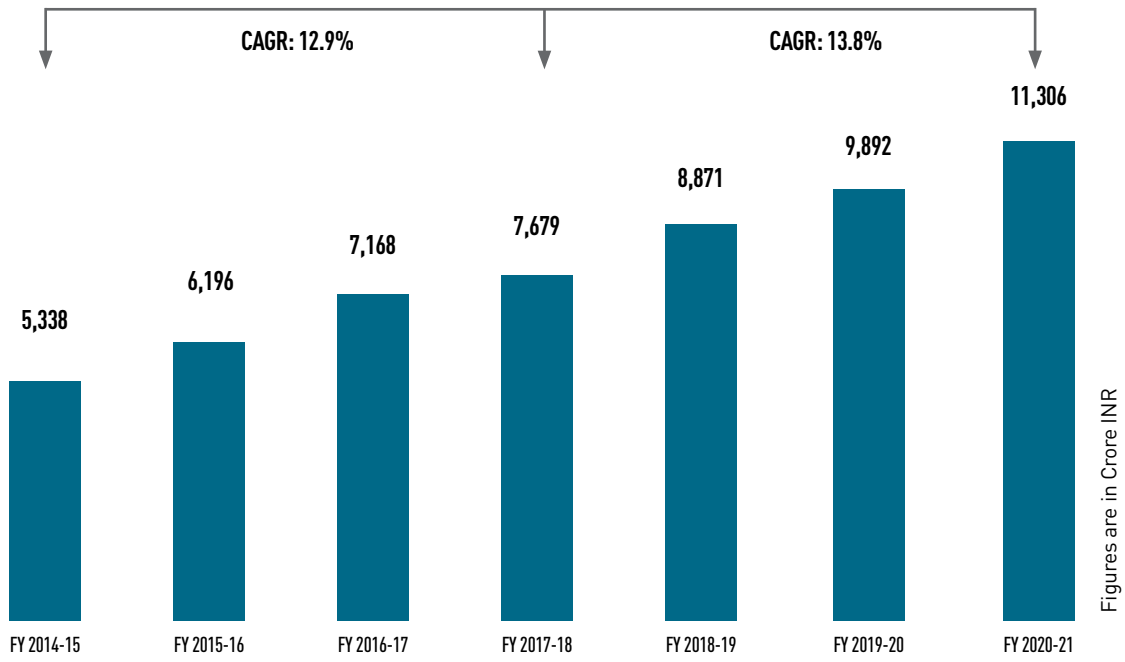
(d) The National Association of Software and Services Companies(NASSCOM): Established in 1988, NASSCOM represents the IT BPM industry in India. It focuses on building the architecture integral to the development of the IT BPM sector through policy advocacy, and helps in setting up the strategic direction for the sector to unleash its potential and dominate newer frontiers.

MARKET LANDSCAPE

India's geospatial market has grown from INR 5,338 crore in 2014-15 to an estimated INR 7, 679 crore in FY 2017-18 at a CAGR of 12.9% - notably higher than the global average of 11.5% CAGR for geospatial technologies during the same period[1]. The major growth drivers have been the central and state governments' push for robust physical infrastructure, effective governance delivery including e-governance and digital economy initiatives, integrated programs on urban and rural development initiatives such as smart cities, RURBAN clusters etc. These initiatives have provided a significant momentum for enhanced adoption of geospatial technologies.

GRAPH 1.2

India Geospatial Economy -18: Indian Geospatial Market

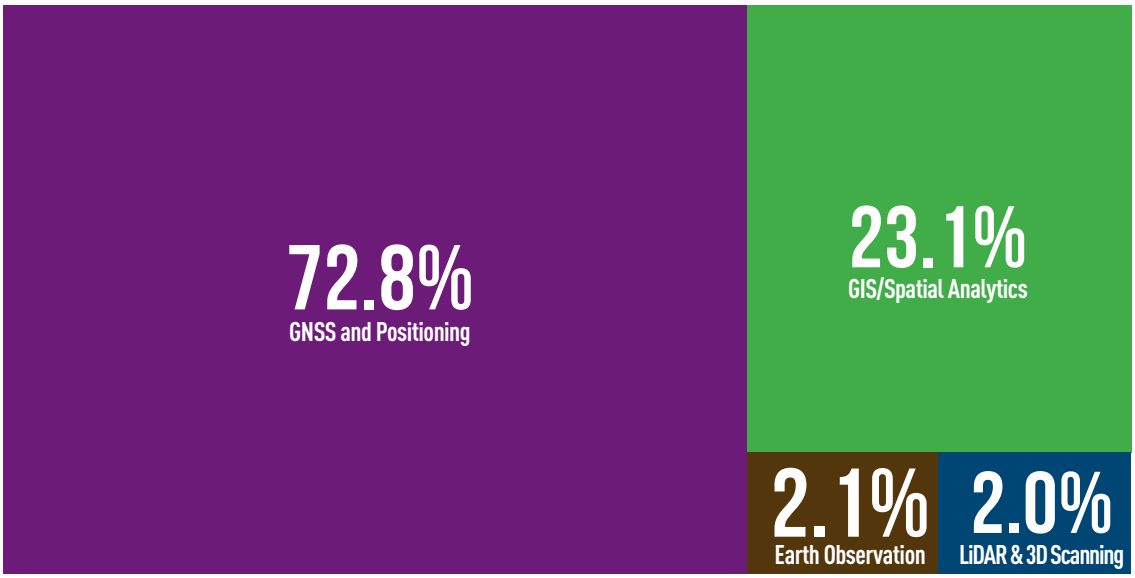


Source: Geospatial Media Analysis

- In terms of the four technology segments, the geospatial market is found to be dominated by GNSS and Positioning segment, and GIS/Spatial Analytics segment in FY 2017-2018 with a market share of 72.8% and 23.1% respectively.
- Earth Observation and 3D Scanning and Surveying segment accounted for 2.1% and 2.0% respectively

GRAPH 1.3

Indian Geospatial Economy -18: Distribution as per Technology Segments (FY 2017-18)

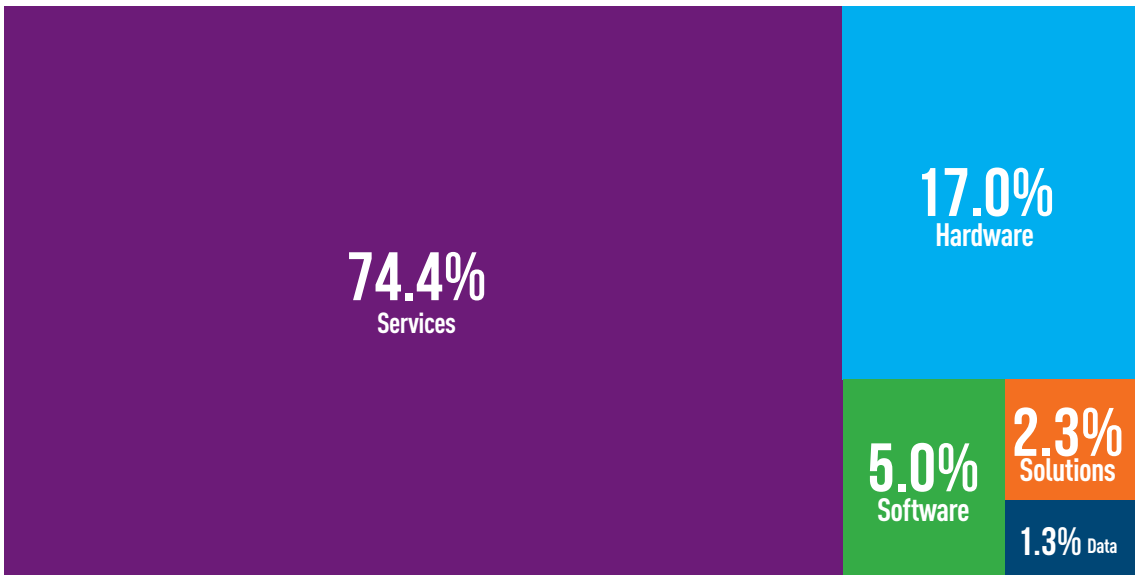


Source: Geospatial Media Analysis

→ In terms of geospatial technology subsegments, it is found that the Indian sub-continent is dominated by the services segment. The services segment accounts for 74.4% of the total market share, followed by hardware at 17%. Software, solutions and data segments account for 5%, 2.3% and 1.3% respectively.

GRAPH 1.4

Indian Geospatial Economy -18: Distribution as per Sub-Segments (FY 2017-18)



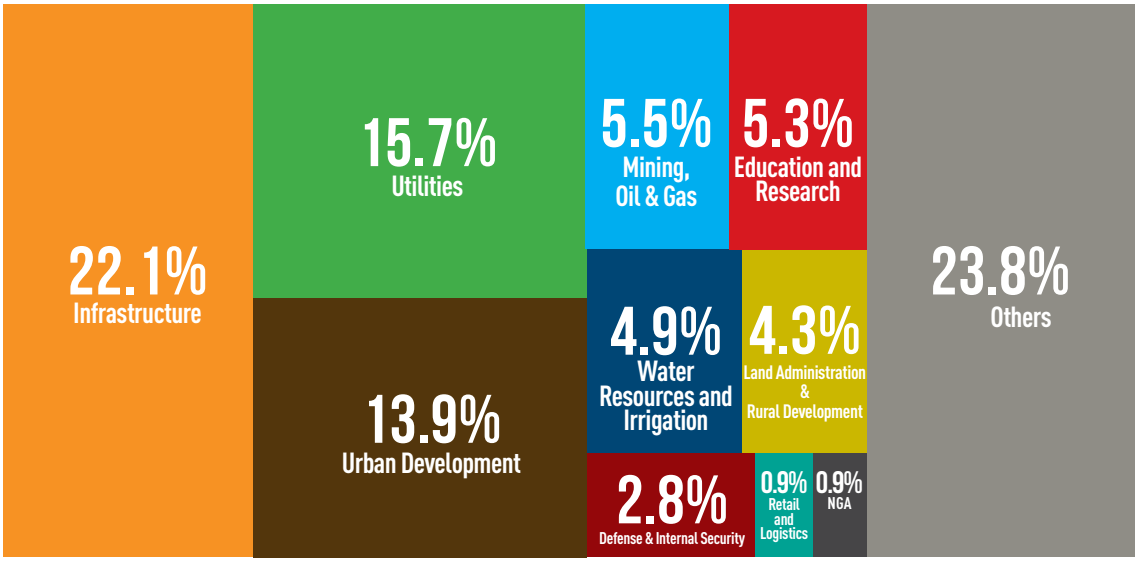
Source: Geospatial Media Analysis

MARKET ANALYSIS BY APPLICATION AREAS

- In terms of end-use sectors (or application areas), the geospatial market of India is dominated by infrastructure, urban development and utilities. Together in FY 2017-18, these three sectors have an estimated market share of 22.1%, 13.9% and 15.7% respectively, representing nearly half of the total geospatial market of India.
- Mining, Education and Research, Water Resources and Irrigation sectors are the next three major user segments contributing nearly 5.5%, 5.3%, and 4.9% respectively in FY 2017-18

GRAPH 1.5

Indian Geospatial Economy - 18: Distribution as per Application Areas (FY 2017-18)



Source: Geospatial Media Analysis

Infrastructure

- GNSS & Positioning and GIS/Spatial Analytics technology groups have an estimated market share of 80.4% and 17.1% respectively during FY 2017-18.
- Maharashtra, Andhra Pradesh, Telangana, Uttar Pradesh, West Bengal generated the maximum demand during FY 2014-15 and FY 2017-18

Utilities

- Between FY 2014-15 and FY 2017-18, the revenues grew at a CAGR of 13.9%. and is expected to grow further on demand from telecom companies followed by electricity and water distribution bodies
- Maharashtra, Karnataka, Tamil Nadu, Uttar Pradesh and Gujarat generated the maximum demand during FY 2014-15 and FY 2017-18.

Urban Development

- Municipal bodies are the biggest users of geospatial technologies with a market share of nearly 48% during FY 2014-15 and FY 2017-18.
- Maharashtra, Karnataka, Telangana, Rajasthan, Madhya Pradesh generated the maximum demand during FY 2014-15 and FY 2017-18.

Mining, Oil & Gas

- The future growth rate for geospatial technologies in the sector is expected to be a moderate 4.1% CAGR by FY 2020-21.
- During FY 2017-18, public procurements accounted for nearly 24.6% of the total estimated market from this sector.

Education and Research

- Within the sector, there is a great demand for Earth Observation data by research institutions such as DRDO, and autonomous research institutes under various ministries.
- Andhra Pradesh, Tamil Nadu, Uttarakhand, Karnataka and Madhya Pradesh generated the maximum demand during FY 2014-15 and FY 2017-18.

Water Resources and Irrigation

- Key national projects such as the National Hydrography Project (NHP), Integrated Watershed Management project, etc., are expected to aid the demand growth in coming years.
- During FY 2014-15 and FY 2017-18, public procurement accounted for nearly 20.2% of the estimated market, indicating that the majority procurement happens to be direct or discretionary.

Land Administration and Rural Development

- During FY 2017-18 and FY 2020-21, the growth rate from the sector is expected to be nearly 13.7%, similar to the growth rate of Indian geospatial market
- The geospatial market in this sector is almost equally divided between GNSS & Positioning and GIS/Spatial Analytics technology segments.

Retail and Logistics

- The GNSS & Positioning market is observed to be split in the ratio of 40:60 between hardware and services, based on the market revenues between FY 2014-15 and FY 2017-18.
- During FY 2014-2015 and FY 2017-18, the market grew at a CAGR of 18.0%. The growth is projected to be above 15% CAGR in the period FY 2017-2018 and FY 2020-2021.

National Geospatial Agencies

- NGAs contributes nearly 16% of the total Earth Observation data market in India.
- Contrary to other sectors, the hardware category accounted for nearly 86% of the total revenue generated during FY 2014-15 and FY 2017-18.

BFSI and Taxation

- Most banks and insurance companies on being approched expressed inadequate knowledge about geospatial technology and its contribution in improving the efficiency of their operations.
- Use of location analytics (mostly non-spatial data) for advertising and risk control purposes is on the increase in the sector.

Defense

- Defense and Internal Security is the biggest consumer of Earth Observation data in India, with over 15% market share.
- Although, the GIS/Spatial Analytics segment has been stagnant, GNSS & Positioning and Earth Observation have seen steady growth of 8.4%, 17.7% CAGR respectively during 2014-15 and 2017-18.

Others

- Some of the conventional geospatial users such as Forestry, Agriculture, Healthcare and Tourism are the major constituents of the 'Others' category.
- While GNSS & Positioning is the largest technology segment with a market revenue share of nearly 84%, LiDAR & 3D Scanning is witnessing the quickest growth rate.

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GEOSPATIAL STRATEGY FOR NEW INDIA

A national level geospatial strategy framework is critical to bring multiple designated agencies together on common and holistic geospatial eco-system development agenda. The current scenario of fragmented policy development with piecemeal perspectives and continuous control on geospatial information provisioning from pre-digital economy days is not conducive to the vision of 'New and Digital India'.

Strategic Framework for Geospatial Capacities and Competencies

The geospatial vision of the country should be the one to galvanize the designated agencies and institutional setup in fostering a participatory, innovation and entrepreneur friendly eco-system. Such a vision is essential for the country to harness the opportunities in emerging scenarios of 'Digital Economies'. A cultural shift is required for the national geospatial agencies to move away from the legacy of functioning as the 'only source' to produce and geospatial information to the new role of being a enabler of national geospatial sector competitiveness in collaboration with industry and institutional stakeholders. There are multiple references of leading geospatial agencies in the world to benchmark and follow on the way forward for such transformation.

Example 1: *European Union (EU) initiatives like INSPIRE (to complete by 2021) to develop national geospatial information coordination framework and European Space agency (ESA) initiatives to promote commercial technology entrepreneurship are ready reference for harnessing current capacities to build future readiness. To put in perspective, India despite having more than 1000 TBI incubators, co-working spaces and accelerators for technology ventures lacks initiative on geospatial technologies/space technology venture incubation and funding support when compared to countries like United States of America, Canada, United Kingdom, China, Germany, France, Singapore, Australia and other EU member countries.*

India needs a comprehensive, forward-looking geospatial policy with clear quantified goals with 10-years framework of implementation. To put things in perspective, a corollary can be drawn with the evolution of mobile telephones in India. Started in 1997, with the formulation of TRAI, the Indian Telecom Policy, 1999, established a separate Department of Telecom to look after the forward-looking policy formulation in line with technology adoption and overseeing the regulatory aspects. The recent National Digital Communications Policy, 2018 (Draft) has clearly defined goals on investment, employment generation, contribution to GDP, new technology adoption, and Make in India as presented below. The geospatial sector in India currently requires the same approach to harness and deliver on its potential.

Envisioning National Geospatial Policy

National Geospatial Coordination Mechanism:

- → Establishing a Department of Geospatial Science and Technology (DoGS&T) in the country.
- → National Geospatial Policy with definite goals on investment in the sector, exports, employment, contribution to national GDP (taking the geospatial economy from current INR 20.3 thousand crore to INR 97.5 thousand crore by FY2027-28)
- → Open geospatial data access and distribution policy for private sector, institutions, and NGOs

National Geospatial Goals:

- → Geospatial services exports worth INR 39.0 thousand crore by FY2027-28 (from INR 6.6 thousand crore in FY2017-18)
- → Establishing the modern geodetic infrastructure, terrestrial positioning augmentation system by 2022
- → 1 million skill job creation in geospatial domain by FY2027-28
- → Enhanced role and participation in international networks especially UNGGIM, OGC, ISPRS, CEOS, Indian Ocean Rim Association, etc.

Human Resources Development:

- → Holistic geospatial education in India including revamp of higher education and research in geography and geology sciences, postgraduate and interdisciplinary courses, research programs.
- → Establishing GIS labs with access to certificate courses as optionals, self-finance basis to all streams.
- → Vocational skill development and certification courses in survey, GIS, photogrammetry, etc.

Geospatial Industry & Innovation Eco-system:

- → Special focus for establishment of incubators (minimum 10 by 2022), accelerators (establishing a geospatial challenge program), co-working spaces (at NGAs with access to lab and data), venture funds (with target to invest US$ 100 million by 2022), centres of excellences (one in every state), in partnership with private sector, user departments and academic and research institutions under a national geospatial innovation promotion program
- → Special focus on research fellowship and innovation grants for knowledge commercialization in the domain
- → Establishment of a geospatial technology park in Hyderabad, Bangalore, and Dehradun
- → Creation of a separate reporting code to capture the share of geospatial products and services in the domestic and exports market

Enhancing Geospatial Adoption:

- → Establishing geospatial technology integration wings at national and state level
- → The use segment specific geospatial adoption frameworks development with targets for geospatial information management and data-driven decision support systems in different departments by 2022 to enhance productivity and competitiveness.

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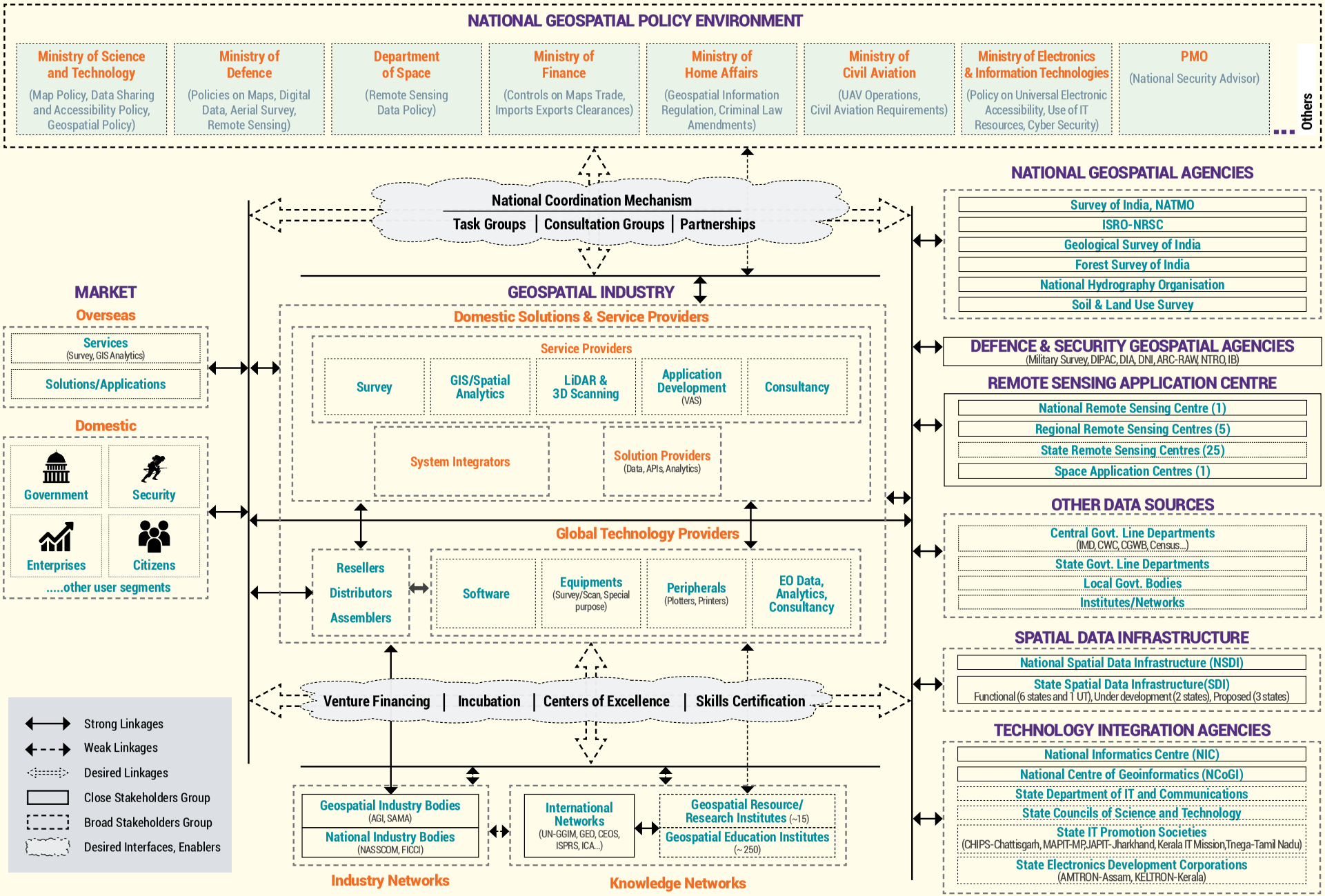
Indian Geospatial Landscape - Recommended



NEW INDIA VISION

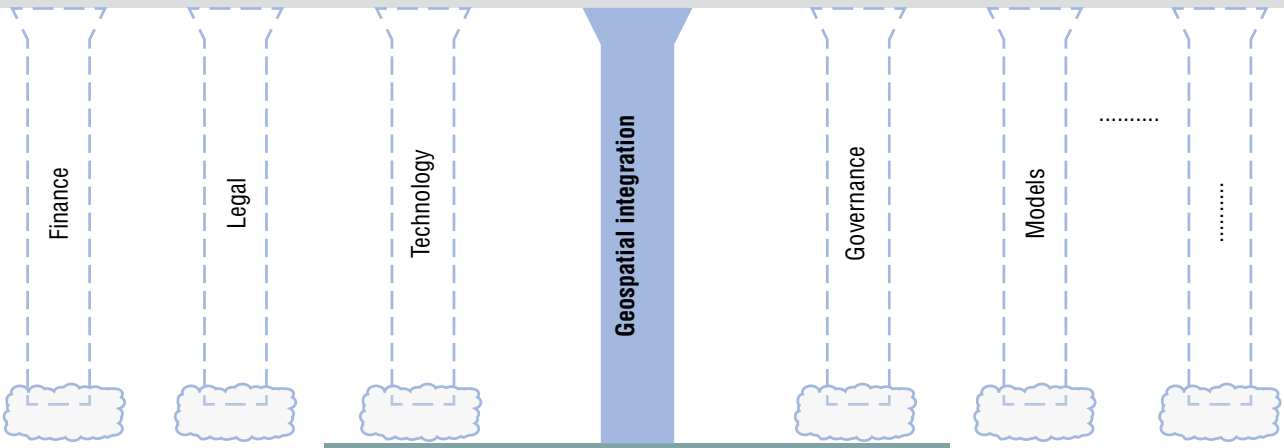
Swachh, Swastha, Shikshit, Sampann, Saksham, Surakshit Bharat by 2022

Plan 2022: Integrated or Umbrella Programs

Roads	Railways	Waterways	Aviation	Energy	Urban & Rural Development	Mining	Natural resources	Agriculture	Digital India, Security, Finance, Skill Dev.
• Bharatmala, Sagarmala, Waterways • Integrated Power Development Scheme(IPDS), UDAY • Smart Cities, AMRUT, Housing • RURBAN clusters						• National Hydrology Project (NHP) • Groundwater Management (NGWM) • Environment Monitoring • River Rejuvenation Programs • Doubling farm income			• E-kranti • Police and armed forces modernization • Direct transfers • Insurance

Key contexts	Emerging perspectives
• 40th place in the global competitiveness ranking of 137 countries by the World Economic Forum (WEF) 2017-18 report • 107th in United Nations(UN) e-government survey 2016 among 193 countries • 131th place in Human Development Index report 2016 (HDI) among 188 countries by United Nations(UN) improving only 4 ranks since 1990 i.e. last 25 years.	• **Ubiquitous digital technology ecosystems** • **Rise of trillion dollar state economies in India**

Strategic Enablers



Policy Framework
Geospatial Policy Framework | Enabling Policies

Geospatial Data Infrastructure
Data Infrastructure | Positioning Infrastructure | Platforms and Portals | Standards

Institutional Capacity
Research and Post-graduate courses | Graduate, Diploma and Certificate courses

User Adoption Level
Mapping or Service Level | Asset Management | Analytics and Workflow | Enterprise Level

Industry Capacity
Industry Networks | Innovation Promotion / Incubation | Industry Capacity

GEOSPATIAL READINESS FRAMEWORK

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