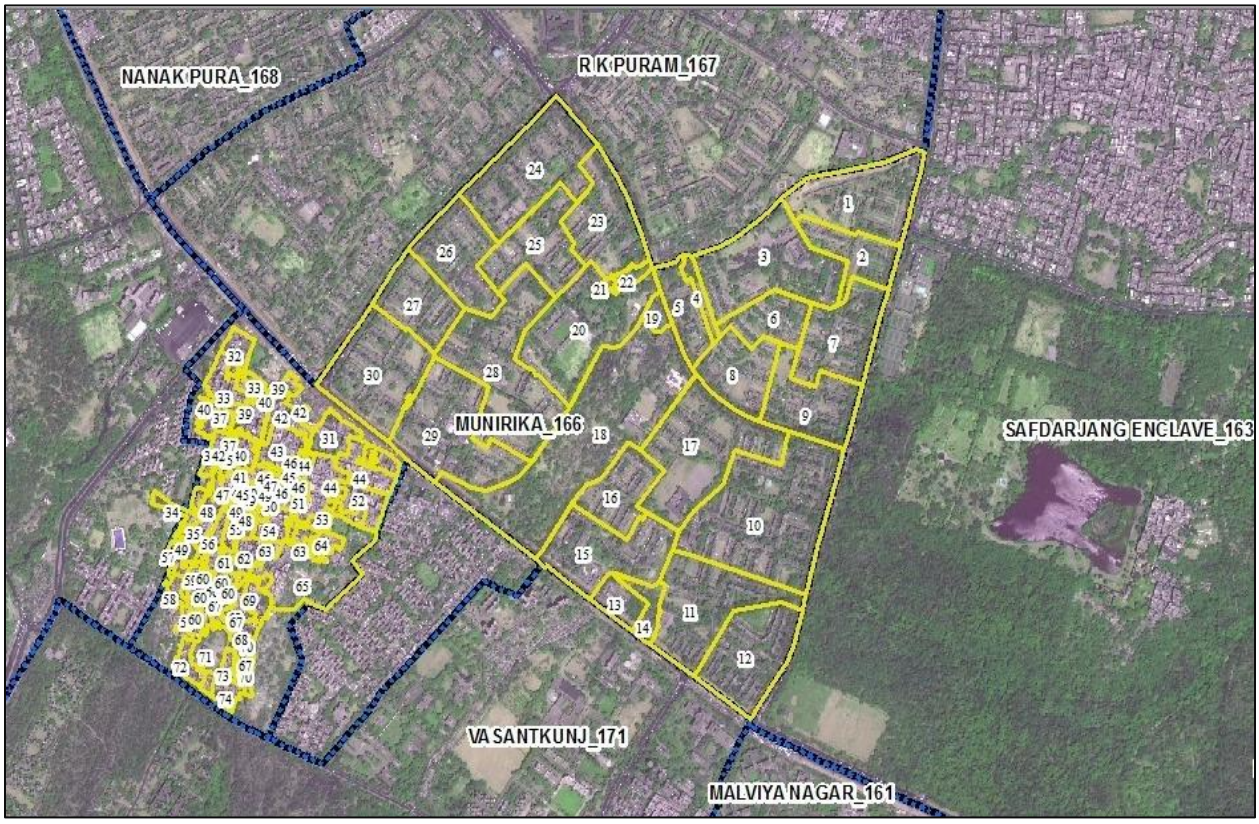
Case Study

Delhi State Spatial Data Infrastructure (DSSDI)



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1. EXECUTIVE SUMMARY

High quality, reliable, geo-spatial information is critical to virtually every sphere of socio-economic activity – urban planning, land management, infrastructure development, disaster management and forestry etc. The Government of Delhi initiated the Delhi State Spatial Data Infrastructure project in 2008 with the intent to use the geospatial technologies in governance / urban planning.

DSSDI project was an outcome of a pilot project by Department of Science and Technology, Government of India, on 3D GIS in Chandani Chowk area, Delhi. The project has proven to be of immense usefulness, especially the 3D databases, for various applications for Government of Delhi. It has enabled change detection on real time as occurring on the ground. The project covers a total area of NCT Delhi of approximate 1500 Sq. km. The Project was proposed to cover all lands, buildings and all underground utilities within the NCTD. The project was proposed to facilitate detection of illegal constructions by the Government of Delhi and monitoring of any changes being made in respect of land and building in NCTD on real time basis.

The project has proved to be the forerunner of many such SDI (Spatial Data Infrastructure) projects within the country, which will give a very sound foundation for e-Governance.

2. INTRODUCTION

The scene of an urban landscape is generally similar across Indian cities, including the metros, and Delhi is no exception. There is the 'old city' area, Chandni Chowk, which has somehow withstood the onslaught of the construction boom, preserving its narrow lanes and cluttered dwellings and shops. Here, the roads get dug up frequently to make room for more sewage lines, telephone ducts, gas pipelines and electric lines. Once you travel away from this 'heart' of the city, you may find yourself in a relatively planned neighborhood. Here, one will find new construction activities in full bloom, along with road widening and laying of new underground utility lines. It is a chaotic backdrop in front of which the Government of NCT of Delhi works hard to provide all utility and related services to its citizens and at the same time tries hard to keep in check illegal construction and its associated menaces.

The government required a vision to make this a less chaotic scene. They wanted a tool, a system, which could pinpoint location of a cable duct underneath a busy road, or the correct location of a disputed land holding. It had to be a system that was always available as and when required - no point digging a well when thirst was felt. The

objective of DSSDI project was to primarily build the 3D spatial datasets using modern technologies.

3. OVERVIEW OF THE PROJECT OWNER

- ***Details of the owner***

Born in 1966, Shri. Rajendra Kumar is an IAS of 1989 batch. He is an IIT Alumni from Kharagpur and has worked in several departments, including education, Information technology, health and transport. He has also been credited for change in Government school performances during his tenure as Director, Education around 10 years ago. Shri Rajendra Kumar has been a former Secretary, DIT, of Government of NCT of Delhi.

- ***Details of his current position/managing unit:***

He was recently serving as the Principal Secretary to the Chief Minister of Delhi till the time the Government dissolved. He is currently serving as Secretary, Department of Urban Development and Director of local bodies (DLB).

- ***His/ her experience on the project:***

At the very onset, a High Power Steering Committee was formed under him to review the project and sort out any contentious issues. As Secretary of Department of Electronics and IT (which was overseeing the project) Sh. Rajendra Kumar was instrumental in taking day to day decisions or advising the High Powered Steering Committee regarding the conceptualization, implementation and monitoring of the project at various stages. He emphasized the immediate requirement of creating the required infrastructure such as generators, UPS, networking facility, so that there is no delay in starting up after the finalization of tenders.

When the project was held up or delayed for any reason, the implementing agency would invariably request Secretary IT for sorting out the issues. During this inception phase, although there wasn't much resistance in the beginning but during the implementation, it came to the fore that various government departments were extremely resistant in providing attribute data and most of the concerned people being unavailable due to exigencies, elections or manpower constraints.

Since the basic premise of implementing this initiative revolved around conducting highly accurate GPS surveys for the entire area of Delhi which could only have been achieved by installing state of art IP cameras at strategic locations, he always expressed his concern towards security and safety of the IP cameras thus installed. Besides, he made sure that HPSC committee so formed shall be convened every fortnight with a view to resolve problems expeditiously by inviting HODs of participating departments so that project gets completed on time. He always expressed the need to finish the project in stipulated time with effective outcome.

4. PROJECT OVERVIEW / HISTORY OF THE PROJECT

Earlier, there were deficiencies in scientific urban planning and lack of basic authentic physical spatial data. Geospatial data was either not available or it was available in fragments with some individual departments. Repeated field surveys were required whenever any department needed geographical attribute. No standard mapping procedures were followed. Thus, integration of maps was not possible and strategic planning based on holistic geospatial data & attributes was not possible. There was no reliability of data either. Different results would be given when data was sought at different times. Searching, collating and analyzing data was a herculean task in itself involving lot of time and effort. Top level management was unable to get an overall view of the ground level attributes / status along-with geo-spatial data.

Seeing the impending requirement of a system which could provide holistic and uniform ground level realities to the top level management, an MoU was signed between Delhi Government and Survey of India in 2008 to implement the DSSDI project. Contract was awarded on March 7, 2008, through competitive bidding.

Entire area of Delhi (except the restricted area) has been covered under the project. The dataset of the DSSDI project includes 356 geo-spatial layers (above the ground, on the ground and below the ground) with the attribute data of about 29 departments / agencies.
The project was intended to achieve high accuracy GPS surveys for entire Delhi, establishing control network including monuments, photogrammetric capture (from aerial photographs and in 3D) of roads, buildings, parks, water bodies and all over-ground features, generation of base map on 1:2000 scale and an Orthophoto; surveys for underground utilities using Ground Probing Radars; creation of Land Information System (LIS) and Urban Spatial Information System (USIS), setting-up of 2 Control Centers and 10 Monitoring Centers with IP Cameras and a DSSDI Portal for line departments of Government of Delhi, and generation of 3D pictorial data base as well as capacity building for line departments of GNCTD. The LIS was conceived for up to date cadastral information. The USIS was conceived for the spatial data/information requirements of urban planning for routine functions of the line departments of Delhi.

GNCTD, through legislation has made it compulsory for all government departments to use the common database created under DSSDI project. All GNCTD departments are duty bound to update the data periodically. It is mandatory for all line departments of GNCTD including civic authorities, planning bodies, custodian of cadastral maps and other users of public money to use common digital database with multiple layers as a means of reducing conflicts while undertaking future planning, design engineering and construction activities including digging the roads. DSSDI data is also being used for:-

a) City planning
b) Urban development
c) Land management
d) Management of over ground / underground utilities
e) Traffic management
f) Property tax/other revenue collection,
g) Updating property records,
h) Pollution and environment monitoring,
i) Security planning and management,
j) Hazards and Disaster Management,
k) Change detection Analysis of building construction
l) Deciding the Title of Land/building by judiciary.

5. SITUATION IN PROJECT OWNER's STATE/ DISTRICT

Need for Delhi SDI

The Delhi administration felt the need of large scale accurate spatial datasets covering 1500 sq. km area for planning and monitoring of various developmental activities and providing citizen-centric services. In order to ensure the updated procedure in the spatial and attribute datasets, the need to create a geospatial act was felt to mandate keeping the data and services updated and current, conforming to the emerging technologies and standards.

In the past, several government departments developed spatial datasets with 2D geometry pertaining to their domain but the datasets from different organisations followed different standards in terms of scale, projection, accuracy, content and format.

Geo spatial scientific data has always been in high demand - utility companies like electricity, water and natural gas, government agencies like Delhi Jal Board, power companies, sewage maintenance department, public works department, the list is endless. However, there was always a lack of standardized data. Available data was sporadic and was not useful for all purposes - it was often specific or in poor form, since each agency or department had looked at its own need in isolation whenever such data had to be created.

The reasons for such lack of data are clear - it's no easy task to create this data in the first place. It involves numerous surveys - both air and land based, along with radar based ground mapping. It also involves monumentation and control framework design, ortho photography and photogrammetry. Data modeling and system design is the next phase, along with creation of an appropriate information system which shall present the data in

a usable format. Thus, it was not a task that could have been handled by a single line of department.

- ***Stakeholders***
  - Line Departments
  - Public Authorities
  - Public/Private Agencies
  - Local bodies
  - Regularity Authority of the Govt. of NCT of Delhi
  - Geospatial Delhi Limited
  - Citizens

- ***Beneficiaries:***
  - Municipal Corporations of Delhi (MCDs)
  - Delhi Jal Board (DJB)
  - Directorate of Education
  - Department of Health and Family Welfare
  - Department of Posts, Government of India
  - Delhi Transport Corporation (DTC)
  - Directorate of Census Operation

- ***Steps taken by the owner to address the problem***

This necessity for the data gave birth to a pilot project by Department of Science and Technology, Government of India on 3D GIS in Chandani Chowk area, Delhi.

The successful pilot eventually led to the DSSDI project. The Department of IT gathered inputs from each participating line department and built every component of the project from scratch. The base map was created through the photogrammetric procedures on a large scale (1:2000), using aerial photography substantiated by various kinds of field surveys, namely topographic survey, property survey of dwelling units, underground utility surveys (including water, sewer and energy utility) and field photography in order to generate textures for the 3D models of the buildings. At the peak of the project execution, close to 1000 field surveyors were deployed.

Two major components of Project are the Land Information System (LIS) and the Urban Spatial Information System (USIS). The LIS has been aimed for having up-to-date cadastral information while the USIS shall cater to spatial data/ information requirements of urban planning. Special purpose vehicles (SPV), Geo-spatial Delhi Ltd has been formed, authorized to keep the records of the land-holdings ownership, land use etc.

6. MODALITIES OF THE NEW SYSTEM (SOLUTION)

- ***Details of the solution(s) that is implemented:***

Before the Delhi Geo Portal could go live, it obviously required the databases, maps and the related logic to be built into the system. The preparatory activities included high accuracy GPS surveys for entire Delhi, establishing control network including monumentation, photogrammetric capture (from aerial photographs and in 3D) of roads, buildings, parks, water bodies and all ground features, generation of base map on 1:2000 scale and an Orthophoto; surveys for underground utilities using Ground Probing Radars. The above activities led to the creation of Land Information System (LIS) and Urban Spatial Information System (USIS), setting-up of 2 Control Centers and 10 Monitoring Centers with IP Cameras and a DSSDI Portal for line departments of Government of Delhi and generation of 3D pictorial data base as well as capacity building for line departments of GNCTD. The LIS was conceived for up-to-date cadastral information. The USIS was conceived for the spatial data/information requirements of urban planning for routine functions of the line departments of Delhi.

In order to effectively utilize the geospatial data for urban planning, "The Delhi Geospatial Data Infrastructure (Management, Control, Administration, Security and Safety) Act, 2011" was notified. It envisages inter-alia:

- Mandatory sharing, accessing and utilization of Delhi Geo-Spatial Data (29 line departments were identified)
- Setting up of Legal entity under section 25 of the Indian Companies Act (namely Geospatial Delhi Ltd)
- Service level agreement with other departments
- Establishing Regulatory Authority for enforcing provisions of the Act

- ***Innovativeness of the project:***

  - 63 IP cameras located at building tops with the capability of detecting changes up to a distance of 3-5 kms. The wireless remote controlled cameras monitor the entire Delhi for unauthorized constructions and also used by the Police for surveillance and

management of security events. 2 Control Centers and 10 Monitoring Centers connected through IP cameras at strategic locations. The online video recording with change detection facilities is able to pin point unauthorized constructions as well as act as ears and eyes of Government during major events and demanding situations involving serious accidents/disasters.

- Government departments are able to add data of public interest such as online availability of beds in the hospital, availability of vacant seats in the educational institutions and update them from time to time. Keeping the security aspects in view, select layers of DSSDI are also available in public domain to users across the nation via internet thus commencing the digital era. All other layers are available to authorized users of line departments of GNCTD. Geospatial Delhi Limited, a company already incorporated and functional owns and manages the process.

- ***Technology Platform used:***

The Delhi GeoPortal solution is centered as a Service Oriented Architecture (SOA). It is independent of data format and is platform-neutral. This enables exchange of information with any other service within the reach of the network without the need to make changes to the underlying program itself. The end user is able to avail GIS functionalities using standard web browser. The web portal is linked to around 28 stakeholder departments currently. Dedicated 4 MPLS network is being used as virtual private network. The network is configured with a unified architecture and provides scope for future scalability of the whole system without major architectural changes.

The Delhi GeoPortal

- provides a solid foundation to discover, query, and access multi- geospatial data and services
- enables Portal users to connect with related user departments through authored channels, search for and view metadata, access and view geographic data and Web services, and publish (register) their metadata and services on the geo-portal and
- facilitates value added applications from the main server

Moreover, mobile GIS enabled person are based in the field to acquire, store, update, analyze and display geospatial information. Mobile GIS integrates one or more of the following technologies:

- Mobile devices.

- Global Position System
- Wireless communications for Internet GIS access

The use of smartphones for collecting data (providing feedback about the actual state in the field and integration with GIS maps) for feedback and remedial action has been demonstrated. In the long run, there is potential to use remote sensing by enabling near-persistent surveillance of key geographic areas and identifying anomalies through spectral processing etc.

SMS & email:

The Delhi GeoPortal is integrated with email services through which line department/stakeholders communicate to the concerned officials of Geospatial Delhi Ltd.

- ***Interoperability:***

Interoperability implies that the communicated information is understood by the receiving system. This has been taken care of by taking following steps:

- The software used can seamlessly integrate with most existing GIS environments. It can support numerous geospatial data formats.
- It is compliant with OGC and ISO standards and can interact perfectly with external systems and applications.
- Proven technological standards such as Java results in ease integration into IT environments, including security.

- ***Security/ User Management and Administration***

Security is one of the important components in the entire system. Access to the system is password protected. DSSDI Project has implemented various layers of security.

- Physical Security
- Software Security
- User Management and Administration: For secured and authorized access to Data, Network, Devices and Application
- Physical Controls: Physical controls to access the data center and other resources
- Access Control (Web Feature Services) : Secure access to data
- Service Continuity: Redundant IT resources, including bandwidth
- SSL : The DSSDI portal has been developed and deployed on Secure Intranet. The DSSDI Public Portal has been developed using SSL.

- ***Any issue with the technology used:***

  - Initially there was a delay in GPS observations because of unprecedented rains. Difficulties were faced in survey of properties because of unavailability of residents or resistance on part of residents to provide data
  - In some cases, there was a delay in providing attribute data by stakeholder departments due to exigencies, elections, manpower constraints etc.
  - While connecting IP cameras to monitoring centers, it was observed that some of the buildings had excessive interference due to other radio waves. This implied that wireless feed was not of high quality and leased lines had to be considered.

- ***Service level Agreements (SLAs):***

  - The MOU between GNCTD and SOI (Survey of India) was signed with Government of Delhi.
  - There were various SLAs that were signed with MTNL for providing connectivity to the departments.
  - Multiple department level SLAs will be in picture once the citizen centric information will be provided by GSDL.

- ***Measures to ensure replicability:***

- The DSSDI Project has a highly distributed, replicable and scalable architecture. The project has implemented 10 identical Monitoring Centers equipped with miniature version of the Control Centers to share the load when required. The Monitoring Centers also balance the load of Change Detection Processing for all IP Cameras deployed across the city. In case of failure of a Monitoring Centre, the entire processing can be shifted to another Monitoring Centre on the MPLS.
- The system has been implemented on state of the art Enterprise Grade Equipment. The current storage requirement of the project is 25 TB and the available storage subsystems are scalable up to 96 TB. The Database server is currently populated with Dual EPIC Processors and is scalable up to eight processors providing a 4 times scalability in processing performance when required.
- Currently, 28 stakeholder departments have leased line facility with control center. In due course more departments are expected to get this facility. Scalability will not be a problem as:
  - Connectivity will be ensured through SLA based leased lines and

- There will be only a marginal increase of load on the server at the backend as the geospatial features have already been mapped.

o The existing database will be thrown open to the public shortly through internet based public geoportal. In case planning for the entire NCR region is to be done on a holistic basis, the same infrastructure can be suitably upgraded with nominal investment and satellite/aerial imagery.

➢ ***Restrictions, if any, in replication and or scalability:***

DSSDI Project has a highly distributed, replicable and scalable architecture. Hence there are hardly any restrictions for its replication or scaling up in future as required. Redundancy is maintained by having 10 monitoring centers and in case of failure in one or more centers, remaining centers can cater to the additional load.

➢ ***Risk Analysis:***

The project involves gathering, processing, analysis and publication of geo spatial data which may capture details of sensitive establishments, such as layouts, bird's eye view showing detailed facility structure as well as personally identifiable data such as housing scheme layouts and locations of specific assets. Moreover, during processing of data, the data may get modified intentionally or unintentionally, if it fell in wrong hands. Thus, data security was a critical risk that was analyzed early and addressed by hosting the data at the secured data center and using secured and encrypted connections. Data open to public access was only for viewing purpose, without any scope for modification.

➢ ***Capacity Building model used:***

Department level workshops were held. The advisors of GSDL interacted with their allocated departments to enhance the level of the departmental users in updating and utilizing Geospatial data/maps. It is now proposed to set up full-fledged facilities for hands on training over the Geospatial system (including geo web portal). A workshop "Sensitizing schools with the versatility of GIS" was conducted for the school students on November 14, 2012

7. IMPACT ON THE STAKEHOLDERS/BENEFICIARIES

➢ ***Cost benefit analysis:***

Each of the department especially like MCD are likely to increase their revenue by 50 % immediately and other departments cost will reduced by on average of 20 to 30%.

Costs are further reduced as the leased line access available to departments enables visualization of database on computers, thereby reducing the need for excessive printing through costly plotters.

- ***Value delivered (qualitative and quantitative):***

  - ***To Organization:***

    - All stakeholder departments have access to Geospatial maps/imagery along with attribute data in respect of more than 356 layers (as authorized) through a dedicated high band-width (4Mbps) leased line. The graphic interface provides easy navigability after clicking on the website icon. Use of DSSDI database will lead to enhancement of property tax collection, report generation on status of property tax and updates on tax paid.
    - The DSSDI project has revolutionized the planning process. Generation of high resolution maps (on a scale of 1:2000) with attributes, have facilitated micro level planning. There is reliability of results. Query facilities have drastically reduced the time required to access data, analyses it and present in a form that is useful. Now there is no need for each department to do field surveys as the DSSDI database/maps are available. This has led to savings in costs of repeat surveys.
    - The top level management is now able to get overall view of the ground level attributes/status along-with geo-spatial data, thereby facilitating planning for remedial measures.
    - The "Plan Dig Monitor Application" has eased the process for the departments for planning and getting utility and spatial information of the area of interest, for digging/excavation purposes.

  - ***To Citizens:***

    Applications for using mobile and GIS are being conceptualized. For example, a mHealth system can serve pregnant women. The pregnant woman can send SMS via GPRS network thereby giving her ID and coordinates (Longitude and Latitude). The server, on receiving the SMS can search database and help the pregnant women in different ways e.g. find her location (home, market, etc.) in emergency cases, inform ambulance service about the co-ordinates, advise about the nearby health care centers, send message to nearby hospital etc.

  - ***Other Stakeholders:***

    Through the PDM Application, online enrolment of contractors and grant of permission on a single window interface would be possible in a few months.

8. FUTURE ROADMAP / SUSTAINABILITY

The existing portal is being revamped for streamlining web enabled single window services to contractors for registration and permission for construction/excavation activity. It is proposed to set up a separate Geo portal for the public/citizens in the next phase. Crowd-sourcing is contemplated for Geo-tagging, updating and validation of Geospatial/attribute data.

A separate project "Development of Smart city using DSSDI dataset" with an estimated cost of Rs.21.1 crores has been recently approved by the Department of Electronics and Information Technology (DeitY), Government of India under World Bank funded scheme. Citizen centric services will be one of the components of the project.
In future digital certificate tokens are envisaged upon integration with G2C services such as Property Tax etc.

- **Sustainability**

Since the architecture is such that it has been developed using Open Geospatial Consortium (OGC) GIS standards, there is no vendor lock-in, thereby ensuring longevity and adaptability. A common standard for all departments enables sharing, overlay of different thematic layers, integration of Geospatial data/maps and effective planning on a sustainable basis. The network is configured with a unified architecture and provides scope for future scalability of the whole system without major architectural changes.

Creation of infrastructure and facilities for updating through leased lines between departments and control centers has provided a sustainable basis for updating of data. Frequent updating of data is being ensured by GSDL through field surveys/departmental inputs. Satellite has been purchased in 2012 and has become base for geospatial data updation.

GSDL has large pool of dedicated resources not only for updating the spatial data but also to train the officials of stakeholder departments such as Geospatial Advisors for interaction with the line department and planning of long term and short term activities with the department using Geospatial technologies, Geospatial Executives for development of application software, maintenance of geo-portal, liaison with departments and lastly, Geospatial Associates and Assistants for lab based creation and updation of GIS data using satellite image and departmental inputs. This ensures quality inputs on sustainable basis for data updates, maintenance and utilization.

9. ANNEXURE(S)

EXHIBIT – 1 – Glossary

Sr.	Abbreviation	Explanation
1.	DJB	Delhi Jal Board
2.	DSSDI	Delhi State Spatial Data Infrastructure
3.	DTC	Delhi Transport Corporation
4.	ERDAS	Earth Resources Data Analysis Systems
5.	GIS	Geographic Information System
6.	GNCTD	Government of National Capital Territory of Delhi
7.	GPS	Global Positioning System
8.	GSDL	Geo Spatial Delhi Limited
9.	HPSC	High Power Steering Committee
10.	IIT	Indian Institute of Delhi
11.	IP cameras	Internet Protocol cameras (Send/receive data using internet)
12.	LIS	Land Information System
13.	MCD	Municipal Corporation of Delhi
14.	MOU	Memorandum of Understanding
15.	MPLS	Multi-Protocol Label Switching (networking technology)
16.	MTNL	Mahanagar Telephone Nigam Limited
17.	NCTD	National Capital Territory of Delhi
18.	OGC	Open Geospatial Consortium (Standards organization for GIS and related domains)
19.	SDI	Spatial Data Infrastructure
20.	SLA	Service Level Agreement
21.	SOA	Service Oriented Architecture
22.	SOI	Survey of India
23.	SPV	Special Purpose Vehicle
24.	SSL	Secured Sockets Layer (protocol for securing websites)
25.	TB	Tera Bytes (1 TB = 1000 Giga Bytes)
26.	USIS	Urban Spatial Information System

EXHIBIT -2 – Comparative Analysis of earlier vs. new system:

SN	Criterion	Before DSSDI	After DSSDI
1.	Business Process Reengineering	• Lack of a unified process for availing GIS information • Unavailability of Geospatial data; Any available data was in fragments with individual departments	• Scientific methods for collecting and preparing geo spatial data • GIS data available to individual departments as required i.e. GIS as a Service • Department (Customer) centric service
2.	Change management	• Lack of standard operating procedures and little knowledge of geo spatial data usage among the departments	• Training given to all departments • Department wise Geo-spatial advisors appointed to enhance level of GIS data usage and updating
3.	Outcomes achieved	• Repeated surveys carried out by departments • Unreliable data, not updated frequently	• Savings in individual departmental efforts and costs • Strategic planning possible based on holistic geospatial data & attributes
4.	Benefits	-	• Reliable and authentic data available as required • Easy searching, collating and analysing data • PDM (Plan Dig Monitor) application enables exact digging/excavation in city areas
5.	Legal changes	-	• Delhi Geospatial Data Infrastructure Act, 2011 (Management, Control, Administration, Security and Safety) • A separate company was set up to manage the geo-spatial database. It has four levels of geospatial personnel on its rolls. • A Regulatory Authority was constituted to enforce the provisions of the Act.