LIS DIVERSIFICATION & PARCEL FABRIC APPROACH IN EFFECTIVE LAND ADMINISTRATION

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ABSTRACT

Being the national organization responsible in Surveying and Mapping for the entire country, Survey Department of Sri Lanka (SDSL) initiated the Land Information System (LIS) in 2007. LIS has been followed in many transitional stages to overcome the issues prevailed in spatial data processing in different times. This paper describes on several stages of the LIS transition.

The experience, we gathered in working for the Land Information System (LIS) for last few years, made us realized both complexity and simplicity of land data compilation and modelling to the parcel fabric for diversification of the LIS. The LIS, at its current status, aims to produce sketches for issuing of land Title Certificates through the Register General Department (RGD). With this thematic orientation of the Land Information System, the importance of valuable land data at high accuracy levels collected at high cost would be idling and out-dated at absence of dynamic resolutions. Proper management of these land parcel data beyond statistical manner, to elaborate multipurpose cadastre phenomena on collaboration with prospective dynamic data sources currently available with many institutions would benefit the nation in effective land administration. Further, the un-surveyed areas of the country would be mapped with tracing the boundaries of individual land parcels with comparatively lower accurate survey techniques in order to elaborate seamless parcel based LIS to sustain the government concept of e-Land Banking. Hence, product diversification can be positively realized through integration of various data sources.

In this technical paper, we endeavour brief introduction about materializing and functioning of Parcel Fabric and e-Land Bank, which finally elaborate a smart LIS towards product diversification.

1. INTRODUCTION

1.1 LIS Inception

Survey Department of Sri Lanka (SDSL) had initiated the Land Information System (LIS) in 2007 with the idea of elaborating a friendly system to facilitate the spatial data community with up-to-date land information. Since its inception, the cadastral survey data collected in field surveys under the Land Title Registration Project (LTRP) had been taken as the LIS input source. The field survey data collected with electronic total station equipment and the tenement information as collected at field survey stage have been processed to develop the LIS.

Land Title Registration of the Country has been mandated by the Survey Act, No.17 of 2002, from which the Surveyor General has been empowered as the principal authority responsible for receiving, storing and exchanging in any form land related data for maintaining the Land Information System. Hence, the responsibility of the SDSL in maintaining the LIS is expanding continuously with improvement of the enabling technology in the spatial data environment.

However it's very important to mention that the SDSL has commenced to collect spatial data in digital format-AutoCAD drawings, since 1990 onward, aiming the final product of conventional printed survey plans.

By 2008, Land Titling Registration act was fully implemented under the "Bimsaviya[*]" project with initiating at 18 administrative divisions; Divisional Secretary Divisions (DSD[†]). Further, field survey data collection has been

[*] *Bimsaviya" is an expedited project to issue Title Certificates to land owners under Land Titling Registration Act.*

expedited with increasing the land surveyors in each DSD[**]. With expediting the field data collection and related field activities through "Bimsaviya" project, receiving of field survey digital data to the LIS has been increased at a great deal.

1.2 Initial Step of LIS Data Processing

The field surveyors stationed in respective project areas, firstly investigates and demarcates the survey block/zone, which consists about 100-land parcels, mostly bounded by natural features, in order to conduct the survey and preparation of Cadastral maps. Then the surveyors conduct collection of data with electronic total station equipment and follow up necessary editing, through AutoCAD software tools to prepare the layout plans. They should structure raw digital data in accordance with the guidelines provided by the Departmental Survey Regulations (DSR) to satisfy the LIS requirements. The LIS spatial data preparation is done through the ESRI-ArcGIS software tools following the coverage topology principles. The processed datasets are then archived in seven different layers as detailed in the Figure-1,

LIS data preparation is conducted in order to clean and build the topology of spatial datasets so that parcel polygons, boundaries and nodes are created as identical object entities. Each land parcel is then numbered with 12-digits national unique number as the specific key attribute for all the references. The parcel inherited attributes; such as extent and the boundaries are maintained as the feature class attributes at this stage. These sets of block based spatial data have been archived in the LIS center as Electronic Spatial Archives.

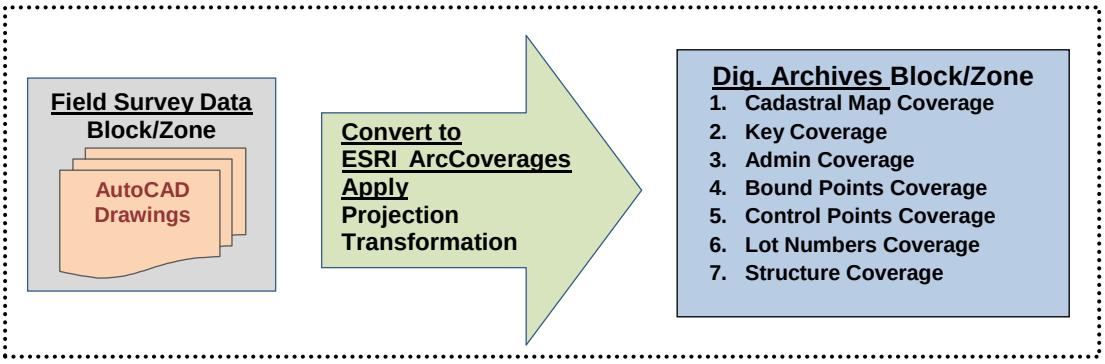

Figure-1: Electronic Archives of ESRI ArcInfo Coverages

Associated land tenure information for each land parcel, which hava been collected in field survey stage are maintained in MS-Access Db-files named as TLDb. These two sets of spatial and non-spatial attributes data are separately archived at the LIS center of the SDSL. Since, the TLDb has been maintained in MS-Access, it cannot be used in multiple editing environment through network. The data collected over the country has to be populated in to single database at the LIS center. Even though each set of attributes have been specified with the corresponding parcel number, it could be learnt that an ambiguous situation in consistency at the effort of linking the data sources. Therefore, the TLDb data can only be maintained as an Electronic Inventory of the land parcel information.

Working with an Inventory based spatial data sets is rather complicated and it arouses controversial situation at the presence of GI based sophisticated software tools, which immensely supports towards user friendly geo-spatial information systems. Availability of parcel based spatial data in SDSL archives and being unable to corporate interactively with the stakeholders with relevant information would result towards darkness of the LIS community.

Land Information System as a total solution for the country's land administration has to be thorough for stakeholders' requirements. While the SDSL being a key organization for the LIS, who provides the system with spatial component of the LIS with parcel inherited attributes, collaboration with external organizations is crucial for a sustainable system performance. A brief configuration of the LIS and its internal and external stakeholders are shown in the figure-2.

Information & Communication Technology (ICT) as an essential component of the LIS has to be magically performed in all the activities of the LIS. However, while the SDSL faced a critical drawback in ICT applications

[**] Divisional Secretary Division (DSD) is the 3rd hierarchy of Administration of Sri Lanka

since last two decades, the improvement of the LIS can be stated as a greater achievement for land administration of the country.

LIS as an information producer should possess as many as its entity related non-spatial attributes on stakeholders' interest. It has been resulted towards an ambiguous situation of data analyzing and manipulation of the LIS. Therefore developing an electronic protocol for sharing the basic information related with land parcel at stakeholder forum would elaborate the prospective clients to initiate value added services on their own interested scope.

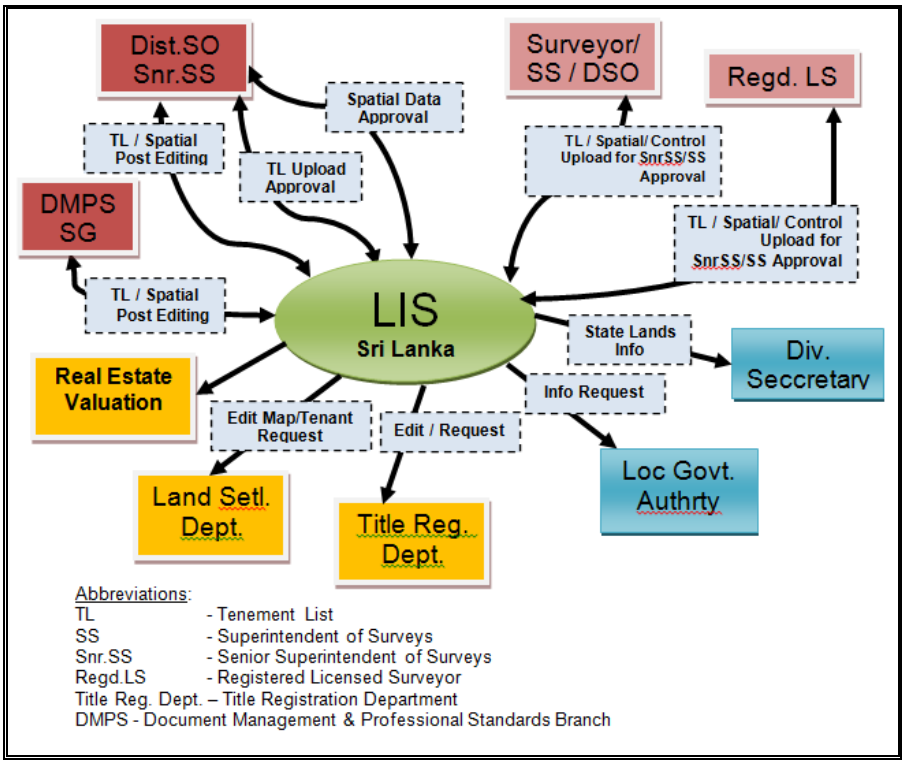

Figure-2. LIS-Sri Lanka and Its Stakeholders

2. SPATIAL DATA CONSISTENCY AND SEAMLESS APPROACH

Manipulation of spatial data in a parcel based LIS is rather complicated in both aspects of accuracy and maintenance for subsequent surveys. Land parcel as the main object entity of the system should be dynamically managed for its changes in individual properties. Therefore a proper study of the each dataset is essential for defining the method of data processing to LIS.
The digital spatial data archives in SDSL can be learnt in three different categories in respect of accuracy, lineage and their processing levels as follows;

1. Field Surveyed, parcel based Data with identical national grid coordinates.

2. Field Surveyed, parcel based Data, scanned/digitized from hard copy plans, which can be considered as graphic land parcels.
   Field surveys, which had been carried out in years back and no digital data available are considered in this category. Since the data have been extracted from old survey sheets, merging the adjoining sheets would form gaps and overlaps, which could really be learnt as digitizing errors and no seamless approach be possible for these data.

3. Field Surveyed, block or area based Data, scanned/digitized outer boundaries from existing land administrative survey plans.
   There are a large amount of conventional survey plans, which are essential to be dealt with new surveys. Even the outer boundaries of these survey plans with relevant Meta information are crucial to depict in a LIS. Hence, the digital traces under this category can be incorporated in the LIS as graphical displays for maintaining the system consistency.

A combination of the above three data categories with corresponding information would formulate an effective LIS for Sri Lanka at preliminary level. Defining of specific attributes to manage each dataset identically has to be followed at Data Modeling stage.

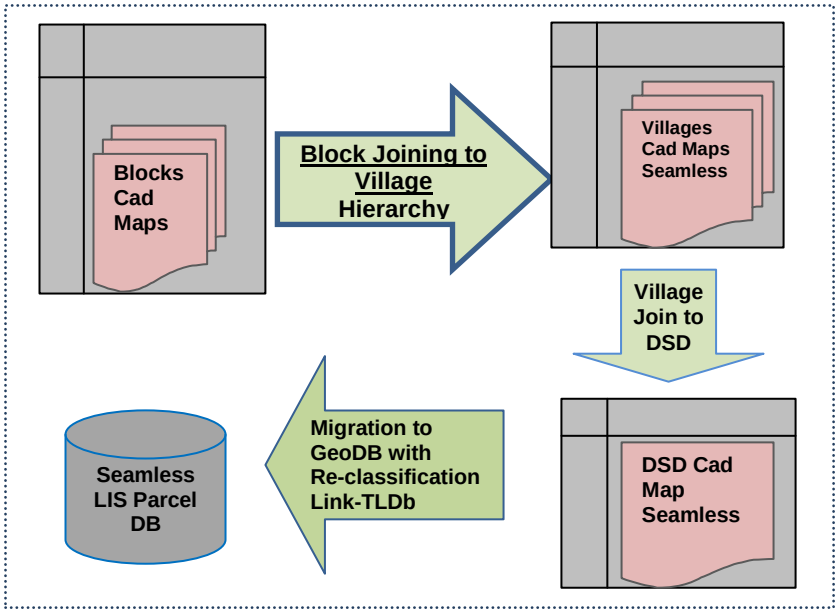

Figure-3. Digital Archives to GeoDB Seamless Approach

Further, in addition to the above datasets, which are in full or partial digital format, there are thousands of land administrative survey plans in the SDSL archives, both in centrally and district offices as hard copies. Within the context of land administration and legal framework of the country, these survey plans are crucial to refer for new surveys in order to maintain the legal consistency of individual land parcel enabling to depict in the LIS.

Therefore, digital approach of all the existing land administrative survey plans could be a boon towards an effective decision making tool for property ownership handling through the LIS.

The steps followed in approaching the seamless datasets for afore mentioned category-1 (high accuracy) dataset is illustrated in the Figure-3.

3. CONCEPTUAL MODELS OF SD-LIS AND CORPORATE LIS

Field survey data collected by the SDSL has an utmost legal authority in which the Surveyor General is responsible for their respective adjudication matters. Hence, the conventional survey records; field books and originals of hard copy plans are archived in respective district offices in secure manner. In digital environment, similar responsibility should be maintained in the SDSL offices while a greater attention should be paid on data duplication and unauthorized alterations.

While maintaining a secure digital archive, dissemination of Geo-information would become a major responsibility of the SDSL as the national organization for Cadaster. In order to face this challenge the SDSL needs to follow its own strategies on prevailing ICT arena. Hence, conceptualizing the needs in Survey Department administration and stakeholders' corporation of the LIS, the terminologies; SD-LIS and Corporate-LIS will be discussed in the following paragraphs.

3.1 SD-LIS

In the process of modeling the land parcel data, there are many specific regulations carried out to maintain the spatial data accuracy and consistency in which, general customers and the external organizations are not merely interested. Such a dataset should be properly maintained and dynamically updated by the SDSL within the organization and it could be denoted as "SD-LIS".

The SD-LIS should mainly be consisted with following spatial entities and consistencies with relevant attribute information to explicitly describe, manipulate and update the dataset in any location.

- Should be a well-structured set of parcel data in a specific domain area of DSD.
- History records should be maintained as dead parcels with status date.
- Specific spatial entities, which may explicitly describe a land parcel; Polygon, Boundary and Nodes with inherited attribute information, should be maintained.
- Associated and supportive feature classes for analyzing and visualizing should be incorporated.
- All the tenement information as available in the collection should be associated.

In addition to the above main feature classes, the associated feature classes; Admin, Transport and Building feature classes or any other raster images can also be maintained as the supportive data layers.

3.2 Corporate LIS

As detailed under SD-LIS, since the general customers and external organizations are interested in corporation with the LIS for their individual or organizational needs and interaction with their own data for elaborating towards value added products, there should be a simple and consistent dataset for external client's interaction.

An up-to-date dataset which provides land parcels as closed polygon entities with related parcel information and privilege to interact with external users is considered as Corporate-LIS, which is explicitly a subset of SD-LIS.

Gaining the reality of sustainable Corporate-LIS would not merely be SDSL's individual effort. However, the land parcel as the key object with its inherited attributes becomes the initiative and crucial beginning for the concept of Corporate-LIS.
The SD-LIS, which contains every aspect of basic survey data, interactively collaborates with the SDSL administration as internal clients; it externally collaborates with the GIS community or any other legal needs of interested parties, such as court commissions and adjudication institutes.

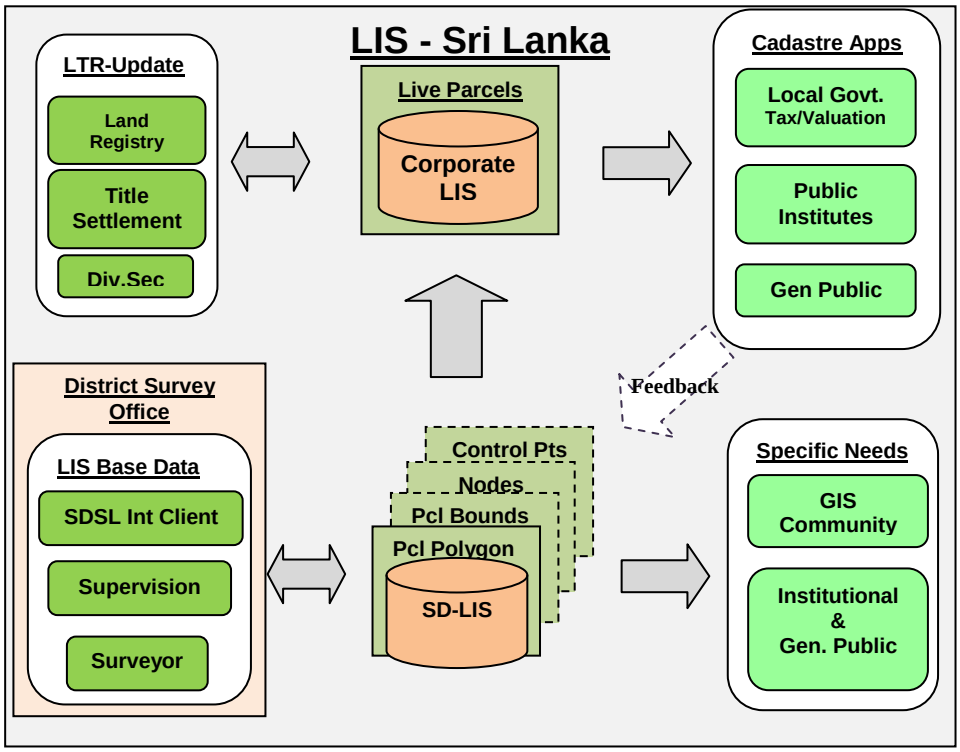

Figure-4: LIS-Sri Lanka: System Architecture

The Corporate-LIS, which contains a refined set of parcel data, fulfills the national needs of a Land Information System towards an effective land administration. This dataset should frequently or on-line be updated as privileged by the software tools. Information through Corporate-LIS may be accessed to any interested parties, explicitly towards multi-purpose cadaster applications.

The figure-4; shows the LIS top-level conceptual architecture for SD-LIS and the Corporate-LIS.

Client feedback can be expected through the cadaster applications for the improvement of Admin-LIS with value added information. Specially, the Admin-LIS may be incorporated with up-to-date building and land use data from the municipalities.

4. PARCEL FABRIC APPROACH

4.1 Parcel Fabric Terminology and Overview

In conventional terminology; the word; "Fabric" comes under textile and dressmaking industry. However, there are subtle differences of this term in specialized usage. In geo-information environment, the word; "fabric" is coupled with the word; "Parcel" to form the new terminology "Parcel Fabric". Hence, a clear definition of the term "Parcel Fabric" is unable to trace in any reference media. However, modern geo-information industrialists have collected few specific meaningful set of words to elaborate definitions on their specific industrial scenarios.
The terminology; "Land Bank" in many countries refers to an inventory of lands with relevant information for effective real estate management. Hence, the term "e-Land Bank" can simply be described as an inventory of land and connected information on electronic manageable protocol.

Commencing from the paper based media, Geo-information, comparatively at larger or smaller scale, publication had been conventionally played specific role in location based information at prevailing user demands. In the electronic transitional era, a several species of productions, which are being extinct from time to time, had been introduced in the market. They can be learned in numeric hardware and software tools, which were available in the market as mass production for the Geo-information community. While Magnetic Tapes, Floppy Disc, Compact Disc and Flash drives were most common as data travellers or archives, publication of interactive geo-spatial data in AutoCAD, ArcMap, Cartographically enhanced digital maps became so popular as application tools in various computer devices.

Meanwhile, with the drastic improvement of on-Line integrated electronic protocols in every aspect of computerized systems, geo-spatial infrastructure opens unstoppable way forward to the Geo-data producers. Therefore, drafting a conceptual model for proposed Parcel Fabric in Survey Department would be a forum to share new thoughts among the potential Geo-spatial community.

The government policy plans and follow up strategies in land sector has clearly shows the provisions to way forward in land bank concept. The sustainability of land bank concept would basically depend on its main input source; the land plot with relevant information. Since, the parcel fabric would be a real spatial data engine to support the land bank, its model should be a genuine and well defined architecture to enforce the land bank functions.

4.2 How to Define Parcel Fabric & e-Land Bank

4.2.1 Parcel Fabric

With referring to the terminologies given in introduction, parcel fabric as a new terminology can be defined in different scenarios. Therefore, with in the context of Survey Department functions, the following meaningful definition can be drafted in order to elaborate the expected mechanism.

"A collection of Topologically related land parcels, put together, in which the information of any geo-referenced plot of land could be electronically accessed at anywhere, anytime"

In more complex manner, further extended definitions may be formulated at different scenarios in order to manipulate a system on adjustable control point basement. However, a simple and timely achievable scenario may be much convenient to initiate targeting to cater the national demands in land information. Further, a simple and objective scenario may facilitate to accommodate the system with conventional data available at different accuracy levels.

4.2.2 e-Land Bank

Basically, the terminology, "Land Bank" as detailed in introduction, refers to an inventory of Land records for effective manipulation of banking proceedings. In most of the conventional cases land bank records have been maintained as tabular inventories similar to land registry folios. However, in the prevailing status, the e-Land Bank obviously refers to an electronic protocol, which elaborates an interactive graphical performance of each land plots

with connected information to facilitate the general banking requirements. Therefore, the Parcel Fabric should provide the up-to-date and consistence sets of base data, especially, live land parcel to e-Land Bank.

4.3 Parcel Fabric as a Tool in Land Administration

In conventional land administration, Land Information System (LIS) can be learned as a tool for land administration and the Cadaster can be considered as the main facilitator in LIS. Conceptual architecture of the three terminologies is illustrated in the figure-5.

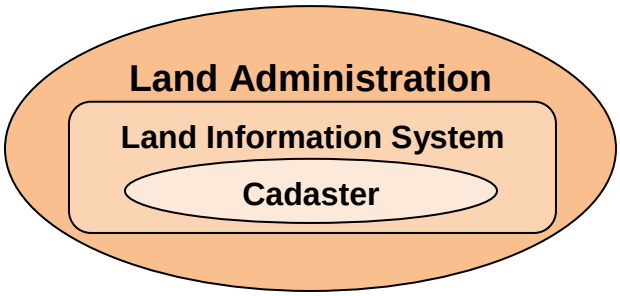

Figure-5: Conventional LIS at Cadaster & Land Administration

The LIS of Sri Lanka, maintained by the Survey Department is based on the Land Plot (Land Parcel) boundaries collected in cadaster surveys under "Bimsaviya" project in order to facilitate the issuing of land titles. Hence, the current LIS can be denoted as "Conventional-LIS" and a new system, which will be designed in collaboration with parcel Fabric interaction, would be much diversified to cater the dynamic need of e-Land Bank objectives. LIS can elaborate magical performance at interactive electronic protocol with customizing numerous GIS application tools. Such a LIS can really envisage as Smart-LIS. Figures 2 & 3 below illustrate functional models for Smart-LIS in collaboration with Parcel Fabric and e-Land bank.

Product diversification would be the main characteristics of the proposed Smart-LIS. System architecture of the proposed Smart-LIS would be figure out as shown in the Figure-6. LIS stakeholders' interaction at Parcel Fabric would privilege the system more dynamic towards a Smart-LIS.

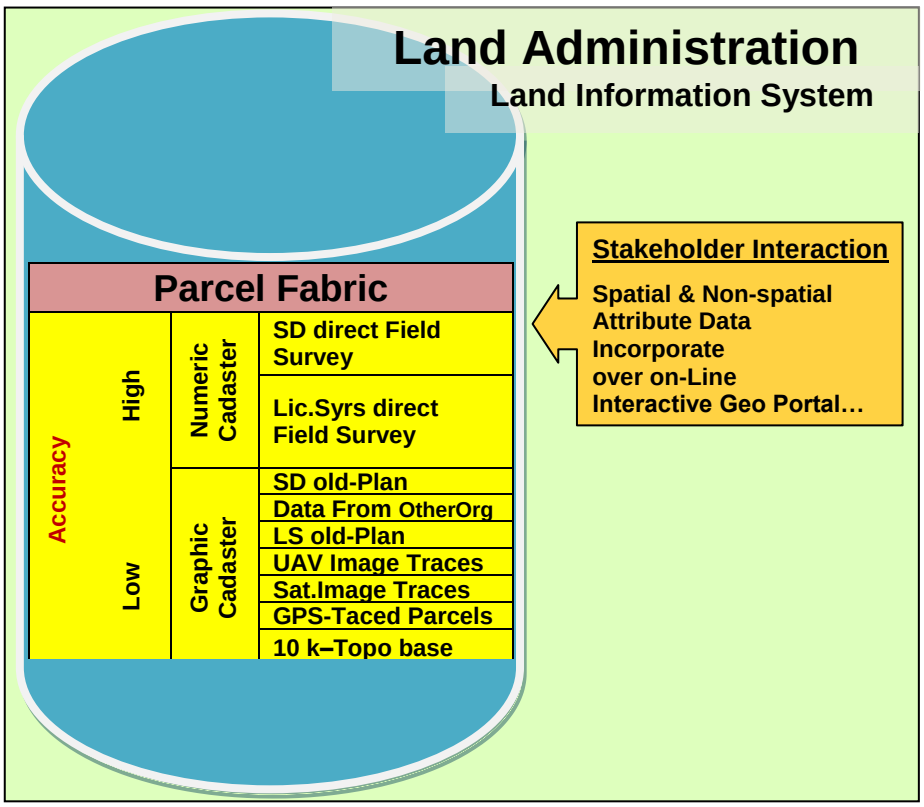

Figure-6: Smart-LIS over Parcel Fabric

4.4 Parcel Fabric Provisions to e-Land Bank Approach

As detailed early in this paper, Parcel Fabric and e-Land Bank can be considered as new technical components in LIS. The performance of the Parcel Fabric would configure the effectiveness of the e-Land Bank. Therefore, the Survey Department as the responsible organization to define a conceptual model of parcel fabric should concern the Parcel fabric functions and materials within. Figure-7, below illustrates the Parcel Fabric functionality and the e-Land Bank services.

In modeling the Parcel Fabric, data can be basically learnt in two approaches; namely, Graphic cadastral Data and Numeric cadastral Data. These two data species can also be learnt, depending on accuracy status; low to high, from which cadaster can be differentiated as Graphic cadaster and numeric cadaster. Graphic cadaster is a graphical representation of land parcels as traced polygons, which can be a collection of land plot boundaries extracted in various methods rather than comparatively precise land surveying. Numeric Cadaster is too a graphical representation of land parcels as polygons but these polygons would be crated with accurate field surveying with well-defined vertex coordinates, which can be used in subsequence survey proceedings.

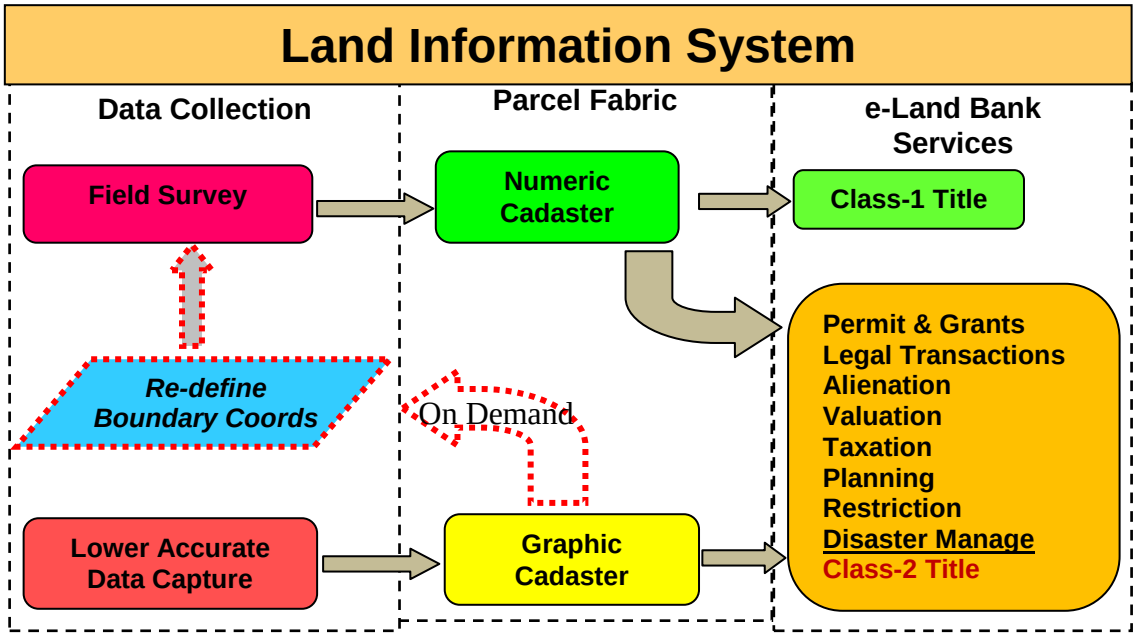

Figure-7: Parcel Fabric and e-Land Bank Architecture – Logical Model

Both the species; graphic cadaster and numeric cadaster would facilitate the e-land Bank to generate numerous services as illustrated in the figure-7. However, only the Numeric cadaster would facilitate issuing of class-1 title certificate under the Land Title registration (LTR) Act no.21 of 1998. The class-1 Title Certificate is the government guaranteed certificate for land ownership under the aforesaid Land Title Registration act. The LTR authorities may have to concern about issuing of Class-2 Title Certificates, from which ownership may be secured subject to a judicial decision, on basis of graphic cadaster. Possibility of converting the graphic cadaster in to numeric cadaster as an on-demand optional routine through a re-survey of parcel boundary can be exercised as a pilot project so that the minimum cost and time effectiveness would be observed.

4.5 Parcel Fabric Working Model

A several steps can be experienced in the process of real world applications as illustrated in the figure-4 below; Conceptual models and logical models of parcel fabric have been discussed briefly in the previous paragraphs. The most important step of the application; working model, which shows the work proceedings to carry out, will be discussed under this chapter. Figure-8, illustrates the working model of the parcel fabric with its functioning steps.

4.6 Topo-10 data Basement

Some of the feature datasets of 1:10,000 scaled Topographic data (Topo-10) available in GIS unit should be traced in to the system as base data. These data should be processed under Geo-processing tools to prepare 25 District seamless data sets. The consistency of each District dataset may be followed in image comparison (*eg: Google satellite images)* or field investigation. This dataset can be considered as the base layer in the parcel fabric.

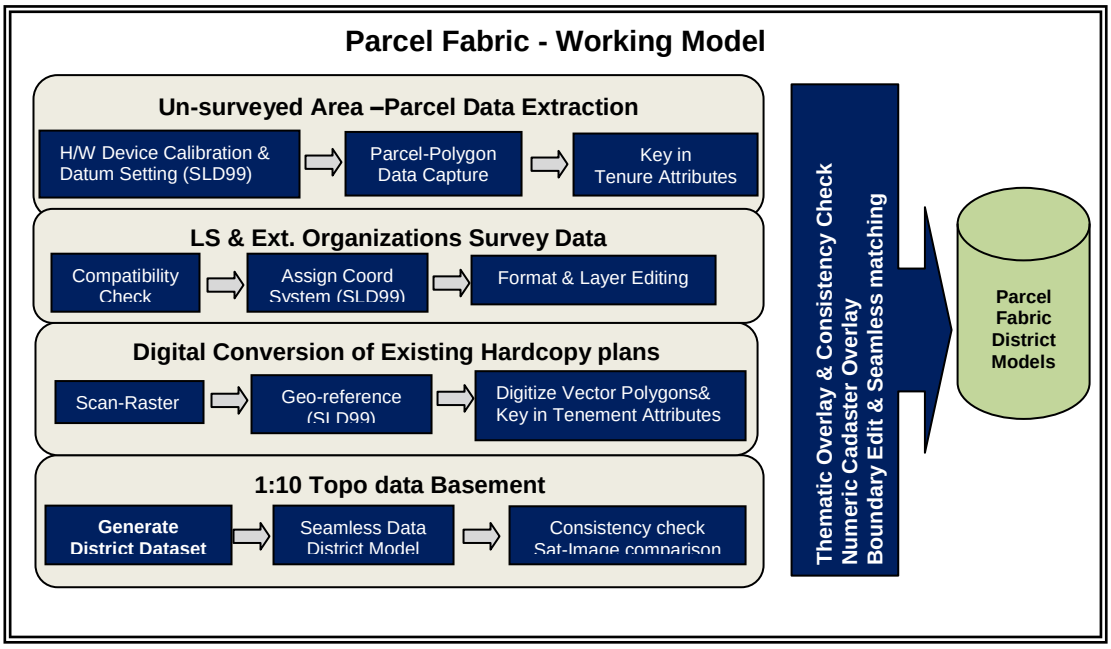

Figure-8: Parcel Fabric Working Model

4.7 Digital Conversion of Existing Hardcopy plans

The digital data set of all the surveyed land plots, which are in hardcopy stage or soft images should be learned for digital vector conversion. In this process, selected raster images should be geo-referenced in to Fabric coordinate system; SLD99. Then digitizing of identified polygons and key in tenement attributes should be followed.

4.8 Licensed Surveyors & External Organization Data

Variety of geo-spatial datasets, collected in different format, accuracy levels & purposes, which could still be meaningful for many applications can be found in different organizations. This type of data may firstly be checked for fabric compatibility. Correct coordinate system; SLD99 may then be applied. These data can easily be traced to the system after format editing and validation process.

4.9 Parcel Data Collection for Un-surveyed Area

Modern technology at numerous survey methods in capturing the parcel boundaries and relevant information of un-surveyed areas may be followed in order to compile the seamless District in parcel fabric. The survey technics and software tools may differ from place to place and even from time to time. The datasets can be images, vector data and also hybrid spatial data as Fit-for-Purpose mode.

4.10 District Seamless Models

Thematic layers and numeric cadaster overlay together can be very much meaningful at this stage for consistency checking. Edge matching of individual datasets should then be followed up and clipping away the lower accuracy datasets at the presence of higher accuracy data can be strategically managed.

The above proceedings can be repeatedly followed up at initial stage to elaborate a cleaned and comparatively precise and consistent District parcel fabric.

5. CONCLUDING REMARKS

Similar to any other workable system, sustainability of parcel fabric and e-land bank would depend on how far it satisfies the prospective stakeholders, how far it is closer to the real users and even how much it's profitable in fulfilling customer needs.

Parcel Fabric should be consisted with seamless sets of spatial data, which are consistent and compatible with the remaining data within the system.

Creation and maintaining of Parcel Fabric would be a technical solution for compiling land parcel data to cater the e-land bank services. However the legal framework and the logical data model should be drafted as prioritized task to streamline the regulatory updates and to ensure the legal validity of the system.

In this extended massive task, to be carried out over the country by dedicated group of employees, the data standards and uniform electronic protocol would be a crucial factor for everyone to follow up.

e-Land Bank services to cater the growing customer needs could only be achieved by proper IT protocol with assistance of state-of-the-art technology.

Proper approach of parcel fabric concept over the country would be a great opportunity to challenge the organizational strength of the present Survey Department.

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