OSCAR PROJECT REPORT – GHANA

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List of Important Acronyms

ICT	Information and Communications Technology
IT	Information Technology
GoG	Government of Ghana
FLOSS	Free/Libre Open Source Software
FAO	Food and Agricultural Organization
IP	International Programmer
IPL	International Project Leader
LAP	Land Administration Project
LCS	Lands Commission Secretariat
LDBD	Local Database Developer
LIS	Land Information System
LITT	Local Information Technology Trainer
LIU	Land Information Unit
LP	Local Programmer
LRD	Land Registration Division
LSA	Land Sector Agencies
LVD	Land Valuation Division
MiDA	Millennium Development Authority
MLNR	Ministry of Land and Natural Resources
NLP	National Land Policy
OASL	Office of the Administrator of Stool Lands
OSCAR	Open Source Cadastral and Registry (tools)
PVLMD	Public and Vested Land Management Division
SMD	Survey and Mapping Division
STDM	Social Tenure Domain Model
UMLIS	Urban Management Land Information System
TCPD	Town and Country Planning Division

1. Introduction

This report contains a series of sub-reports comprising individual work products on cadastral and land registration conditions and processes in Ghana relative to the input requirements for development and implementation over the next three years of the 'Open Source Cadastral and Registration' (OSCAR) tools, prototyped at the School of Surveying, University of Otago, New Zealand.

Several documents have been used as benchmark references for the current state of cadastral records management in Ghana. These include the work of Dr. Isaac Karikari, who has published a number of peer reviewed papers on the challenges facing land administration in Ghana and the implementation of information technology-based solutions (Karikari, Stillwell and Carver 2002; Karikari, Stillwell and Carver 2003a; Karikari, Stillwell and Carver 2003b; KariKari, Stillwell, and Carver 2005; Karikari 2006). In addition, documentation from the on-going Ghanaian Land Administration Project (LAP) managed by the Ministry of Lands and Natural Resources (MLNR – formerly the Ministry of Lands, Forestry and Mines (MLFM)) through funding from multiple donor agencies including the International Development Association (IDA), Nordic Development Fund (NDF), Canadian International Development Agency (CIDA), United Kingdom Department for International Development (DfID) as well as the German Bank for Reconstruction (KFW). The LAP has insisted on the use of a free/libre open source software solution (FLOSS) in their latest projects. Hence, there is compatibility in principle between the proposed OSCAR approach and LAP's general philosophical stance on software procurement and development.

As is the case with many developing countries, there are currently several similar, overlapping and potentially duplicating land information projects either underway or planned in Ghana. In September 2009 Phase 1 of the development, design and installation of a land information system (LIS) commissioned by the LAP will be completed by the Danish COWI Group (van Bennekom-Minnema, J., S. Johnson, S. Keith, Peter R. Eigaard, Bagge Nielsen, Lars 2008a, 2008b; Johnson 2008; Johnson and van Bennekom-Minnema 2009). In addition, the Swedish Government (through Swedeseurvey) is currently undertaking a project titled 'Urban management land information system' (UMLIS), which is being prototyped in three parts of the Accra metropolitan area. Whereas the first project seeks to develop a more integrated LIS concept, the second is more specific in that it seeks to create a database for management of land rent (through real property valuation and taxation).

The underlying data model for the Swedish UMLIS project is being developed in the proprietary environment of Microsoft SQL Server. Following the wishes of the LAP the COWI Group's project team has implemented their LIS software using two industry standard FLOSS database components, namely PostgreSQL and the PostGIS extension to handle spatial object geometries and spatial data manipulation (Johnson and van Bennekom-Minnema 2009). Both of these components are also used in the OSCAR prototype developed at the University of Otago (Hay and Hall 2009). The choice of the mapping component of the LIS project is a FLOSS tool named SharpMap, programmed in the .NET environment using C# code. Both the COWI LIS and the OSCAR tools are licensed under the GNU General Public License (GNU GPL).

van Bennekom-Minnema et al. (2008a 40) propose in the development of the LIS 'a holistic national approach of data, (where) the data in the UMLIS is recommended to play a role in the exchange of

data, to and from the LIS'. The same general approach is also used in the OSCAR approach, namely that all land related data should be as format neutral to the extent possible so that data exchange between potentially incompatible formats and software environments is not necessary (i.e. projects should aim both for software *and* data fusion in order to avoid the problem of conflicting tools and conflicting data for the same end goals – improving the easy of managing land parcel and registry records management).

Since it appears that the LIS project objectives are generally similar to those of the OSCAR project the COWI group's work has been examined closely in preparing this report. Despite similarities in purpose and approach, there is an important difference between the two projects in that the latter uses a flexible event-based approach to the modeling of land records, whereas the former uses a state-based approach derived from the complex entity-relationship model that comprises the Social Tenure Domain Model (STDM) (Lemmen and van Oosterom 2006). Event-based database modeling is based on the concept of change (i.e. the arrival of a new event, which may be a new document or a changed existing document, for a process) as the underlying driver of database operations. In contrast, state-based models are concerned with checking the current state of records to determine whether anything has changed since the last check. State-based models record the changed state, but this has no association with the process or the event that caused the change. This makes it extremely difficult (practically impossible) to rollback states, and there is no association with state changes in other objects. If these functions are added to a state-based model it quickly becomes very complex, hence this is a partial reason why the relationship between child and parent parcels is removed from the land administration domain model (LADM) and the associated STDM.

Hence, static, state-based database models have trouble dealing with bi-directional change (that is, moving forwards and backwards through the states of the system, which is usually achieved through the use of time stamping). They also have difficulty dealing with systemic change in that the complex schema of a state-based model, such as the STDM, must be reconstituted every time there is a change in a process that defines the system. In time as tables and relations are added such models can quickly become very unwieldy. The Land Information New Zealand LandOnLine application is an example of such a model. In contrast, an event-based database model handles systemic change relatively more easily as it requires little more than adding, removing or otherwise modifying events within workflows.

Despite this fundamental difference in approach, every effort must be made to coordinate the LIS and OSCAR projects in order for the Ghanaian government and its front line Ministries, Departments and Offices not to be faced with the problem of conflicting approaches, designs, and software tools at their disposal. In this context it is not necessarily a matter of one approach being better than the other. Rather it is more a matter of harmonization of approaches in order to avoid overlap and redundancy, and to provide end users with the greatest functionality and longevity in use as possible.

2. Review of existing environment

This section reviews the existing environment in Ghana's land records management. The five subsections provide a comprehensive overview of the nature, current state, and future plans for the Ghana's cadastral land registration system.

2.1 Legal Lands Administration Framework in Ghana

2.1.1 Brief Overview of Land Tenure System

Land law in Ghana is a complex mix of constitutional, legislative and customary law. Land is owned predominantly by customary authorities (stools, skins, clans and families). Together they own about 78% of all lands, the State owns 20%, and the remaining 2% is owned by the State and customary authorities in a form of partnership (split ownership or vested lands). From the perspective of tenure, two broad arrangements exist, namely customary and public land tenure.

2.1.2 Customary Land Tenure

The term customary land is used to represent all the different categories of rights and interests held within traditional systems in Ghana including stool lands, skin lands, clan lands, and family lands. They occur where the right to use or to dispose of use-rights over land rest neither on the exercise of brute force, nor on the evidence of rights guaranteed by government statute/law, but on the fact that they are recognized as legitimate by the community, the rules governing the acquisition and transmission of these rights being usually explicitly and generally known, but not normally recorded in writing (Bower 1993). Such ownership may occur in any one or a combination of the following ways:

- discovery and long uninterrupted settlement;
- conquest through war and subsequent settlement;
- gift from another land owning group or traditional overlord; or
- purchase from another land owning group.

Four categories of interests were adopted in the Land Title Registration Law, 1986, namely the Allodial title, the Freehold title, the Leasehold and Lesser Interests in land. These categories are briefly summarized:

- The **Allodial** title is the highest interest known to customary law beyond which there is no superior title. It is an interest which in some traditional areas in Ghana is acknowledged as being held or vested in stools or skins. In other traditional areas, this interest is held by sub-groups like stools, sub-stools, clans, families as well as individuals. The Allodial owner holds his/her interest under customary law in such a manner that he/she is under no restrictions on his/her rights of use or any obligations in consequence of his/her holding except such restrictions or obligations imposed by the laws of Ghana. The stool/skin in which the Allodial title is vested has complete and absolute freedom in dealing with the land. However, this is subject to the rights of the subjects of the stool/skin who may be in possession.
- **Freehold** title is categorized into two forms: customary law freehold and common law freehold. *Customary law freehold* (also called usufructuary title), is an interest in land held by sub-groups and individuals where the land in question is acknowledged to be owned allodially by a larger community who acquired it either by first cultivation or by succession from the first owning group of which they are members. In customary law, subjects of a stool have an inherent right to a portion of the allodial land and whenever they exercise such right by effective occupation or cultivation, this is enough to establish their usufructuary interest without the necessity of a grant from the stool/skin. Customary law freehold may be held

either on a corporate status by the sub-stool, lineage, family or by individuals. Customary law freehold is perpetual; it subsists as long as the owning group or subject or his/her successors continue to acknowledge the superior title of the stool. The interest is also inheritable and devolves on the holder's family upon the death intestate of an individual holder. The holder of the usufruct has the right to alienate his/her interest either by sale, lease, mortgage, pledge, or to grant agricultural tenancies such as "abunu" or "abusa", but such alienation carries with it the obligation upon the transferee to recognise the superior title of the stool and the performance of customary services due from the subject grantor to the stool/skin. *Common law freehold* is an interest in land which arises out of a grant in the nature of freehold made by the allodial owner either by sale or gift. Apart from this, the holder of a customary law freehold can create a common law freehold by grant to another person out of his/her interest. The effect of such a grant is that the parties have either explicitly or implicitly agreed that their obligations under such a grant should be regulated by common law. The grantee's rights under such a grant are defined by common law and it is common law rules that govern any dispute which may arise over the land.

- **Leaseholds** are rights granted to any person to occupy specified land for a specified term. They are derived not from customary law but from common law. A lease may be granted either by the holder of the allodial title or a customary freeholder provided he or she has not granted a conflicting interest in the same piece or parcel of land. A lease may be granted for any period of time. The 1992 Constitution, however, imposes a 50 year limit for leases granted to non-citizens.
- Various **Lesser Interests** in land can be created by owners of the allodial title or customary freehold. The two best known are "abunu" and "abusa" which are usually share-cropping arrangements by which the tenant farms the land and, at harvest, gives a specified portion of the produce to the landlord. In general, under "abusa" tenancy, the tenant farmer is entitled to a third of the produce from the land; while under the "abunu" system he is entitled to half of the produce. Variations of this practice exist in various forms or arrangements in the farming communities. There are instances where the land rather than the crops are shared.
- **Alienation** holdings include land acquired outright by a non-member of the land owning community usually for agricultural purposes.

Other customary tenancy arrangements.

- Community's common property rights – rights to secondary forest produce, rights to water, rights to common grazing grounds, etc.
- A range of derived/secondary rights.

There are, however, a number of traditional groups in Ghana which do not recognize a stool or skin as symbolizing communal land ownership. In such places, the allodial title may be vested in a clan or family. This form of land ownership is common in the Volta Region and in some areas in the Eastern, Greater Accra, Central, Northern, Upper East and Upper West regions. In these areas, the owning clan, family or individual which holds the allodial title has complete and absolute freedom to dispose of it. They can legally sue and be sued in any dispute involving such lands.

2.1.3 Public Land Tenure

Apart from the customary tenure arrangements described above, the State has powers through the instrumentality of legislation such as the Administration of Lands Act, 1962 (Act 123); State Lands Act, 1962 (Act 125); the Lands (Statutory Way Leaves) Act, 1963 (Act 186) and the Public Conveyancing Act, 1965 (Act 302) to acquire and hold land. The 1992 Constitution leaves intact the powers of the State to acquire and hold land. However, this power is subject to certain limitations.

Under the Administration of Lands Act, 1962, the President has power exercisable by an Executive Instrument (EI) where it appears to him that it is in the public interest so to do, to vest any stool land in him in trust for the stool. A similar provision exists under the State Lands Act, 1962. Under this Act, wherever it appears to the President to be in the public interest so to do, he may by an EI declare any land other than stool land to be acquired, and accordingly on the making of the instrument, it shall be lawful for any person acting in that behalf and subject to a month's notice in writing, to enter the land so declared for any purpose incidental to the declaration so made.

The Lands (Statutory Way Leaves) Act, 1963 permits the acquisition of land by the State for use as roads, highways and other utilities. The Public Conveyancing Act, 1962 also enables the Government of Ghana (GoG) to declare a stool land as a selected area for use by a select group/number of persons. Instruments made pursuant to the Public Conveyancing Act, 1965 have the same effect as those made pursuant to the Administration of Lands Act, 1962. Lands acquired by GoG under the instrumentality of any of the above pieces of enabling legislation become public lands, thus enabling the State to hold the same for purposes deemed to be in the public interest.

2.1.4 Legal Framework

The overall legal regime for land administration in Ghana consists of constitutional provisions, policy instruments, statutory enactments, judicial decisions, common law principles and customary laws and practices which have been enacted and developed over the years to regulate land rights generally. Courts have also ruled on customary law issues resulting in a body of legal precedents for some land related customs. Currently some 166 state laws that regulate land administration and establish mandates for different agencies exist in the statute books.

Under the currently operating Land Administration Project (LAP), the laws relating to land are to be consolidated into two pieces of legislation, namely the Lands Act to provide for Land Tenure, Land Administration and Land Management and Surveying and Mapping, and the Land Use Planning Act.

The key pieces of legislation within the Ghanaian legal framework are summarized in Appendix 1.

2.1.5 Constraints in Land Administration

The land tenure systems and land administration in Ghana are beset with a number of constraints. These are aptly captured in the National Land Policy of Ghana (Ministry of Lands, Forestry and Mines 1999) and can be summarized as follows:

- General indiscipline in the land market - characterised by the current spate of land encroachments, multiple sales of residential parcels, unapproved development schemes,

haphazard development, etc. These issues individually and cumulatively lead to environmental problems, disputes, conflicts and endless litigation.

- Indeterminate boundaries of stool/skin lands - resulting directly from the lack of reliable maps/plans, and the use of unapproved, old or inaccurate maps, leading to land conflicts and litigation between stools/skins and other land owning groups.
- Compulsory acquisition by government of large tracts of land which have not been utilised and for which payment of compensation has been delayed. By this policy, land owners have been left almost landless, denied their source of livelihood and have, in effect, become tenants on their own lands, giving rise to poverty and disputes between the State and the stools, as well as within the private land sector.
- Inadequate security of land tenure due to conflicts of interests between and within land owning groups and the State, land racketeering, slow disposal of land cases by the courts and a weak land administration system.
- Difficult accessibility to land for agricultural, industrial, commercial and residential development purposes due to conflicting claims to ownership and varied outmoded land disposal procedures.
- A weak land administration system characterised by the lack of a comprehensive land policy framework, reliance on inadequate and out-dated legislation, lack of adequate functional and co-ordinated geographic information system (GIS)-based tools as well as of transparent guidelines; poor capacity and capability to initiate and co-ordinate policy actions let alone resolve contradictory policies; and inappropriate policy actions among various land delivery agencies.
- Lack of consultation with land owners and chiefs in decision-making for land allocation, acquisition, management, utilisation and development has generated intractable disputes between the State and the private land owning groups and within communities.
- Lack of consultation, co-ordination and co-operation among land development agencies.

The net effect of these constraints is a distorted and dysfunctional land market that is not investor and development oriented and which cannot guarantee security of tenure, resulting in high transaction costs and high incidence of poverty.

2.1.6 Policy Framework

The first step in addressing, in a comprehensive manner, the myriad of land tenure challenges noted above was the formulation in 1999 of the National Land Policy (NLP). The long-term goal of the policy is to stimulate economic development, reduce poverty and promote social stability by improving security of land tenure, simplifying the process for accessing land and making it fair, transparent and efficient, developing the land market and fostering prudent land management.

The principal objectives of the policy are to:

- ensure that Ghana's international boundaries are maintained at all times and cross-border activities are managed jointly;
- ensure that shared water bodies are utilised to the mutual benefit of all stakeholder countries;
- ensure that all forms of socio-economic activity are consistent with sound land use through sustainable land use planning in the long-term national interest;

- facilitate equitable access to and security of tenure of land based on registration;
- protect the rights of land owners and their descendants from becoming landless or tenants on their own lands;
- ensure the payment, within reasonable time, of fair and adequate compensation for land acquired by government from stools, skins or traditional councils, clans, families and individuals;
- instil order and discipline into the land market to curb the incidence of land encroachment, unapproved development schemes, multiple or illegal land sales, land speculation and other forms of land racketeering;
- minimise and eliminate where possible, the sources of protracted land boundary disputes, conflicts and litigations in order to bring their associated economic costs and socio-political upheavals under control;
- create and maintain effective institutional capacity and capability at the national, regional, district, and where appropriate, community levels for land service delivery;
- promote community participation and public awareness at all levels in sustainable land management and development practices to ensure the highest and best use of land, and thereby guarantee optimum returns on land;
- promote research into all aspects of land ownership, tenure and the operations of the land market and the land development process; and
- ensure continuous education of the general public on land matters.

(Ministry of Lands, Forestry and Mines 1999).

The policy makes broad proposals for intervention and addressing the key bottlenecks besetting the sector. These proposals are aimed at:

- securing Ghana's international boundaries and shared water resources;
- facilitating equitable access to land;
- security of tenure and protection of land rights;
- ensuring sustainable land use;
- enhancing land capability and land conservation; and
- human resource development and institutional reforms (NLP 1999).

Within the policy framework, it is envisaged that the land administration agencies (also referred to in other documentation as land service agencies (LSA)) would be restructured and strengthened with a view to enhancing their capacity to deal effectively and efficiently with land administration delivery. In addition, a geospatial framework database would be established to serve as a backbone to an integrated LIS that would link and network all the LSAs in the country (Government of Ghana 1999 18).

2.1.7 The Land Administration Program

Based on the NLP, the land administration program is regarded as the means for implementing the individual policy proposals. It is a long term venture which seeks to enhance economic and social growth by improving security of land tenure, simplifying the process for accessing land, fostering prudent land management by establishing an efficient system of land administration, both State and

customary, based on clear, coherent and consistent policies and laws supported by appropriate institutional structures. It is to be implemented in five-year phases over 15 to 25 years (Project Appraisal Document 2003).

The first phase of the program is the creation of the Land Administration Project (LAP), which has a six year time horizon from 2004 – 2010. Its primary objective is to undertake land policy and institutional reforms and key land administration pilots for laying the foundation for a sustainable decentralized land administration system that is fair, efficient, cost effective and assures land tenure security. It has four main components:

Component 1: Harmonizing land policy and the associated regulatory framework for sustainable land administration.
Component 2: Institutional reform and development, which deals with the following components.
Component 3: Improving land titling, registration, valuation and information systems.
Component 4: Project management, monitoring and evaluation.

The overall expected outcomes of the project are:

- enhanced economic and social growth and poverty reduction through improved access to land and enhanced security of tenure;
- expanded role of civil society and private sector in land administration; and
- improved governance.

One of the major outcomes of the LAP to date is the passage of the Lands Commission Act, 2008, Act 767. The objectives of this Act are:

(a) to promote the judicious use of land by the society, protect people's rights and interest in land and ensure that land use is in accordance with sustainable management principles and the maintenance of a sound eco-systems; and
(b) to ensure that land development is done in conformity with the nation's development goals.

Section 5 of the Act reproduces the functions of the Lands Commission as set out under articles 258 (1) of the Constitution of the Republic of Ghana and adds to them the functions of the agencies that are to operate as Divisions of the Commission as re-established. The Divisions and their functions are summarized in Appendix 2, Parts 1 and 2 as the first two Divisions (Surveys and Mapping Division (SMD) and Land Registration Division (LRD)) are centrally important to the OSCAR project, and the additional Divisions will become eventually also be included in the OSCAR framework.

2.2 Status of Digital Data, Existing Data Model and Database Structures in Ghana

A summary of the status of existing spatial data in Ghana is included in Appendix 3. It should also be noted that the data sources at each LSA were identified as part of the implementation strategy report for the COWI LIS project (Johnson, 2008). The following subsections outline specific aspects of this information that relate to data needs of the OSCAR software as well as general spatial data structures. It is important to note that *there is no underlying 'data model' as such in Ghana and rather land information data lie scattered across the different LSAs in different formats, at different stages of currency, and with varying levels of*

quality and standards compliance. Steps are being taken under the LAP to remedy this. With the formation of the Land Information Unit (LIU) of the Lands Commission Secretariat soon to come a reality, a rationalization of the data will ramp up in the near future. In the interim, the closest that current data come to forming part of a functional data model is in the use of the STDM by the LIS. This model is not yet deployed in any of the LSA offices and pending the outcome and approval of the COWI project this may become a *de facto* data model for the land sector agencies of the GoG. However, it is not yet operational and this still appears to be some way off.

2.2.1 Land Ownership Data

The most significant land ownership data available in digital format are the sectional maps held by the SMD. These maps show the delineation of land parcels for each Land Title Registration District. A district, comprising one or more sections, is part of a region or area, and is defined (declared) according to the Land Title Registration Law PNDCL 152 of 1986. The parcels within the sectional maps are identified by a unique concatenated (XXDDDSSSBBPPPP) fourteen character field that is comprised of a two character (XX) Region Code, three digit District Number (DDD), three digit Section Number (SSS), two digit Block Number(BB) and a four digit Parcel Number (PPPP). All sectional maps within the Greater Accra Region have been digitized by the SMD.

Currently, all land title parcel maps digitized by SMD are in two of the ten regions namely, the Greater Accra and Ashanti Regions. Each region is zoned into Land Title Districts, demarcated into sectional areas (surveyed by licensed surveyors). Each sectional area has an average of 1500 parcels with sectional areas sub-divided into blocks of 30 parcels/Block. To date 7,000 parcels have been surveyed and registered (or in the process of being registered) at the LRD.

2.2.2 New Unique Parcel Number (UPN)

In 2008 the LAP constituted a Technical Committee to formulate and define the syntax for a *common* Unique Parcel Number (UPN) to be used by all LSAs. The final report of the committee's work was submitted in June 2008 and adopted for use by all LSAs at a stakeholders workshop organized by the LAP. The syntax adopted for the national UPN is EEE-NNNN-PPPP, where EEE is the 3-digit Easting of the 1km-UTM-grid cell (using the bottom left corner of the km-grid cell as the reference point), NNNN is the 4-digit UTM Northing of the grid cell, and PPPP is the given parcel number within this cell.

Figure1: Unique Parcel Number Seven Digit Prefix in 1 KM Grid for Section 02

The following digital datasets are also held by the SMD in ESRI coverage format or in Autodesk (AutoCAD) .dxf format:

- 1:2500 scale town sheets of urban areas and major towns
- Orthophotos and photomaps of urban areas and major towns
- National coverage of 1:50000 scale topographic base maps.

2.2.3 1:2500 Town Sheets

These maps were produced for the SMD under contract to private survey and mapping firms licensed by the Division. The town sheets comprise data layers on building footprints, contours, water bodies, roads and streets. Final outputs delivered in hard copy and digital formats (ESRI coverage format, Autodesk's AutoCAD .dxf format and Intergraph's Microstation .dgn format) were checked and approved by the SMD. Given that these datasets were produced under various projects, dates of map production vary for the different towns and it would be very difficult to establish dates of origin.

2.2.4 1:50000 Scale Topographic Base Maps

The national topographic map series is organized by tiles with 1 tile equating to 4 mapsheets excluding the international boundary. In total 102 tiles comprising 351 mapsheets composed into 102 digital tiles cover the land area of Ghana. These were photogrammetrically produced and compiled from aerial photos flown in the late 1970s. Since then these base maps have been updated for parts of the country depending on the availability of funds. The western region was updated in the 1990s in conjunction with the Japan International Co-operation Agency. The digital topographic dataset is therefore a product derived from the maps produced with aerial photographs acquired in the late 1970s. The constituent base layers of the topographic dataset are contours, hydrography, transportation network, settlements, and protected areas.

2.2.5 Orthophotos and Photomaps

Digital orthophotos, produced from 10,000 scale color aerial photographs acquired in 2004, exist for the entire coastal stretch of Ghana. Under the direction of the Land Use Planning and Management Unit of the LAP, a total of 15,000 sq km is to be flown to produce orthophoto maps. However due to several challenges, only 20% have been produced to date. In order not to forestall the land use planning activities, high resolution satellite images have been ordered and so far the area of Asankrangua in the Western Region has been received and accepted.

Under the UMLIS project orthophoto maps have been produced for the Ayawaso sub-metropolitan area. In addition, the whole of Accra is covered by aerial photographs. LAP is in the process of developing a call for proposals for the production of scanned orthophotos out of these images.

2.2.6 High Resolution Satellite Images

The GoG has taken delivery of IKONOS high resolution satellite images to support the production of enumeration area maps for the 2010 census. The spatial resolution is 80cm, with an accuracy of 15m CE90-exclusive of terrain displacement. The projection is UTM Zone 30 and the WGS84 datum. The imagery was delivered in GeoTIFF format. The extent of coverage is shown in Figure 2.

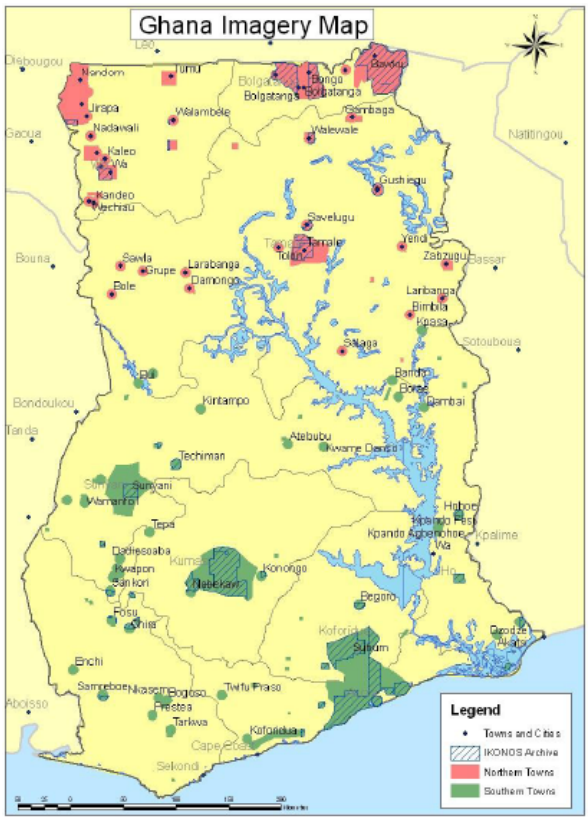

Figure 2 Distribution of town covered by IKONOS images

The Millennium Challenge Account Project managed by the Millennium Development Authority (MiDA) is piloting the systematic registration of land titles in the one of three targeted project Districts, with the objective of creating a virtual land bank to be made available for further development by both smallholders and agribusiness investors. Land parcels within the project enclave have been surveyed with survey grade global positioning system (GPS) receivers and converted into Environmental Systems Research Institute (ESRI) shapefiles.

The UMLIS Project referred to in Section 1 of this report is currently being piloted in three sub-areas (Ayawaso East, West and Central) of the Greater Accra Metropolitan Area. The project has captured in digital format land parcels and associated building footprints in the study areas with the objective to 'develop land information data bank which would contribute to effective and efficient collection of land rent and urban land use management'.

As noted earlier, the UMLIS database is implemented in Microsoft SQL Server database software and contains the following items:

- administrative boundaries; and
- unique identification of a parcel and building based on region, district, section, and block consistent with the SMD internal coding system.

The main tables and fields of the UMLIS database are listed in Table 1.

Table	Fields	Related fields
Persons (or non-natural owners)	ID Name Address	Customer no Etc
Parcels	District Section Block Parcel no	
Buildings	Building ID Locality Address	Class Use Valuation Photograph Tenure Permit
Payment	Invoice no	

Table 1: Main Tables in UMLIS Database

The SMD is the sole agency responsible for the checking and approval of all survey and mapping projects including cadastral surveys that update and maintain land title registry maps, parcel maps and cadastral plans undertaken by private licensed surveyors. Sectional maps are also produced by local consultants under contract to the SMD. The preparations of title plans, which are attached to land certificates issued by the LRD, are produced exclusively by the SMD. The work of the SMD is directed according to the following laws:

- Survey Act 127 of 1962.
- Land Title Registration Law, PNDCL 152 of 1986.
- Survey (Supervision and Approval of Plans) Regulations, LI 1444 of 1989.

2.2.7 Other digital datasets

A digital elevation model (DEM) derived from the 1:50,000 topographic contour layer with a 50 foot contour interval exists for the whole country at a resolution of 60 meters. In addition, the following land-related datasets exist at a scale of 1:250000 for soils, land cover and land use, and the road network.

Data Layer	Custodian	Attributes	Data Format
Soils	Soil Research Institute	Soil Types	ArcInfo Coverage ESRI Shapefile
Land Cover/Land Use	CERSGIS	Land cover/Land use type Code	ArcInfo Coverage ESRI Shapefile
Road Network	Department of Feeder Roads	Road Code Segment Name Road Surface Road Type Road Width	ArcInfo Coverage ESRI Shapefile

Table 2: Additional digital spatial datasets

2.2.8 Coordinate Reference System

The current coordinate reference system used in Ghana is specific to the country and is known as the 'Ghana War Office' system. Recent work under the LAP has resulted in the computation of transformation parameters to convert coordinates given in the war office system into the international standard WGS84 datum and coordinate system. The intention is for WGS84 to become the standard for all base mapping produced in Ghana, including cadastral and land parcel maps.

2.2.9 Metadata Database Development

The LAP has contracted to a local company, CTK Network Aviation Ltd, to develop a metadata database of existing geographic, cadastral and other land related information covering the whole of Ghana. The metadata are documented using the international Federal Geographic Data Committee (FGDC) and International Organization for Standardization (ISO) TCI-211 Metadata Standard (ISO 19115). Availability of the metadata will provide access to elements such as geographic extent, data processing methods, data quality, currency, and custodianship. The consultant has submitted a final draft report and is yet to deliver the final database to the LAP. Further reference to this metadata initiative is made in Section 2.4.

2.3 Existing Communications Environment in Ghana

The Lands Commission Act (Act 767, 2008) states that one function of the Commission is to "establish and maintain a comprehensive land information system" for which purpose there will be a LIU located in the Commission's secretariat under the direct control of the chief executive officer "The details of the functions of the Units and Departments shall be written by the chief executive officer in consultation with the Heads of Divisions and approved by the Commission". In general, these statements do not specify clearly the role of the LIU *vis-à-vis* the land information holdings and existing partial systems that are in place across the Divisions under the Lands Commission Secretariat (the coordinating body – see Figure 3). For example, *several important questions need to be considered concerning communications and information flows between LSAs, as well as the design and implementation of the LIS, relative to the role of the "establishment and maintenance of a comprehensive LIS" under the Act*:

- Will the LIU be responsible for the function and management of the LIS as a whole?
- Will the LIS be developed as a client-server application with the server (database and core functions) residing in the LIU and selective read/write (edit) access given to the parts of the current system physically located in each Division (LSA)?
- Will the LIS itself or parts of it be installed in each LSA, running different instances of the same database (i.e. stand-alone and not networked as in client-server mode)?
- Will the LIU only have a coordinating role supporting for each Division's own parts of the LIS?
- To what extent will the currently fragmented or partial LIS pieces in each Division be amalgamated into an integrated LIS, of which OSCAR might be one part?
- To what extent will the individual systems remain fragmented or balkanized within the individual LSAs, with the LIS being simply an additional silo of data and functions that will reside under the custodianship of the LIU?
- Can the LIS live comfortably using a monolithic model (the STDM) that will satisfy the needs of all LSAs?

- How will the system (i.e. that under development by COWI) be networked between LSAs to ensure concurrency and equivalence between individual units? etc.

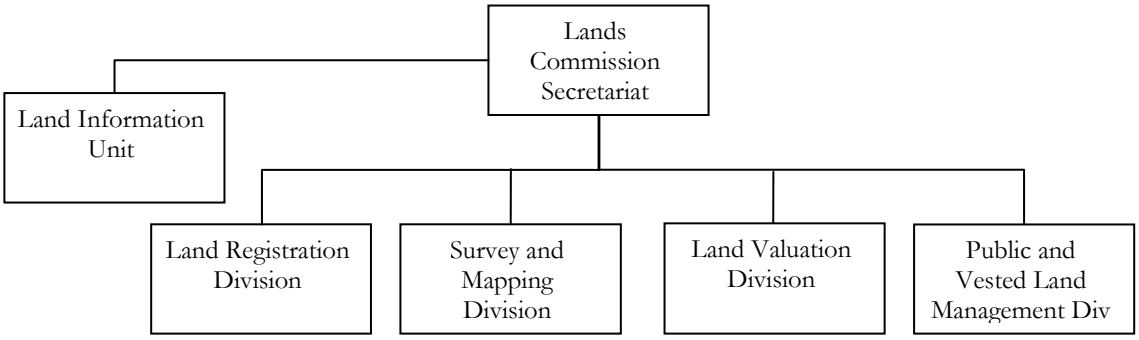

Figure 3 Land sector agency organizations

None of the above questions seem to have been addressed adequately. The high level organizational model shown in Figure 3 substantially simplifies the detailed model shown in Appendix 4, where the LIU is replaced with a Land Information Department (LID) *and* an IT Department (ITD), both under the Deputy Executive Secretary of Operations. On the other hand, the four front line land records Divisions (the SMD, LRD, LVD and PVLMD) sit directly underneath the Executive Secretary of the Commission. Hence, there is some ambiguity at the moment as to how exactly the *land information technology* management group will relate to the front line *land information gathering and processing* management Divisions, not mention the exact form and role that the former will finally take.

In general, however, the design of the current LIS seems to assume that each Division of the new Lands Commission Secretariat will be responsible for its own data held by separate servers linked in a distributed LIS. This architecture will have very important implications in terms of the data and information flows. Moreover, the need to ensure *integrity and concurrency of any individual instance of the database* under this scenario is complex. The role of the LIU would be to provide IT support to each division and to coordinate the sharing of data across the system. As noted this is a difficult goal to achieve with multiple instances of data records scattered across different Departments and Divisions. Under this scenario, communications and integrity checks in the software take on paramount importance.

In a manual system, agencies may be unable or unwilling to share data, because for example, the data may be incomplete or unreliable. Agencies may also be uncooperative with respect to the sharing of data because of financial reasons. The implementation of an integrated LIS cannot by itself be expected to transform uncooperative agencies into cooperative ones and other measures will be needed. However, this depends fundamentally on good communications and cooperation as well as efficiency in information flows between Divisions, Departments and Units. Without having a structure that clearly defines these flows and lines of communications, such an approach will struggle. This structure would include requisite inter-Divisional and inter–Departmental working committees as well as a digital data communications model that supports information sharing.

In the absence of specific measures in the Lands Commission Act about the sharing of data between LSAs, *a policy should be drawn up, agreed, implemented and enforced, and adequate budgetary provisions made to*

produce and maintain data and to encourage the unrestricted sharing of data between GoG agencies in the lands sector. As far as can be determined, at this point in time, such a policy and clear strategic framework does not exist. Hence, the current LIS under development falls into somewhat of a vacuum and the developers will have had to make certain assumptions about its deployment in order to get the job completed.

2.4 Plans, Policies and Standards – Land Related ICTs

Whilst there is no formal government policy in Ghana regarding the use of FLOSS, there is every indication that the GoG supports efforts in that direction. Speaking at a free and open source software media training conference in Ghana in April of 2007, the then Minister for Communication noted that the government had already tasked the Ghana-India Kofi Annan Centre of Excellence in ICT to spearhead the national consultation process on an open source policy and to provide an initial draft document for consideration. There is, however, no evidence that this consultation process has been undertaken or whether a policy document has been prepared.

The Minister also noted that Ghana's legislators use Linux to support the computing facilities at Parliament House and the Ghana-India Kofi Annan Center of Excellence in ICT had migrated all servers to open source. He further hinted that the use of FLOSS was important to the GoG because it allowed the Government to reduce costs and retain ownership of its own technology. Importantly, he noted that relevant courses in open source, including courses tailored to specific client needs, will be offered at the Kofi Annan Centre. It is possible that the transfer of knowledge underlying the geospatial tools used in the OSCAR project may be dovetailed to fit within this process, maintaining consistency with the stance taken by the Government in general. Hence, if there is passage of a formal policy on FLOSS in Ghana, the OSCAR project will be entirely consistent with this.

However, currently there is no formal mandated requirement within the LSAs in Ghana to adopt specific land-related standards or to require agencies to use one form of ICT over another. There are no 'preferred vendors' of land-related information technology, as the range of tools and approaches discussed in this report suggests. However, informally, there has been, as with many countries, a general convergence within Ghana to the use of a small number of proprietary software packages (especially ArcGIS, although Microstation is used for drafting work, and one or two other minor GIS packages are used). In particular, the relatively high profile of the Environmental Systems Research Institute's (ESRI) suite of tools across a number of the LSAs suggests that any FLOSS venture should maintain, at least in the short term, compatibility with ESRI's informal *de facto* industry standards, such as the use of shapefiles or the ability to exchange data with personal or file geodatabases.

However, in the longer term, the prohibitive acquisition costs of ESRI software and the need to pay high annual support and maintenance fees in order to remain up to date, are significant disincentives to follow this path indefinitely. There is also an implied dependence on external consultants whenever customization of any sort is required.

As noted in Section 2.2.9 of this report, the MLNR has engaged a local consultant to produce a metadata database of mapping products, aerial photographs and derivative products currently in use in Ghana. As noted, this project is employing the harmonized international standards for geospatial metadata under auspices of the United States Government FGDC and ISO 19115. Progress report 2 for this project identifies use of a metadata gazetteer named Meta Organizer that is not at all well

known, and it is unclear whether this was developed locally or not (CTK-Network Aviation, 2009). No reference to this tool on the Internet. A variety of commonly used FGDC and ISO 19115 metadata editing tools are available, hence the choice of Meta Organizer is difficult to reconcile.

Component	Standard
Coordinate system	WGS84 Datum (ITRF - latest realisation) Universal Transverse Mercator (UTM) projection, Zone 30, metres
Spatial data accuracy (absolute)	+/- 2.5 metres (95% confidence level)
Spatial data accuracy (relative)	1/200 (within a block)
Spatial objects	1. Parcels (closed, non overlapping, polygons) 2. Blocks (closed, non overlapping, polygons) 3. Sections (closed, non overlapping, polygons)
Spatial annotations	1. Text (parcel UPN) 2. Text (block no) 3. Text (section no) 4. Text (location name) 5. Text (street name)

Table 3: Current spatial data standards

2.5 Existing ICTs for Land Registration and Cadastre

2.5.1 Current Status of ICTs

The ICT infrastructure in Ghana has seen some improvement since 1995. Teledensity (fixed lines) increased from 0.4 in 1995 to 2.9% in 2001 putting the country well above the 1.1% average for sub-Saharan Africa. The country's National ICT Development Policy, was adopted by Parliament in 2004. Following its adoption, the 'ICT Implementation Strategies' program is being developed in numerous Ministries and strategic initiatives.

The ICT Policy has a four year rolling plan and an operational life span of between 15 to 20 years. Its priority areas are mandated to concentrate on promoting rapid ICT physical infrastructure development, modernize agriculture, and facilitate development of the private sector. The ICT Policy goals of the MLNR are, among others, to:

- establish databases and information systems to facilitate decision making and policy analysis;
- exploit ICT to provide coordination and synchronization in the delivery of land administration services;
- deploy ICT to improve and strengthen organisation, management and operations of agencies in land administration at the central, regional and district levels;
- to replace the current manual geographic and land information system with an automated information system;

- use ICT to develop integrated user-friendly and one-stop-services to deal with land transactions at regional and district levels;
- develop, through through the use of ICT, traditional land secretariats entrusted with land related responsibilities in relation to the administration and management of communal land held in trust for stools/skins, clans and families.

Despite these laudable goals, several issues were noted by the COWI group in the Ghanaian LSAs concerning the current state of their ICT infrastructure in the following offices:

- the Public and Vested Lands Management Division (PVLMD);
- the Land Registration Division (LRD);
- the Land Valuation Division (LVD);
- the Survey and Mapping Division (SMD); and
- the Office of the Administrator of Stool Lands (OASL).

These issues are likely to be relevant to the current status of all ICT systems that will impact on the OSCAR project. Hence, the issues and their recommended remediation are noted in Table 4:

Issue	Observation	Recommendation
IT Infrastructure	Servers freely accessible by all staff (except PVMLD and LVD)	Servers should be in a secure room with access only by IT staff
	Servers place high on tables	Servers should be in cabinets
	Servers turned off at night and on weekends	Servers should never be switched off
	Servers in rooms without air conditioning	Server rooms should have air conditioning always running
	Servers only supported by mediocre UPS (1000 watt)	Servers should have >2500 watt UPS with slow shut down software in the event of failure
IT Security	Servers connected to Internet through DSL modem and standard router from local ISP. No firewalls installed in any of the offices. Servers vulnerable to hacking via the Internet	All servers need to have firewalls running and configured by a professional security expert
IT Personnel	Server and system administrators not all well qualified	Persons servicing the IT infrastructure must undertake training courses to attain formal Microsoft Certification as system administrator
		Management of IT infrastructure, backup and server maintenance should be taken care of across the organizational boundaries by professional IT staff as a roaming IT-management section.

Table 4: Known hardware issues
Source: Johnson and van Bennekom-Minnema (2009)

2.5.2 Details of Existing Land Related ICTs Under the Lands Commission

Several systems are currently in place and all are undergoing various levels of development toward satisfying relevant policy goals of the Government. Each of the key systems, the agency they reside in, the format of data that are maintained by the agency and the most frequent use the software and constituent data are put to are summarized in Table 5.

It is possible that there are minor instances of digital spatial data currently being used that are not reviewed in Table 5. However, these instances would be trivial. The diversity of systems, formats and uses further confirms the difficulties that will be faced in successfully bringing all systems under the control of a single LIS database operating either out of the LIU or separately in the offices of each of the individual LSAs.

Agency	Format	Use
PVLMD	ArcGIS shapfiles and personal/file geodatabases AutoCAD .dxf	Maps for dispute resolution Miscellaneous maps and drawings
LRD	None	None
SMD	pcArcInfo 3.1 (customized) coverages ArcGIS shapefiles and geodatabases Microstation .dgn AutoCAD .dxf	Parcel map maintenance and parcel plan production Map production Large scale map maintenance (1/2,500) and small scale thematic map production (e.g. road maps) Miscellaneous maps and drawings
LVD	AutoCAD .dxf	Maps for land acquisitions
OASL	None	None
Town and Country Planning Division (TCPD) (LUPMP)	Map Maker Format unknown	Land use planning maps

Table 5: Existing land related software and uses in Ministry of Lands and Natural Resources

2.5.2.i Land Registration System

Under the LAP a systematic approach to title registration is to be piloted in 8 sections in the main urban centres of Accra and Kumasi. Private sector firms are to be retained on a consultancy basis to collect field data and also to survey land parcels. To facilitate this process, an ESRI personal geodatabase (ArcGIS 9.3) has been developed in Microsoft Access by an individual engaged under a consultancy with the GFA/GCI Consulting Group from Germany. The database has a customized user interface to capture attribute data about applicants, buildings etc. Currently there are only test data in the database and each consultancy that is retained to collect data will be given a copy of the database to work with. This again *is an approach that is fraught with potential problems as personal geodatabases do not support versioning and each consultancy will maintain a different version of the data (as per their own contracted work).* Merging the data back into the LIS or cross-agency databases may be a difficult and error prone process. Moreover, *this fragmented approach to data management is likely to cause more problems than it solves.*

The geodatabase is suggested to have the capability of:

- storing all the spatial and non-spatial data to be collected during the systematic land titling exercise;
- generating and printing parcel plans that conforms to the format to be provided by SD;
- compiling list of proprietors for publication;
- generating Land Title Certificates;
- generating other reports based on the data stored in the database; and
- guaranteeing the security of the data in the system.

It is estimated that approximately 8,000 parcels will be covered using this approach. In addition, the outline of building footprints on the parcels, other data (utilities, construction details) will be captured. The data will be submitted to the LRD of the LC to assist in the process of issuing Land Title Certificates. Eventually, the relevant data will be imported into the LIS being developed by COWI Group of Denmark. However, the process for this is not at all clear. Moving data from an Access database to PostgreSQL, which the LIS is built on, will require export and import of data and there will have to be account made within the STDM for the additional data to be imported into existing tables. *This should have been taken into account in the design of the Access database naming conventions and attribute definitions* and not after the fact.

2.5.2.ii Rating System
The Rating Section for the LVD is currently running a customized 'client-server' database management system developed by a local information technology company.

The system customization is based on Microsoft's Visual FoxPro software running on a MS-Windows platform. The graphical user interface (GUI) has been designed for data input, data management, and report generation. According to its documentation, the system is able to generate the following reports, among others:

- property record sheet; and
- valuation List.

Stand-alone versions have been installed in the LVD offices in some of the District and Municipal Assemblies. Technicians of the Rating Department of the LVD have been trained by the developer on how to interact with the system. The developer continues to provide technical backstopping as and when required. The system runs on a standard Pentium 4 computer, configured as a 'server', and used for other computer-assisted tasks required by the Department, thereby sharing CPU resources with other unrelated tasks. Though there is a local area network (LAN) in place, there is no decision as yet on the location of a server room for the LVD. Though it would have been ideal to host the property rates system on a dedicated server, this is not the case at the present time.

The property rates system has no mapping module, though technicians of the Rating Department make use of hard copy maps as working documents for field data capture and field validation. This is obviously a major short-coming of the current system, which needs to be addressed in terms of whether or not a computer assisted mass appraisal (CAMA) approach is to be introduced for property valuation and taxation.

The system analyses field data and assists in determination of the rateable values of properties which are used, in turn, to asses the property rate by the District assemblies. Under the UMLIS project, an attempt is being made to use the information (valuation list) generated by this approach.

2.5.2.iii Parcel Preparation System
Title plans (also called parcel plans) are prepared by the SMD for the LRD. A title plan is an extract of a section map (called the registry map in the Land Title Registration Law - see Section 2.1) that delineates the land parcel in the land certificate prepared for the proprietor (registered owner). The role of title plans are outlined further in the workflows and business processes discussed in Section 3.1.

Preparing and printing parcel plans uses pcArcInfo 3.1 software directly from the digital sectional maps in conjunction with an additional program at the Production Section of the SMD in Accra. Both packages run in a DOS environment. A local server holds the digital section maps. The customized system was developed under the Ghana Environmental Management Project (GERMP) initiated in 1995 and is clearly now outdated and in need of upgrade.

Sporadic surveyed plans (cadastral plans) are drawn using Microstation computer assisted design (CAD) software and saved as Microstation (.dgn) or Autodesk exchange (.dxf) format files. The data are not stored in a common database. Rather, they are stored locally on the various workstations that produce cadastral plans. Once the data are entered into Microstation the cadastral plan is printed.

2.5.2.iv Land Use Planning Management Information System
Under the LAP, a further tool named the Land Use Planning Management Information System (LUPMIS) has been developed to run with the MapMaker GIS software package. This is intended to introduce and support IT in the preparation of schemes for urban planning in Ghana. LUPMIS is reported to work primarily as a decision-support tool for planning and decision making processes, however this claim is questionable. Criteria for the development of this system were:

- efficiency;
- sustainability;
- appropriateness in its technology;
- simplicity and ease of use; and
- compatibility with other databases.

Currently, the system is reported to be installed in a small number of pilot Districts in Ghana (Kasoa in the Central Region, Asankragwa in the Western Region, Ejisu in the Ashanti Region and Savelugu in the Northern Region), with the goal of nationwide coverage in the future. The full implementation of the system in these districts has been impacted by a delay in the production of orthophoto maps. It is envisaged that the system will be used in all aspects of land use planning at the local level. Data will be collected from the field. Staff at the District level have been trained and continue to receive training. No complex customization or expensive software development is necessary. All aspects of technology transfer, i.e. control of the system by in-house human resources, are reported to be assured.

The COWI Group of Denmark is the consultant in the development of both the LUPMIS and the LIS. However, the two systems are not developed on the same underlying model or in conjunction with each other. Even though the LIS and LUPMIS tools may not be at the same level for now, there is the assurance from the consultants that they can be integrated into a future national LIS for Ghana.

2.5.3 Data Digitalization and Quality Concerns

The existing digital sectional maps at the SMD are held in ArcInfo .e00 (ESRI coverage export) format. Since ESRI coverages are in a proprietary format and will only run in ArcInfo or ArcGIS software, the SMD has started converting the .e00 files into ESRI shapefile format to enable the Division to import these files into the LIS (and other programs). This conversion of coverages to shapes is a simple process can be run in batch job (i.e. all at once).

Test transformations of some of the sectional maps by consultants (GFA/GCI and Swedesurvey) have indicated significant issues with respect to the transformation accuracy and the resulting dislocation of parcel shapes. In particular, it has been found that:

- Using the best available transformation parameters results in a mis-registration of the parcels with the underlying orthoimage (and directly with GPS data). This suggests an imperfection in either or both the source data and the transformation parameters. Refined parameters may correct this problem.
- The second problem suggests any one or more of the following causes: (a) that the section map is not up-to-date; (b) that compilation of the section map contains some gross errors; and/or (c) that occupation on the ground (physical boundary lines) are not coincident with the surveyed boundary lines. Cases (a) and (c) would seem the more likely explanations.

Cadastral record maps depict registered parcels in declared registration areas that are not covered by a section map. Parcels are surveyed individually and plotted *ad hoc* onto cadastral record maps. For recent surveys using GPS, the absolute position of a parcel could be quite reliable, but for older surveys this may not be the case. Similar quality issues for PVLMD town maps can be expected relative to the SMD cadastral record maps.

A contract has been awarded to Jodanti InfoImaging, a local consulting company, for the intelligent scanning of the registered documents held at the Deed Registration Division of the LRD in Accra. It is estimated that there are about 220,000 documents running into over 2,000,000 pages of text, much of which is in deteriorated condition. This change from paper format to digital format will serve several purposes, namely:

- to secure the existing information against all risks of loss or degradation, allowing for the transfer the originals to the National Archive;
- to enable the geographic segregation of the registered documents and indexes actually stored within the Accra Land Registry;
- to supply each of the eight deed registries established or to be established with electronic copies of the respective deed documents; and
- to transfer knowledge to staff of the registries.

The configuration proposed by the service provider includes the use of the following equipment and software:

- Electronic Document and Records Management System from Laserfiche, USA;
- specialist document scanners and software from Zeutschel, Germany;
- regular Document Scanners from Kodak, UK;
- Permanent Archiving Solution from Plasmon Data, UK;
- computer servers; and
- computer workstations.

Currently, all the equipment and software have been procured except for the servers and workstations and the service provider has commenced the scanning of some of the records. *Not much thought seems to have put into the storage requirements for this substantial task and how the scanned documents will be integrated into LRD and SMD workflow processes.*

2.5.4 Future Plans

According to the terms of reference for the development of the LIS stage one (focused on the development of sub-systems for the individual LSAs and on systematic land titling), which is now drawing to a close, stage two is planned to focus on the integration and scaling up of the LIS to cover the whole country and include all of the processes of the relevant LSAs. In stage three, which can be implemented in parallel and simultaneous with stages one and two once the processes are stabilized and guaranteed to work successfully, it is proposed by the COWI Group that all relevant information will be entered into the system.

Under the recent institutional reforms of the land sector, a new Head Office Building is planned to house the corporate head office of the Lands Commission Secretariat and its constituent agencies, as well as the regional office of the Lands Commission. It is envisioned that a data centre will be located in this building to support the entire country. However, the current main offices for SMD and LRD will remain some significant distance apart and this restricts the type of computer networking solution that can be implemented to integrate workflows between the two.

2.6 Summary

This section has presented a comprehensive review of the existing situation in Ghana regarding the state of land information and its associated records management. This review forms the backdrop for the following sections in this report, which outline successively related requirements and recommendations for the implementation of the OSCAR framework into the current environment.

3. Statement of Requirements

Discussion of requirements for the implementation of OSCAR in Ghana focuses on compatibility with the current land records projects underway there (i.e. primarily the LIS and UMLIS projects, but also the numerous additional data gathering exercises discussed in the previous section). As noted

earlier, it is assumed that the OSCAR project will focus on the MLNR, and especially within the SMD and LRD of the LC as well as the as yet unformed and not clearly defined LIU.

Hence, the requirements discussed below relate to the core data needs of the Divisions. At this stage there is no inclusion of land valuation activities by the LVD or the land management functions of the OASL within the OSCAR framework. In addition, the PVLMD is not considered in the requirements for OSCAR's initial implementation in Ghana. However, the workflows and needs of these latter three Divisions (LVD, OASL, PVLMD) can be modeled within the OSCAR framework as required, without the encumbrance of conforming to a structural model (such as the STDM). Functions developed for their land information processing needs are best treated as extensions or new projects stemming from the current project in order to keep the initial implementation straightforward and manageable.

While Section 3.1 focuses on present and future business processes and workflows, as far as they can be determined at this stage, Sections 3.2 and 3.3 relate to generic considerations for the OSCAR software in terms of how it might satisfy the processes and workflows described next.

3.1 Present and Future Business Processes/Workflows

The processes presented in this section describe the flows of business information relative to the structure of the two LSAs noted above, from lodgment of a land title application (new whole or part parcel or transfer through change of ownership) through to receipt of title. The workflows and their components draw generally upon those described by the COWI group (van Bennekom-Minnema 2008a), and what has been learned of the processes during the current mission. The workflows form a foundation for the development of OSCAR in Ghana as the software must be able to capture and manage the flow of information on the creation of new parcels or modification of existing parcels and the associate land title changes through the stages outlined in Sections 3.1.1 and 3.1.2.

It is not expected that the current workflows in Ghana will change much if at all within the OSCAR project time frame or immediately thereafter. It is important to reiterate that the nature and operations of the LIU are centrally important in this project, and indeed in the future of land information management within the LC/LCS, as the LIU is the likely locus of management for an integrated database that will operate in client-server mode with view/edit (read/write) access provided on an as needed basis for each LSA within the cadastral and land title business chain. Since the LIU is not yet operational, *it is essential that personnel (technical and managerial skills) have the ability to trouble shoot quickly and to resolve any unforeseen issues not considered in initial prototyping*. It is also important to note that in the functional and non-functional requirements discussion in this section, a basic underlying consideration is the need to remediate the current significant inefficiencies and potential for error and/or loss of information that exist in the land titling process in Ghana.

3.1.1 Survey and Mapping Division

3.1.1.i Registry/Client service unit

The land title registration process in the SMD is initiated by an application from the LRD. The application consists of an official application letter from the LRD and a site plan prepared by a licensed surveyor. The application is brought into the SMD by the applicant.

The application is received in the SMD's Registry Office. The receiving officer checks the site plan against the land title sectional map to see whether the application should be treated as parcel plan or cadastral plan before a case file is opened. But in most cases this is indicated by LRD in the application letter. The receiving officer looks for:

- An official letter and LRD lodgement number (yellow card).
- A survey plan approved by the Director of SMD.

After the application has been received, the receiving officer opens a case file. In most cases the application is about registration of new land or the transfer of already registered land. This information is central to the core business functions of the OSCAR framework. A fee must be paid by the applicant to SMD. The fee is based on the size (area) of the parcel under review. A numbered receipt is given to the applicant. At this time, the receipt *does not* state the case file number. The case file is registered in a book with the information shown in Table 6.

Columns	Description
Date	Date received
LRD lodgment number	Number from LRD
Date	from LRD
Name and address	Of applicant
Amount paid	In Ghanaian Cedis
Receipt number	
Telephone number	Of applicant
Either Regional number (SGGA/XXXX/2008) Or District/Sectional Map Number Only added for parcels falling into section maps.	Survey of Ghana Greater Accra/jobnr/year (Cadastral plan) e.g. GA 004/056/2/190 Greater Accra (Region), district 044, section 056, block 2, parcel 190 (after the plan has been produced) (Parcel plan)

Table 6: Case file information

If the site is located inside the sectional map, the application is treated as a parcel (title) plan (called a 'parcel plan' in the SMD and a 'title plan' in the LRD) and goes to the Examination Section. If the site is located outside the section maps it has to be treated as a cadastral plan and it is sent to the Greater Accra Regional Survey Department within the SMD for surveying.

3.1.1.ii The Greater Accra Regional Survey Department

The Regional Surveyor receives the application with a copy of the LRD letter and the site plan. A surveyor is assigned to visit the site with the applicant and surveys the parcel. The Surveyor returns with information showing:

- the history of survey on the property;
- a report (if there is a shift in the boundaries of the parcel);

- a diagram of the survey;
- any plan data of the parcel;
- bearings and distances calculated from the coordinates;
- the beacon (survey mark) index; and
- the reults of a GPS survey (if applicable).

The survey record is then submitted to the examination section of the Regional Survey Department for quality assurance and control checking against the standards and regulations of the SMD. According to Survey Regulations (Supervision and Approval of Plans - LI 1444) all plans attached to instruments for registration should be approved by the Director of SMD or his representative. Licensed surveyors therefore submit records and plans of their completed surveys to the Regional Surveyor for checking and approval of the plans on behalf of the Director of SMD. These approval records are kept by the Regional Surveyor.

3.1.1.iii Examination Section
The SMD examination section receives all LRD applications from:

- a Regional Surveyor when the application deals with registration of new land outside the sectional map (cadastral plan);
- a Receiving Officer when the application is a parcel within a sectional map;
- a Receiving Officer when the application falls within a sectional map but does not have a plan (a process known as 'picking'); or
- a Receiving Officer when the application falls within a sectional map but the sectional map has not yet been completely surveyed (also 'picking').

The Examination Section of the SMD currently comprises six groups of surveyors with approximately five surveyors in each group (approximately 30 surveyors in total). The groups visit the location to carry out an inspection that includes quality control (checking) of the cadastral survey using GPS or tape measurements to assess accuracy of the survey records. The record received from the Regional Surveyor's office also undergoes re-computation (office-based quality control) checking before it is committed. If the quality control finds any major errors it is returned to the Regional Office for reassessment. If both there are no errors the record is sent to the Cartographic Section for further action. A copy of the file is also sent to the archive at the SMD. When the record is received from the Regional Surveyor's office at the Cartographic Section the particulars shown in Table 7 are added to the survey case file.

Columns	Description
Surveyor	Name of surveyor working with the case (Added for both cartographic and parcel plans).
CC number	A number added by the Chief Cartographer.
Plan no.	x,y or Zxxxxx (added after return from Cartographic Section).

Table 7: Cartographic Section additions to survey record

3.1.1.iv Cartographic Section
In the Cartographic Section parcel measurements are plotted on a master sheet. The parcels are manually drawn on the map. Each cadastral survey is given a 'cc' number with a suffix 'x', 'y' or 'z' corresponding to whether the parcel is large, medium or small, respectively. The 'cc/x, y or z' number is written within the parcel plotted on the map.

Plotted parcels that overlap each other are treated by the SMD as a dispute case (persons claiming the same or parts of the same parcel) and returned to the LRD for a resolution by the Land Adjudication Committee.

3.1.1.v Parcel (Title) Plan Production
The production of parcel (title) plan process is initiated when the parcel already exists on the sectional map. A surveyor undertakes a site inspection. If the site is identified on the section map, the boundaries are checked by measurement with a tape. The surveyor returns to the examination section and computes the coordinates of the corners of the parcel. A report is submitted, which contains the following:

- the history of survey;
- a diagram of the survey;
- plan data (bearings and distances between boundary corners); and
- a beacon index (coordinates of the corners of the parcel).

The file is submitted to the Cartographic Section for plotting on the sectional map. This means that the parcel identified on the sectional map is drawn in red and a 'cc' number is written in inside the parcel.

If the parcel is already drawn in red on the sectional map the application is treated as a dispute case and a report is prepared and sent to the LRD for resolution on title. If a parcel is sub-divided, the new parcel is given the highest available (unused) number in the block.

Columns	Description
Surveyor	Name of surveyor working with the case.
CC number	Number added by the Chief Cartographer.

Table 8: Parcel (title) plan production

In a case where a parcel plan requires 'picking', the position of the parcel is located within the sectional map but is not plotted on the map. In this case a site inspection is not enough. It has to be surveyed by the SMD, and a file record prepared (as per Section 3.1.1.ii above).

After the site survey, the sectional map is updated with the new parcel at the Cartographic Section. The parcel is plotted and edged in red and a 'cc' number is added.

3.1.1.vi Printing of Parcel (Title) Plans in the GIS Section
The manually drawn cadastral plans and parcel plans are printed in the GIS Section of the SMD. This Section executes two processes.

a) Updating the (digital) sectional maps from new parcel plans (e.g. subdivisions or surveyed parcels within the sectional maps). Preparing and printing a parcel plan using pcArcInfo version 3.1 software in combination with an additional program in the MS-DOS operating system. A local server holds the digital section maps, but it is unknown who is able to access the information on this server.

b) Sporadically surveyed (cadastral plans) are drawn using Microstation CAD software and saved as .dgn files or .dxf files as outlined in Section 2 of this report. The data are not stored in a common database. Rather, they are stored locally on the different workstations that produce cadastral plans. Once the data are entered in Microstation the cadastral plan is printed in hard copy.

3.1.1.vii Digital data sets
The following digital datasets are held by the SMD:

- cadastral parcels - a common digital dataset with the cadastral plans does not exist at this point in time;
- parcel maps (sectional maps and town sheets);
- orthophotos and photomaps;
- administrative boundary maps;
- large scale topographic mapping of urban areas; and
- thematic mapping.

3.1.1.viii Approval (Signing) of Plans
The Director of Surveys appends his signature to the plan if he is satisfied that the plan is accurately produced. The signed plan is returned, via the applicant, to the Land Title Registry for further action.

3.1.1.ix Other Tasks
Strata plans are prepared for apportionments when the property in question is a unit in a multi-storey building. The space occupied by the building is then surveyed to show the floor plan. Each floor or flat is labeled accordingly and indicated in the strata plan by a schematic diagram to show which floor or flat is being referred to. The survey is done by the surveyors in the Examination Section while the plotting is done manually at the Cartographic Section. The lithographic section prints the resulting manually plotted plan, and indeed all large scale plans for the SMD.

Disputed surveys are handled by the Disputes Surveys Unit under the Examination Section. Plans resulting from disputes surveys are known as composite plans. These are presented to the courts by officers of the Disputes Surveys Unit. Requests for surveys are received from GoG institutions including the Army, the Police, the Utility services departments and so on. Plans resulting form the surveys are submitted directly to the agencies concerned for further action.

3.1.2 Land Title Registry

3.1.2.i Background
First registration under the Ghana Land Title Registration Law is mandated by a process known as systematic compulsory adjudication. The declaration of a registration district (and section) by the Land Registrar initiates a process that results in the first registration of all land in each section within a definite, and relatively short, time period. The Land Registrar will consider all claims made to land in a

section, prepare register folios for land held under good documentary title (deeds), summons persons to appear before him/her with evidence of title, and register all unclaimed land in the name of the State in trust for the true owner. A demarcation map indicating all the parcels of land claimed is prepared by the Director of SMD which, together with the adjudication record, at the end of adjudication becomes the registry map and registers (folios), respectively.

In practice, however, this procedure is not currently followed in Ghana. First registration, as described below, is achieved by a process commencing with an application by the owner to register a transaction. This transaction, typically a conveyance, is submitted because the deed cannot be registered in the old deeds registry, and on this basis first registration is compulsory, but it is sporadic and not systematic, and if there is no transaction (or one that the parties wish to submit to the registry) then the register will remain incomplete for the foreseeable future.

3.1.2.ii Applications for First Registration
An application for first registration of land commences with the purchase from the LRD of the appropriate application form. To acquire this form the applicant must submit supporting title documents, properly stamped and signed, such as a deed of conveyance, to the cashier who will issue the appropriate form and a receipt for payment.

The complexity of the form and the requirements for a statutory declaration means that the applicant typically will take the form away to fill it in (with professional assistance in many cases). Following this, a completed application form together with supporting title documents and the cashier's receipt are submitted to the lodgment section. A lodgment officer checks the application to ensure that it is properly completed and all necessary supporting documents are attached, including a survey plan prepared and signed by a licensed surveyor and approved by the Director of SMD, and if all is in order, the registration fees are calculated. The applicant pays at the cashier's office and returns with the receipt. The application is then lodged and a lodgment number is assigned.

An acknowledgment of the application ('yellow card') is prepared which the applicant must collect in 3 days time after it is typed. The 'yellow card' states the applicant's name, date of lodgment and the lodgment number, and the applicant must present this card at the LRD to obtain the certificate of title when it is ready.

3.1.2.iii First Registration Steps
A letter is prepared for the Director of SMD requesting the preparation of a title plan of the land in question. The submitted survey plan is appended to this letter. When the applicant returns to collect the 'yellow card', the letter and plan is given to the applicant with the instructions that it must be submitted to the SMD.

The application is now 'on hold', and the file placed in the vault, pending receipt of the title plan from the SMD. For the majority of applications, this is as far as the process goes, because the applicant, having submitted the deed for 'registration' now has an acknowledgement that the documents were submitted at the registry. This often satisfies the immediate need for official acknowledgment of a land right and protects against others claiming the same land. However, many applicants wrongly assume that receiving the yellow card gives them the right to the land and so only about one third of applications go beyond this step in the process.

The SMD sends completed title plans directly to the Client Services Unit. The plan is placed on file there until the applicant returns to the LRD to pay the required publication fees. A receipt for payment is placed in the file and the applicant is given a letter plus a copy of the survey plan from the SMD to take to the PVLMD requesting a search of the deeds registry and State land records. If there are no objections received within 14 days following publication, and the PVLMD report says that the search did not identify any conflicting deeds and the land is not State land, the Customer Services Unit 'picks' the file from strong room and forwards it to the Records Section.

3.1.2.iv Certificates and Folios
A records officer prepares, using a standard form, the entries and memorials that will appear on the certificate of title and the register folio. The certificates are printed using a template prepared with Microsoft PowerPoint software and typewriters are used for the folios. The records officer checks that there are no mistakes before forwarding the certificates, folios, application form, documents and receipts to the Land Registrar.

The Land Registrar satisfies him/herself that all is in order before signing the certificates and the folios. Everything is then passed to the Technical Section for plotting. If the parcel does not already appear on the registry (sectional) map (some do because some systematic surveys were done in he past) the Technical Officer plots the parcel manually by scaling coordinates from the title plan grid and plotting the parcel shape using the bearings and distances given. The certificate number (not the parcel number) is written inside the parcel. The file is sent to the binding office where the certificate and title plan are bound in a plastic jacket and sealed. The file, including the duplicate certificate, folios, is then returned to the vault. On production of the 'yellow card' and appropriate personal identification the applicant can obtain the land certificate from the Binding Office.

3.1.2.v Transfer Steps
A transfer of registered land is achieved by application using the relevant form. The applicant must present the land certificate with the application form and the form or associated indenture must be stamped by the LVD office.

Most of the procedure steps for a transfer of land are the same for a first registration and any registered transaction, with some specific exceptions, namely:

- transactions of registered land do not require publication for objections;
- transfers of whole parcels do not need a survey or new title plan; and
- transfers of part of parcels must have an approved survey plan signed by the Director of SMD submitted with the applicant.

The processes of first registration, registered transfer of part of a parcel, transfer of a whole parcel, and an overview of the land titling process are summarized respectively in Figures 4 through 7. Further details regarding the steps are not necessary at this point in time as the process steps are covered in the general discussion above.

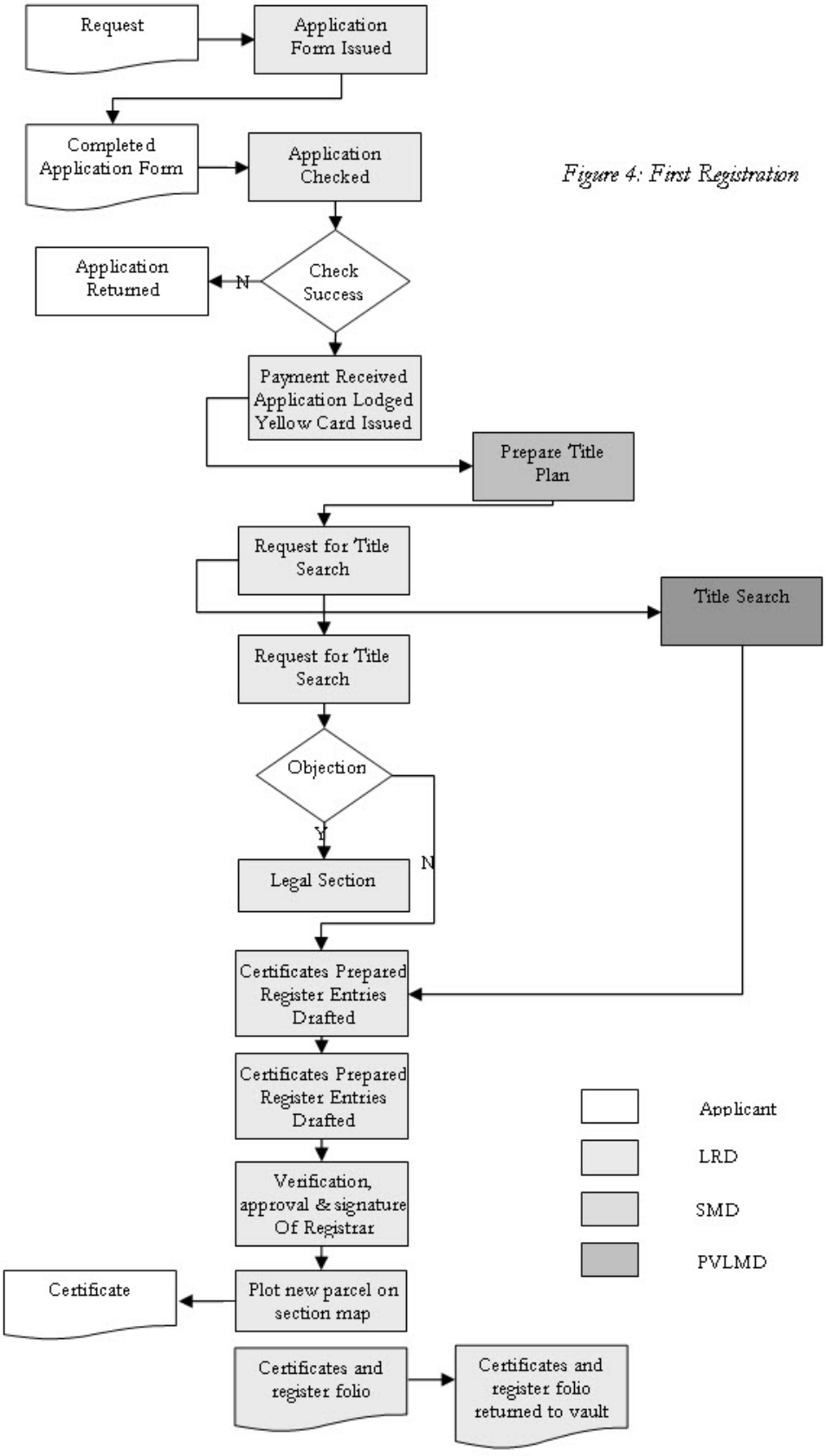

Figure 4: First Registration

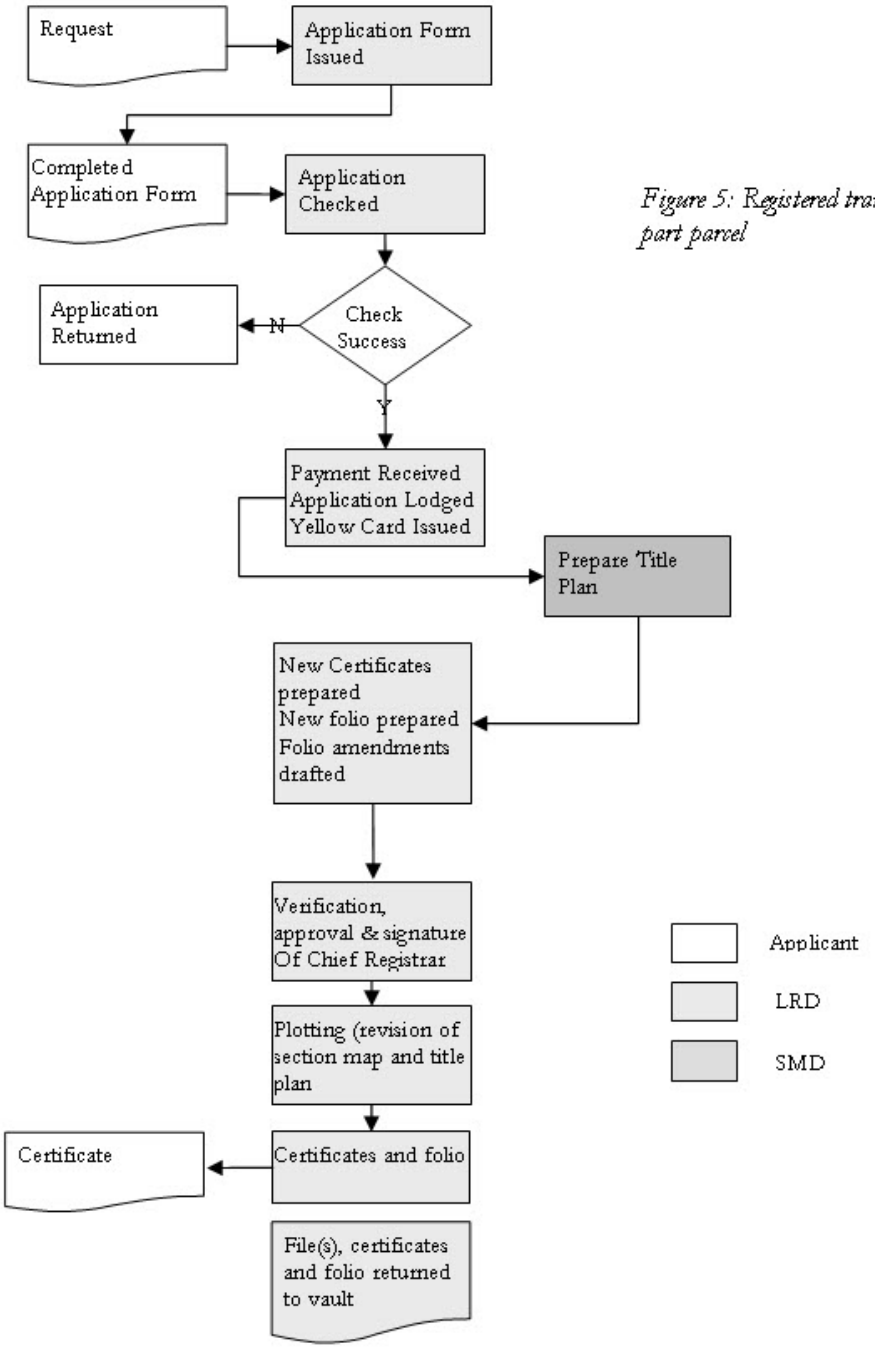

Figure 5: Registered transfer of part parcel

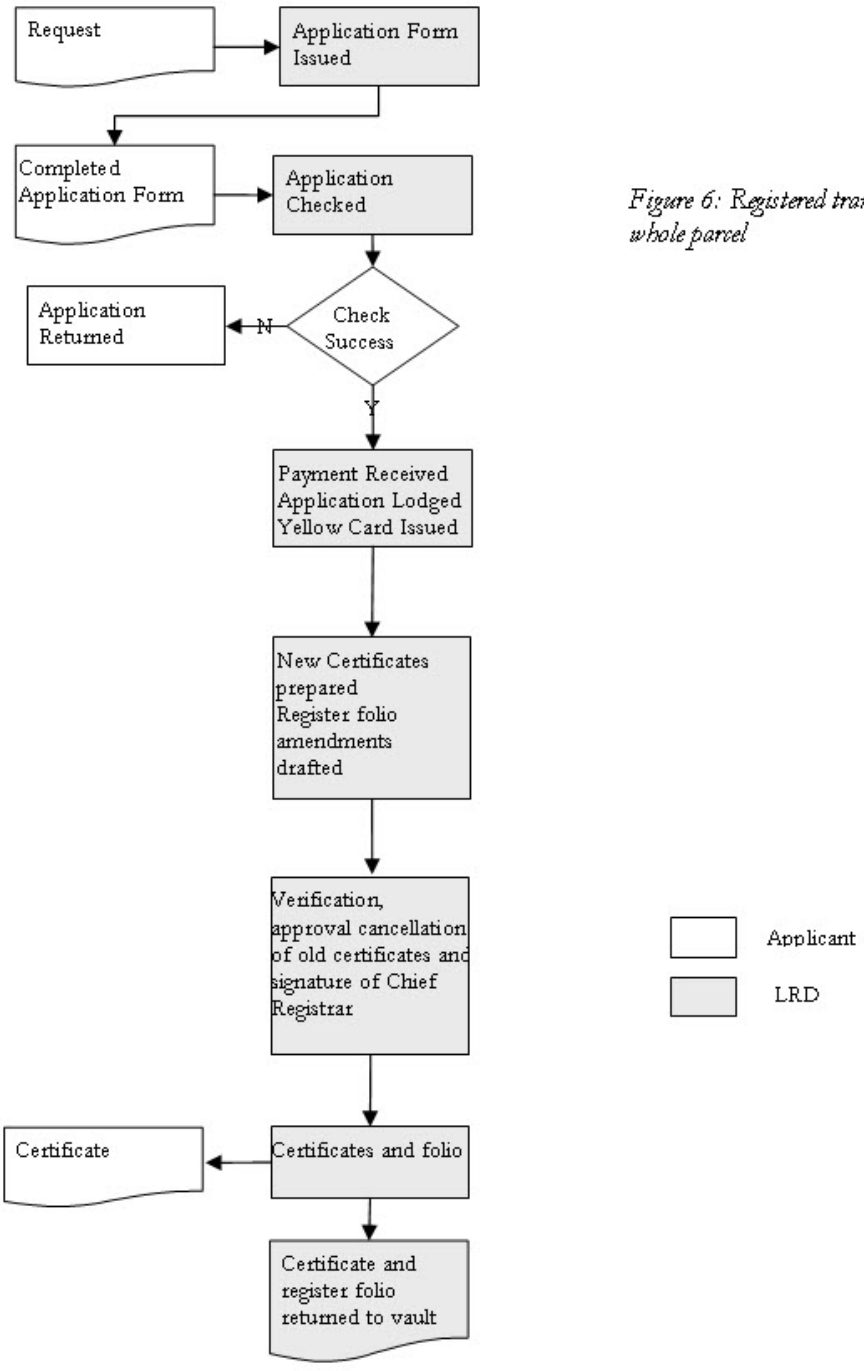

Figure 6: Registered transfer of whole parcel

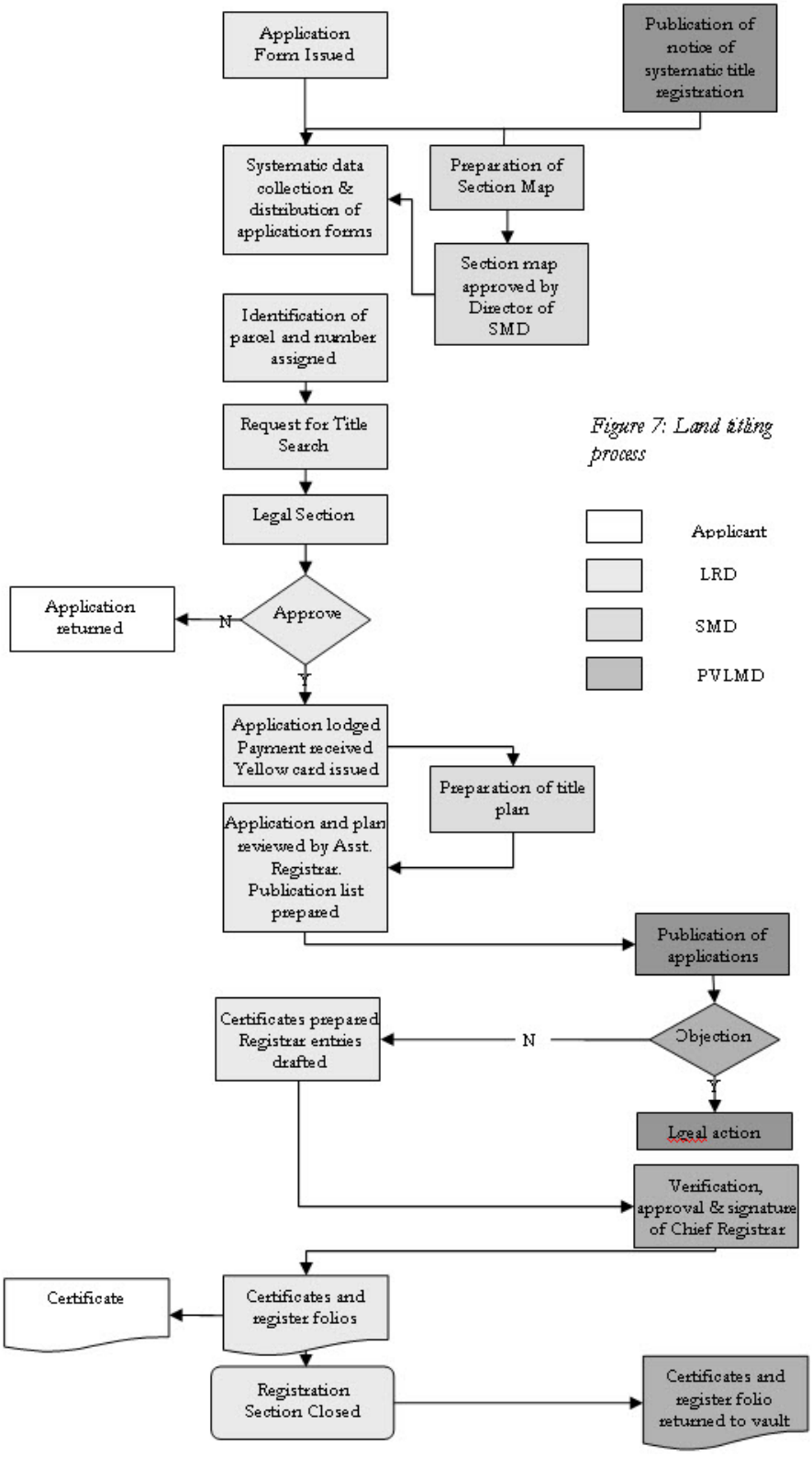

Figure 7: Land titling process

With the description of the business / workflows of land information processing with and between the SMD and the LRD described in detail, attention can turn to the functional and non-functional requirements of the implementation of the OSCAR framework to capture and manage the movement of information into, through and out of the cadastral and land registry components of the overall land parcel and title registration process in Ghana.

3.2 Functional Requirements and Non-Functional Characteristics

The functional requirements for development of OSCAR in any country will largely depend on the outcomes of a detailed user needs assessment. This will have to include steps to identify the specific data needed to support each process modeled within the OSCAR database; the design of the OSCAR GUI for entering, searching and outputting data, and the definition of the system functionality that manipulates data, and applies checks to ensure quality control and integrity of information before it is committed to the database.

As an example of the workflow requirements within the LRD, the generic functionality defined for OSCAR comprises the following steps, which mirror the business process / workflows within the Division as discussed in the previous section:

- start a process (entry of transaction document by a LRD clerk);
- check a process (review and approve by another clerk);
- commit (write doscuments to the database after checking and approval);
- payment (ensure payment of remittances and fees);
- approve (examine all workflow steps); and
- finish (final commit to database and if required generate hard copy output).

These stages in a simple workflow process with loops operate on events (referred to also as transactions in the static database model), such as a request to lodge or transfer a title, and the day-to-day business procedures or flows that move documents through a process towards an end result (e.g. a new title, first registration, addition of encumbrances, etc.).

OSCAR manages all access to data via these and other workflow processes. Workflow processes make use of server-side services that provide a range of operations for updating and maintaining registry repository and associated spatial data of the parcel fabric and related documents and instruments maintained by the SMD. These services are the only mechanism by which data may be accessed. OSCAR services are referred to in the definition of workflow processes and are accessed when a workflow process is executed. This is the mechanism by which generic operations and tasks may be configured for use in specific situations, such as for practical use in Ghana.

The core/common OSCAR software will provide a range of services including, but not limited to:

- **Locking/Transaction service** – lock records for editing/modification and provide a transaction commit and rollback service for spatio-temporal queries. Various lock and

transaction types should be provided to ensure integrity for short-lived and long-lived update processes.

- **Spatial modification** – A range of services for modifying spatial details including boundary adjustment, realignment, merge, divide, edgematch and error checking etc.
- **Thematic modification service** – a range of services for amending repository data.
- **Authentication** – although authentication is provided by third party FLOSS components used by OSCAR, it is expected that a dedicated authentication management service will be required to ensure appropriate levels of security for different Departments and Divisions within the LSAs.
- **Legacy Access** – Access to legacy data stores if they exist. A service should be dedicated to each legacy data store as required. This is a highly configurable type of service that abstracts implementation details so that all legacy services are accessed in a similar manner. Examples of legacy services include databases, file systems, and including proprietary file formats such as shapefiles, Microsoft Access databases, personal geodatabases etc.
- **Naming and lookup service** – A centralized service that abstracts resource or service location details by providing a mechanism for registering and resolving distributed resources. Examples might be individual machines, people, Departments, Divisons, workflow processes, or other services.
- **Repository services** – A number of services will provide access to repository data including read, write services. Expected services are index, search, retrieval, update, create, archive.
- **Ontology services** – Metadata maintenance and retrieval services and including those required for cross-jurisdictional integration and sharing. This service ascribes shared meaning to terms, concepts and even languages that are likely to vary from one country to another.
- **Rule service** – Exposes and centralizes rules (which may be stored in different places) associated with data updates and access. Data can be passed to the rule service for integrity checking, validation, and general quality assurance/quality control. Rules establish whether events in workflows are valid or invalid (i.e. can be passed to the next step in the workflow sequence).
- **Template service** – provides a centralized repository for document templates principally for printing and formatting official documents such as title certificates, which are populated with information extracted from fields in the database.
- **Search/query services** – Search services include title search, parcel title history, encumbrances, appurtenances etc. Search and query services will be stored (for common search/query functions) and locally customizable in a natural language that does not necessitate use of SQL by end users.
- **Financial/Audit Service** – Financial services principally for recording transactions (payments and receipts issued) for auditing purposes.
- **Map making** – A kind of search service that compiles and returns data for the purposes of producing customizable maps.
- **Execution Service** – This is the entry point for executing a workflow process.

In order to describe better the interaction between agents (an agent is an individual who contributes information to the OSCAR database including surveyors, lawyers, conveyancers, members of the public and civil servants among others) and the OSCAR software a simple usage scenario based on the workflow processes described in Section 3.1 is provided.

In a typical paper-based system, an applicant is given documents to fill in with appropriate information and these documents may detail other supporting documents that are required for a particular application. Application forms and supporting documents are completed and submitted to initiate an application process. In OSCAR, real-world processes are defined as workflow processes. Depending on the particular requirements for each jurisdiction this initial scenario may be fully or partially implemented. In either case a civil servant (employee of the LRD in the context of Ghana) would take the completed application forms and enter the data directly into the OSCAR workflow. To do this the staff member would log on to the system using secure access and would be given access to a GUI that contains all the tasks the staff member is currently involved with, as well as a menu of processes that the person may initiate – these are workflow processes. In this case the staff member would select the relevant application process and this would cause a new instance of a predefined workflow process to be executed.

The first task in that process would be a data entry form (which is defined as part of the workflow definition) for entering the application data and this task would be added to the user's list of tasks. Note that the execution of this particular workflow process instance would wait until the data entry task had been completed and submitted before continuing execution. After the data entry task has been completed and any supporting documents scanned if required and attached to the process, the next task in the workflow would be executed. This next task would possibly be a checking and approval process. The executing workflow would place a new task in the appropriate staff member's task list (note that within the workflow definition the appropriate staff members for each type of task are detailed and the actual person is determined at execution time based on workload, authority etc.). The staff member responsible for the checking and approval task would be alerted through a new task, which they would then select and perform appropriate actions, which would most likely involve examining the entered data and checking relevant fields automatically and manually before making and submitting a decision to the workflow task.

Once the task is approved the workflow process would access the lock manager service and acquire locks on relevant records to prevent any other processes interfering with the current operation. The relevant records would then be updated with the new information (again by accessing a specialized service) and once this is achieved successfully, the workflow process would have the locks removed. The next stage in the workflow process might be to produce a new event in the form of a document detailing the new state of the repository object. For this the workflow process might access a document template (via a service) and construct the document for final approval and printing. For tasks that involve modification or creation of spatial data, such as survey boundary coordinate integrity (no overlaps, slivers, holes, all distances and bearings correctly entered if required), the task would be sent to a staff member with a version of OSCAR that includes the uDig mapping software (this does not have to be made available to all staff in a workflow process unless it is required).

Using this software, the staff member would prepare the new spatial detail (such as a series of coordinate adjustments perhaps after further field re-verification on the part of the relevant surveyor) for submission to the workflow, which would then perform the checking, re-verification and approval tasks that are required (defined as part of the definition of the workflow). Note that some services are provided by other FLOSS components and are 'wrapped' as OSCAR services and other operations, such as mapping tools, are provided by additional FLOSS tools included in and extended by OSCAR.

This allows the functional and non-functional requirements of the software to be customized from the core/common functions consistent with the specific needs in a given context (i.e. it does not require all users to conform to a single, rigid, and complicated database model).

3.3 System Architecture Constraints

OSCAR is a distributed multi-tier client-server system. However, it could be configured to run in a peer-to-peer networking architecture where data are accessed and updated between workstations through file sharing. Such a model is feasible, but generally not optimal, in small scale and low transaction contexts (such as a small island state with relatively few land parcels to manage and low volume turnover in titles – perhaps in the context of Samoa). OSCAR is also capable of running as a multi-process system on a single machine if this is required, or as a LAN or wide area network (WAN) client-server system with one or more servers and a many of client workstations. For a nation with a population the size of Ghana, the number of title-based land parcels, and the current modernization and transition that the nation's land records management is undergoing a distributed, multi-tiered solution is desirable.

With such an architecture, much of this infrastructure including concurrency and security is provided by the FLOSS components that make up OSCAR 'bundle'. Due to the component nature of OSCAR, its configuration as a distributed multi-tier system is highly scaleable. It is expected that OSCAR will have a read-only service for browsing, searching and querying (perhaps for access by the public through a front desk service or through a limited Web service) and a secured full access service (available for the land sector agencies, and perhaps on an annual subscription basis by lawyers, conveyancers, registered surveyors, and registered land valuers). The read-only mode may possibly access separate data maintained on dedicated Internet service and database servers (perhaps distributed) which would be updated on a regular basis from the central datastore. Write access would be managed by the workflow server and server-side OSCAR repository management and database management services. OSCAR can manage access to legacy databases (such as employee authentication data) through services which are available to workflow processes. Hence, the constraints are relatively few and the opportunities many.

A minimal distributed LAN or WAN configuration could include a server running PostgreSQL and PostGIS which maintains the spatial (parcel) and the registry repository data. In addition this machine could manage a Web service running Apache, Enterprise Java, and the workflow server processes for updating and maintaining repository data. The Web service and workflow service serve pages to the network (read and write) or wider Internet (read only). The OSCAR server-side services, which manage access to the repository, may be located on one or more servers. Client workstations run either the full or partial OSCAR desktop software or this software and access to the data repository through a browser.

A high load WAN/Internet architecture could include a spatial database, repository database, Internet and workflow server processes possibly running on separate dedicated server machines and possibly across multiple server machines depending on expected load. Each server machine would be configured with fail-over, load balancing, security, and service guarantee support. Spatial and repository data may also reside separately on dedicated read-only servers for Internet access, search, retrieval, and reporting support. The OSCAR server-side services which manage access to the

repository would run on a dedicated server or possibly within the same server as the workflow processes. This kind of configuration is expected where multiple Divisions, Departments, and organizations have write access.

In general the variety of possible architectures require initial decisions about the best architecture for a given circumstance (in terms of volume, use of Web services, security, local or wide area access etc.). This circumscribes perhaps the largest constraint in the sense that the variety of possibilities and determining which is most appropriate for a given country's land records management is a constraint on development in and of itself. However, an initial choice of a development path does not commit the organization to that path forever. The highly customizable nature of the OSCAR environment and the flexibility of its architecture mean that a system can be modified as needs change. This is discussed further in Section 5.

4. Implementation Recommendations

The indicative project plan is moved to Section 6 (Implementation Plan) of this report. This section discusses implementation recommendations for the OSCAR project in Ghana. Information obtained from discussions with staff of the LAP in Ghana is taken into account as well as intuition on how best to implement the OSCAR project in general and specifically in Ghana. Issues related to project implementation are discussed in numerous other places in this report including the terms of reference (TOR) for project staff; present and future business/workflows in Ghana; system architecture constraints, training needs and recommendations; and the mission report. These issues are not repeated here, however their general implications for the implementation of the OSCAR project in Ghana must be considered.

The basic underlying approach behind the recommendations noted below is that the mistakes made in previous or current projects in Ghana must not be repeated in the OSCAR project. It is clear that to be implemented successfully OSCAR must have *a strong local presence in terms of staffing*; *a focus on in-country development*; *very clearly specified deliverables at project commencement that are agreed to and signed off on by all parties*; *and a realistic set of outcomes that do not promise more than they can conceivably deliver*. These are the basic underlying concerns of the implementation recommendations.

4.1 Project Management Mechanisms

Project management mechanisms are described briefly in Sections 4.5 and 4.6 of the FAO project proposal (dated May 15th, 2009). Basically, these state first that the Land Tenure Officer of the Land Tenure and Management Unit (NRLA) of the FAO will be the 'lead technical officer' of the project, whereas the overall project will be managed by a full-time International Project Leader (IPL) under the supervision of the Chief of the NRLA and the support of the Land Tenure Officer. This creates a top tier level of management that is internal to the FAO, but linked to each country project through the IPL. It states further in Section 4.6 of the project proposal that the *participating governments will appoint full-time national coordinators* in each of the three participating countries. This important point is rather buried in the proposal in a single sentence and not referred to further, either in the preliminary risk assessment or in Appendix 3 (the draft workplan) of the elsewhere in the project proposal.

Hence, the approach proposed in the project proposal leaves the important role of a local project leader in each country unclear. It is felt that both *the role and work of a local project leader are essential to the success of the project in Ghana (and indeed the other countries being considered), and this aspect of overall project management needs to be given more thought*. The approach suggested in the proposal document hinges on whether or not the participating government has (a) the staff resources and (b) the right person available and interested to serve in a co-ordination/leadership role. In order to minimize the risk that this assumption involves, the recommended option here, as proposed by the Ghanaian counterparts, is to *keep local leadership close to the project by appointing initially the IP in each country as also the local project leader and subsequently have this individual mentor one of the two local (Ghanaian) programmers into the position of local project leader upon completion of the IP's contract*. This is discussed further below.

Hence, *Figure 8 is a high level three tier model for overall project management that applies to each of the three beneficiary countries*. The top tier is focused on the FAO / NRLA and project management / leadership in Rome. The second level contains the IPL, who serves as the intermediate front line project manager between the FAO / NRLA and each of the three beneficiary countries. The third level contains the beneficiary country project leaders (and, albeit not shown, their project staff).

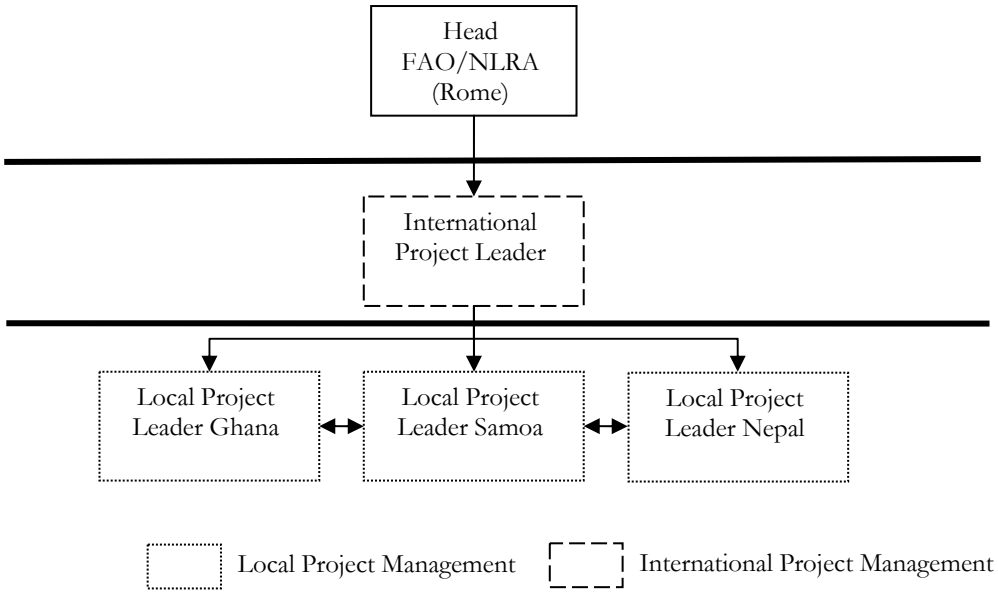

Figure 8: Management model for overall project management
Note: Managerial roles follow arrows, reporting lines reverse arrows, double arrows = equivalence

Note that in the bottom tier there are horizontal double-headed arrows indicating lateral communication between the projects in each of the three beneficiary countries. Although not shown in Figure 9 explicitly, as it relates specifically to Ghana, it is assumed that *there will be various linkages between each of the beneficiary countries*. These linkages are outlined further below.

Figure 9 amplifies local project management in Ghana. At this level, it was made clear during the mission to Ghana that the preferred local management model involve, rather than an appointed Ghanaian project coordinator as suggested (but not explained) in the project proposal, *a local project*

steering committee with the Director of the LAP or his appointee serving as the committee Chair. This committee would meet at regular intervals, perhaps bi-monthly with project staff, throughout the project to discuss progress and problems. All project reporting by the IP, Local Programmer (LP) and Local Database Developer (LDBD) would be circulated to the local steering committee members prior to circulation to the IP and NRLA in Rome, and the local steering committee would have the right to call a meeting with reasonable notice (a week) at any point with local staff during the project. In Ghana *it is recommended that this committee should comprise the IP, LDBD, LP, the Director of the LAP or his appointee (as Chair) and the Heads of the SMD and LRD*. Their immediate point of reference to the FAO / NRLA will be through the IPL as shown in Figure 9.

Further to the structure shown in Figure 9, it is recommended that operationally *the three local project staff members (LP, LDBD and the local information technology trainer (LITT)), initially work under the leadership of the IP*. However, *as the project evolves local project leadership responsibility will be passed to either the LP or LDBD, who will assume this role in the third year of the project after the conclusion of the IP's contract.*

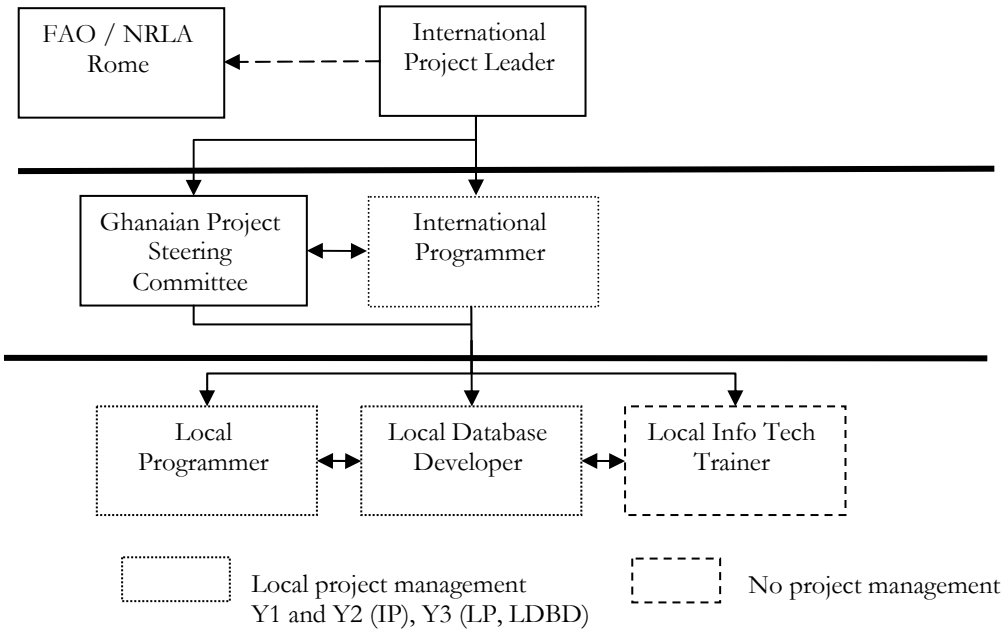

Figure 9: Interpretation of management model from project proposal – core staff
Note: Chair of Steering Committee serves as local project coordinator. Managerial roles follow arrows, reporting lines reverse arrows, double arrows = equivalence

As stated above, it was made clear in Ghana that the GoG is unlikely to have the resources to appoint or to second a full-time project coordinator for two years. In any event, the management model shown in Figure 9 and described above is superior to any other in the context of Ghana as it engages the recipient branches of the GoG in a steering role throughout the project, and encourages them to remain close to project activities rather than mere recipients of work products they may have little knowledge of. This risk could easily evolve with a model that has a single local project coordinator liaising internationally with the IPL and locally IP, LP, LDBD etc. Hence, in order to minimize the risk of dislocation between project activities and the local recipients, the three tier model with steering

committee liaising with the IP in the middle tier, as shown in Figure 9, is the most appropriate model for Ghana.

An important aspect of the project management mechanisms in Ghana is the inclusion of the Leader of the LAP or his appointee as part of the steering committee chair. This committee has equivalence with the IP and thereby local project leadership in Figure 9 and as such it will play a centrally important coordinating role in the project.

4.2 Skill and Expertise Shortcomings

The skills and expertise required to implement successfully the OSCAR software within Ghana are considered also in Sections 7 (Risk Analysis), Section 8 (Training and Knowledge Transfer) and are implicit in the required skills for the TOR listed in Section 9 of this report.

The skills and shortcomings can be discussed for three levels, first international expertise, second local technical expertise, and third local data entry and data processing knowledge and skills. *Points made in the latter two contexts are based strictly on cursory observations made in Ghana and are impressions, not facts*. The reality of the terrain as far as skilled computer programmers is concerned may be very different from initial impressions. Moreover, only brief site visits were made during the mission and it is difficult to gain a full and complete understanding of skill levels based on such short visits.

4.2.1 International Skills

The skills sets described in Section 9 for the IP form basic and necessary requirements for this project to succeed. If appropriately skilled and knowledgeable individuals cannot be recruited and retained for the project then it will more than likely fail. To find three individuals with the skill sets described will not be easy. The skills are a unique combination of computer science-based programming and geomatics and talented individuals with these skills are typically already employed and working in stable jobs. Hence, it may be difficult to recruit individuals with the skills needed.

In this regard it is of the greatest importance that the project advertise and network thoroughly within the international OSGeo community and within the Ghanaian land administration sector to recruit an international level programmer with the knowledge and skills required to fill this position. Considerable care has to be taken in vetting all candidates to ensure that the knowledge and skills are at the levels claimed in curriculae.

4.2.2 Local Skills

In the same sense that filling the international position may be problematic, filling the LP and LDBD positions may also pose a problem. While it is assumed that there are many individuals in Ghana with excellent programming capabilities, it is fair to assume that very few if any of these have much if any knowledge of geospatial data handling. Hence, there are likely to be shortcomings in knowledge. An unfortunate fact is that no matter how much training is devoted to creating a sound knowledge base, this is a long term venture and cannot be accomplished normally in a short period of time (a year or so).

Hence, a significant challenge will be to find two locals who have the requisite skill levels expected in Java programming in a client-server and web environment, understanding of spatial data and

databases, and the management experience to make things hold together locally. As noted above, these skills cannot be taught in a few training sessions, hence it is desirable to have a preliminary scan of the terrain to see if likely candidates exist before investing substantial amounts of time and money in the project.

4.2.3 Data Entry Skills

The state of the storage of land registry records in Accra is shown in Figures 10 and 11. To convert these paper files and modernize a lodgment and registration process that hinges primarily on the manual transmission of paper documents is a very difficult task to achieve under good working conditions, let alone under the adverse conditions suggested in these figures. This will not happen simply by placing a computer terminal on staff desks, providing some training and moving from one system to another. This is certainly not going to happen in an environment where virtually everything is done manually. Basically, to achieve the goal of modernizing a large and extensive paper-based system in an adverse environment is a lifetime's work.

Figures 10 and 11: Condition of current land title filing systems

Training for front line cadastral and land registry staff is going to be a large job in the OSCAR Ghana project. It will require a significant commitment of time and effort not only by the Local Information Technology Trainer (LITT) the project will retain, but also on the part of LC staff. Staff must have the confidence that the training they receive will be useful in their work to deploy it for entering new lodgments and transfers when they return to their duty station.

From discussion with Mrs. Rebecca Sittie, the Ghanaian Chief Registrar of Lands, the Ghanaian Land Registry handles on average 80 titles per day (either new titles or transfers – she could not give me the

split between the two). This is more than sufficient to maintain at least three or four data entry clerks. However, prior to reaching the point where new titles can be processed it is important to manage the existing titles. As noted in Section 2 of this report this equates to 220,000 documents and over 2,000,000 million pages to be scanned and stored in a database. Consideration of this volume of data has to coincide with current plans of the GoG. In general, however, it is fair to say that data entry skills are lacking and staff have little knowledge of basic computer operating and maintenance skills. Hence, for the data entry level of the land records process these basic computing skills need to be provided at least for LRD staff (and likely also for SMD staff, although there was no opportunity to witness these first hand).

If this training is included in the OSCAR terms of reference it will significantly add to the training overhead. However, it is felt that this is essential in order to introduce systemic change in the land records management process.

4.3 Familiarity with the Rational Unified Process

There is no familiarity within the MLNR, the LC, any of its 4 divisions (SM, LR, PVLM, OASL), or any of the related LSA departments (LVB, T&CP) in Ghana of the rational unified process (RUP) of software development. Moreover, there was no hint of knowledge of this process from anyone encountered during the mission, largely because the individuals working in the land sector in Ghana are not software engineers or programmers. Hence they have no knowledge of best practice in this field and there is no reason why they should. However, since the RUP is a process framework intended to be adapted by a software project team that will select the elements of the process that are appropriate relative to meeting the needs of the development organization, it could be possible to use this approach for the development of the OSCAR core or common code. However, the actual approach would have to be carefully devised as part of the lead into the programming/implementation phase of work for the main project.

In this respect, it is useful to note that the COWI Group team expressed some caution in this regard, noting that at their project start the requirements for the Ghana LIS were unclear and not detailed enough. Hence, they adopted what they describe as a spiral/iterative method of software development. This approach described information system development in iterations, each going through sub-phases including *identify*, *design*, *construct*, and *evaluate and plan* the next phase. In the final analysis this careful approach ended up instigating the potential for project creep and changing terms of reference, which led to significant additional time requirements on the part of the developers and changing needs on the part of the clients.

Their iterative approach has some overlaps with the RUP, which is also iterative, with risk being the driving factor at each iteration. However, the other best practices underlying the RUP, namely manage requirements, employ a component-based architecture, model software visually, continuously verify quality and control changes were seemingly not so prominent in the COWI approach. If the requirements at the start of a development process are very clear, use of a process such as the RUP can indeed help clients to improve the quality and predictability of software products. However, where the requirements are somewhat vague and not necessarily clearly understood equally by the developers and the clients then the project life cycle phases can become difficult to manage due to changing expectations and requirements as the project unfolds.

4.4 Project Activities Prior to Recruitment of Software Programmers

The proposed project start date is not clear in any of the documents available. Hence, it is assumed that this would be some time in the early new year, 2010. This would leave approximately 5 months between now and a projected start date.

Clearly during this period advertisements for the various initial positions (international staff only – 4 positions: IPL, IP (*3)) would have to be prepared and circulated to recruit appropriate candidates. If top shelf developers are found, this will make many of the downstream tasks easier. However, sufficient time needs to be allocated to advertise (three weeks to a month), interview (three weeks), offer and negotiate (two weeks), pass United Nations suitability tests (one to two weeks) and then allow the successful candidates time to commence duties on the project. Moreover, it is likely that that IPL will be hired first, hence there will be some lag between this and recruitment of the three IPs. Hence, if the start time frame is correct, the search for an IPL should commence in September, 2009.

Since the first period of work in the OSCAR project is devoted to development of the OSCAR core/ common code base time must be allocated to taking the existing prototype and substantially consolidating the code, tidying it, documenting it, and packaging it better than it is currently packaged. This work could be underway while the recruitment process is underway for the international level staff, and it could be completed by a collaborating tertiary institution as a pre-coding commencement stage of work. The repackaged and tidied code would form the basis of the first meeting of a small group of expert users in Rome where the user requirements can be consolidated from the initial project reports (including this one). This small group of experts should include one from each country with some senior status in the lands management sector.

I would note here that as a footnote to Section 4.2.1 it is mentioned that a Land Administration IT expert and a Systems Architect would be assigned for detailing the user requirements. However, no further mention is made of these individuals unless they are assumed to be hired as two of the assorted experts who will be retained from time to time during the project. Clarification on this needs to be provided by the FAO, NRLA.

In addition to the above points, hardware for use by the IP and IDBD will have to be specified and purchased. It is possible that the two developers could be provided with high-end notebooks running Kubuntu Linux, as this would satisfy the open source environment all development will focus on and it would provide flexibility in terms of carrying the work platform home from the MLNR offices at the end of the working day. Since, hardware has been purchased by the LAP through the COWI project and in general, it is suggested that this be used for development purposes in Ghana and new hardware for deployment in the OSCAR project not be purchase until well into year two, when the LP and the LDBD are retained.

5. General Input Requirements

General architecture issues and input requirements for cadastral and land registration workflows are also discussed in Section 3 (Statement of Requirements). The inability to state with any exactness an

operational architecture relative to the specific workflows that characterize the present and projected cadastral and registration process in Ghana (Section 3.1) restricts discussion to general requirementsl.

5.1 System Architecture Issues

The system architecture options discussed in Section 3.3 (Architecture Constraints) suggest that there is a considerable amount of flexibility in the way in which OSCAR can be implemented. It is preferable that the software be implemented with a clear upgrade or expansion path so that eventually (perhaps in a follow up project that could be implemented by the GoG) its operations can include land valuation as well as the management of stool lands and activities in the PVLMD that draw upon other aspects of land information maintained by SMD and the LRD. Hence, it is not so much a matter of attempting to satisfy the needs of all Divisions at once with an integrated system, than a matter of starting with objectives focused on cadastral survey and land titles and then expanding using the same system architecture and components to include the land information activities of other Divisions.

One of the major issues in implementation at the current time is that the LRD and the SMD are a long distance apart within Accra (15-20 minutes driving without traffic). This precludes using a LAN to connect the part of the process. Even after the Divisional offices are amalgamated into their new premises (likely prior to the projected end of the OSCAR project), the building will house administrative staff and the operational work will apparently remain at the current locations.

Under these circumstances, a client-server architecture, with both Divisions accessing a common database residing on a server in the LIU of the LCS in the new premises is the most likely alternative. This server and an associated file server would run at a minimum the PostgreSQL and PostGIS components of OSCAR which maintain the parcel and the registry title data. The server would manage access to (read and write where relevant) data records on the part of staff in the two Divisions either through use of a thin client architecture with staff accessing Web-based forms and the workflow services through a secure Internet connection for updating and maintaining repository data. Alternatively, a fat client solution could be developed with client workstations in the SMD and LRD running desktop OSCAR tools locally on their workstation with calls to and from the core database, which would still be resident on a centralized server, as required. All processing of information would be undertaken on the client desktop and then updated either in real time or in batch mode to the server side database, depending on data volumes.

The second solution would be more complex than the first as it would have to provide increased integrity checking of the database state and other updates committed to the server at the time of load. In addition to the thin or fat client architecture running off a single server, it could also be possible to develop an architecture where the processing load is distributed across several servers. However, the need for this is questionable at the present point in time. Use of a file server would become more of a consideration if the LAP proceeds with the current plan to scan all legacy documents. A high load WAN/Internet architecture would include a spatial database, repository database, Internet and workflow server possibly running on possibly multiple servers depending on expected load. As noted in Section 3, each server would be configured with fail-over, load balancing, security, and service guarantee support. Spatial and repository data may also reside separately on dedicated read-only servers for Internet access, search, retrieval, and reporting support.

In general the variety of possible architectures require initial decisions about the best architecture for a given circumstance (in terms of volume, use of Web services, security, local or wide area access etc.). However, an initial choice of a development path does not commit the organization to that path forever, the customizable nature of OSCAR and the flexibility of its architecture mean that the system can be modified as needs change.

5.2 Supported Generic Cadastral and Land Registration Workflows

Like most database modeling paradigms, domain modeling for OSCAR involves gathering the concepts (entities, attributes etc.) and their interactions (rules, processes, functions) into a design that is machine understandable. For OSCAR, the translation of the real world need not consider underlying schema issues (such as normalization or redundancy) to the extent that is required by other data modeling paradigms. Importantly, the metadata associated with domain features should be as detailed as possible in the OSCAR environment because OSCAR is able to encode and use this information in execution. Hence, initial domain analysis probably should focus on business processes within and between organizations, which are translated into workflows. Examples, by no means exhaustive, of the kinds of generic workflow processes that OSCAR can implement 'out of the box' are provided below. It is expected that these workflows will be reused either by versioning, inclusion, or simply used as code examples in the generation of new workflow definitions that stem from input requirements as they are defined.

- **UploadParcelsFromLegacyData** - Defines a workflow for moving data across from legacy databases into the OSCAR repository. Includes spatial object reference coordinates etc.
- **UploadParcelFromPaperData** - Defines a workflow for manually inputting data from paper records. Includes spatial object reference coordinates etc.
- **UploadScanParcelFromPaperData** – Defines a workflow for manually adding a scanned document from paper records. Includes hard copy map output of parcel boundaries.
- **CreateRegObjectInstance** - Defines the process for creating a new registry object instance (e.g. parcel). Includes spatial object reference coordinates etc.
- **CreateRegObjectType** - Defines the process for creating a new registry object type (e.g. parcel). Possibly used to create the event-based database for this land registry type.
- **RetireParcel** - Defines workflow for parcel retirement (marks and removes unique parcel identifier from the set of active identifiers) which would probably be used as a sub-process in other processes such as subdivision.
- **ParcelChangeOf Owner** - Defines the process for changing the owner of a parcel.
- **ParcelChangeOccupant** - Defines the process for changing the legal occupant.
- **ParcelModifySpatial** - Defines a process for modifying the spatial details (spatial extent, topology etc) of a parcel. Mainly used to improve data accuracy.
- **ParcelSubdivide** - Defines process for parcel subdivision.
- **ParcelMerge** - Defines process for merging parcels.
- **RegObjectDetailUpdate** - Generic process for updating a registry object's detail data for adding new detail data (new attributes).
- **SimpleDocument** - Generic process for generating a document. Generates a parcel description including event history and current state map for a particular date/time.

- **SimpleTimeState** - Generic process that generates a new layer and associated table that is the state of the repository at a particular point in time.
- **RegObjectGML** - Generic process that generates GML/XML for a registry object.
- **GenericQuery** - A generic process that generates a repository query.

Clearly there are other workflow processes beyond those noted above that will be added subject to need and the characteristics in any given application context. However, the point is that once these processes are known they can be added to the workflow manager and integrated into the system relatively easily. Workflow processes will be managed to the maximum extent possible with a visual interface which will require defining a process properly and then dragging and dropping the new process within an existing process or defining a new process.

The entities/objects/classes/abstract ideas/concepts, in the specific domain are gathered and encoded into a specific ontology within OSCAR. This should probably be done at the instrument/process level, i.e. as each process is defined and created. Importantly, references to legal documentation should be encoded with each concept. While the process of gathering, analyzing and defining concepts and processes in specific domains would probably be done using OSCAR, the process should result in the generation of detailed instrument-based documentation rather than any encoding paradigm (such as entity relationship modeling) which can be used in the reference construction of OSCAR. It should be remembered that OSCAR data are encoded in an unconstrained graph structure (see Figure 17) so there is no need to be concerned with issues such as repeating data, redundancy, nulls, normalization etc.

5.3 Generic Database Schema Requirements

There is no generic domain database schema as such in the OSCAR framework. OSCAR uses an event-based database model and this is expected to be generated in as part of the parcel and registry object creation workflows which allow for language dependant table and field naming. There is no necessity to define a database model for domain features although this might be helpful in analyzing the domain. Spatial detail is stored in a spatial database and referenced by the event database. Thematic data are stored within the OSCAR repository which is implementation independent, i.e. it might be a resource description framework (RDF) store or a PostgreSQL XML database. Examples of generic OSCAR concepts can be seen in the ontology diagram (Figure 17).

5.4 Software Development Methodology

The process of describing the specific data and processes (schema) in order to produce a computer implementation is similar for OSCAR as for other approaches (e.g. entity relationship modeling), however OSCAR is able to use a richer definition of the data and processes than is possible using other methods. OSCAR can be configured with data definitions in any natural language but all data definitions should be integrated into the OSCAR framework using ontology associations (e.g. inheritance, properties etc). This provides the mechanism for integration with OSCAR and for cross-jurisdictional schema integration (data exchange). Metadata that are collected during the analysis and design phase in other methodologies (and usually not encoded in the final implementation) should be included in the OSCAR data definition (this includes things such as attribute/tuple descriptions etc).

It is envisaged that the basic OSCAR software architecture will comprise a workflow component and a repository component. Both of these components interact with the ontology component that stores meta-information about objects in the repository. It is envisaged that there will be a special set of predefined workflow definitions (or services) for interacting with the ontology component and the repository. Programming OSCAR for use in a specific situation will involve *a data definition phase* that configures the repository and *a process definition phase* that constructs executable workflow definitions. The data definition phase (structural modeling) is similar to that of the relational approach. Data definition consists of defining and describing terms, concepts and associations in the specific domain by inheritance from existing (OSCAR core) ontology. These structures are used in the definition of workflow processes. Workflow processes model the specific actions that are associated with documents / instruments.

Programming OSCAR is the process of converting individual specific instruments into a data structure and process definition. Core or common OSCAR content will offer a set of 'primitive' Java and workflow definitions (such as database access and management) that can be reused within specific workflow definitions. Other executable Java code (rules etc) may be attached to workflow definitions if required. Processes should usually be composed of sub-processes that can be reused. Workflow definitions implement the interaction between users and the repository and this includes interactions with different organizations, Divisions and Departments and so on. Register objects (RegObject) are the primary class of objects in OSCAR. RegObjects are those real world entities for which temporal information is to be stored. Examples of register objects are Parcels, Buildings, Agents, and other aspects of the domain under consideration. RegObjects are defined as subclasses of the OSCAR ontology RegObject concept and are typically related to a database record (which might also refer to a legacy database).

Types (e.g. instrument / document types and other types of 'things') are 'concepts' in OSCAR and these are defined in the OSCAR ontology (Figure 17). New types are added to the ontology where required and these should be integrated using inheritance or other association types. Attributes are typically defined as ontology 'properties' and these may refer to a concept or an instance value. Properties (attributes/fields) are defined globally rather than within the context of a class or table and so can be reused across concepts. Property usage is defined within the workflow (and with reference to any usages defined within the ontology). Hence, this is the implied (instrument level) data model.

It is envisaged that the first task in configuring OSCAR will be to define an 'upload' or 'creation' workflow for RegObjects which populates OSCAR with the primary repository objects. This workflow should relate to an instrument which defines the RegObject and the information that needs to be stored along with that object. It is expected that this initial workflow will define a process that instantiates objects from a legacy database, although this may not be the case and the database may be created *de novo*, and associates the record fields (which may include related tables etc) into the ontology and then stores them as amendments within the repository. This initial workflow might also involve human interaction where paper-based records need to be scanned and uploaded (as in Ghana).

The process of domain analysis for OSCAR is most efficient when the focus is on instruments. For each instrument an account of the involved objects, their attributes (including metadata), and the associated processes (including actors/agents, rules, integrity checks etc.) should be constructed. Where many instruments share attributes (properties, concepts) that already exist, these do not need

to be redefined within the ontology. OSCAR does not require all possible domain attributes be predefined, rather only those attributes required for an instrument need to be defined.

Figure 12 shows the general process of computerizing an instrument. The legal definition is analyzed and the terms and concepts are defined within the ontology (which will probably be managed with an OSCAR defined workflow). A workflow process for implementing the actions associated with the instrument is then defined. This is where access to data (from a land registry repository or other database), user interaction, and specific executable code are all managed. Secure user authentication and allowed interactions are implemented within the standard workflow engine and is configured at this stage. The workflow refers to concepts and properties within the ontology and uses the encoded metadata and associations to configure the user interface and other interactions at runtime.

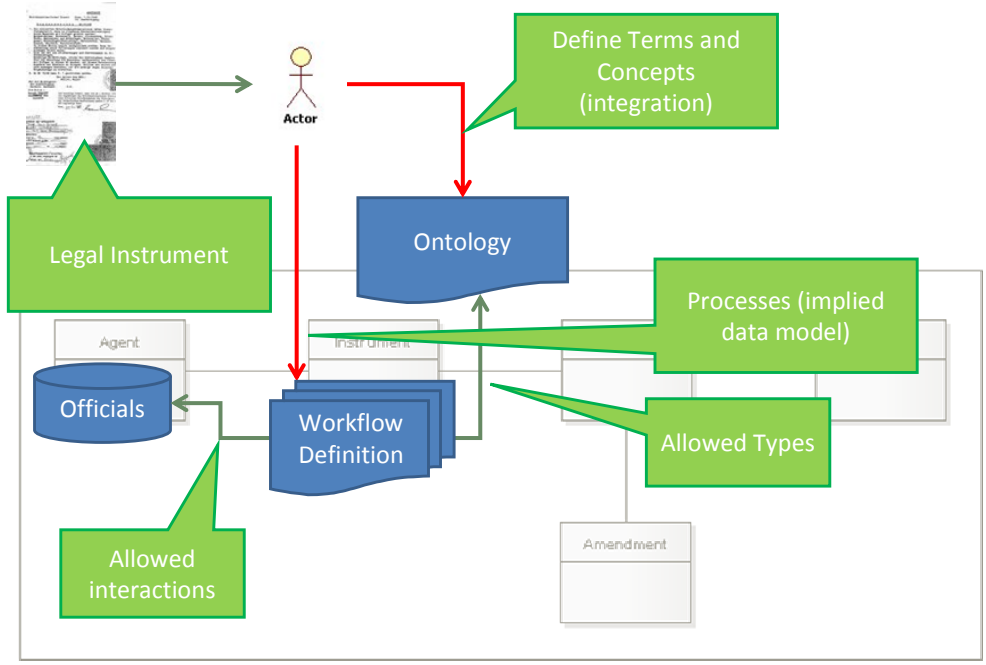

Figure 12: Computerization of an instrument

Figure 13 shows the initiation of a workflow execution by an authorized actor/agent (staff member in a Division/Department of the LSAs). An execution is a unique execution instance and this is recorded. In the reference implementation of OSCAR the execution of a workflow is managed by a workflow server which uses Enterprise Java server pages (JSP) to interact with users. Figure 14 shows the executing workflow accessing various data sources during its execution. The data sources might be legacy databases or the repository. The ontology is accessed for meta-information such as labels for data entry fields or integrity constraints and so on.

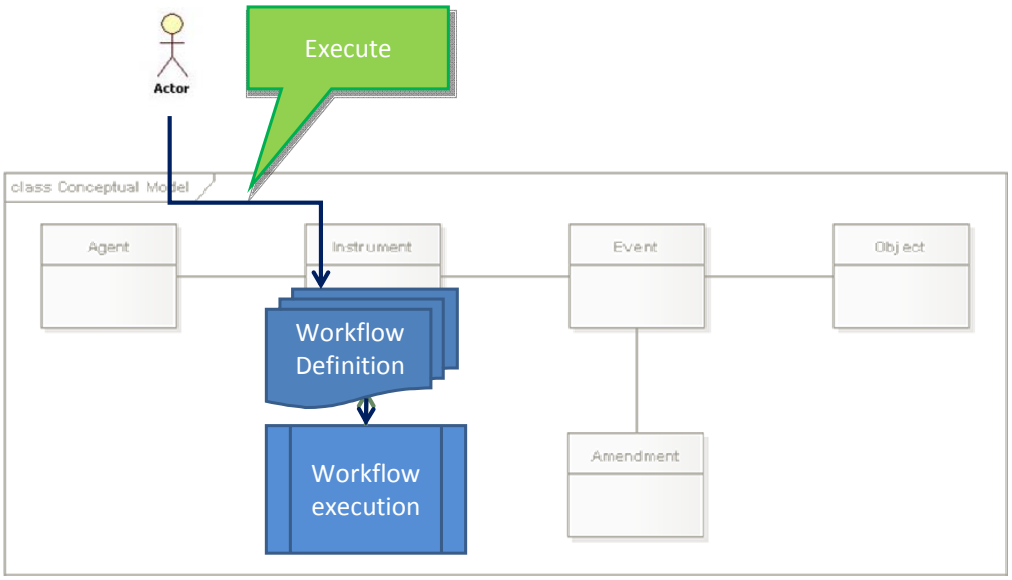

Figure 13: Initiation of a workflow

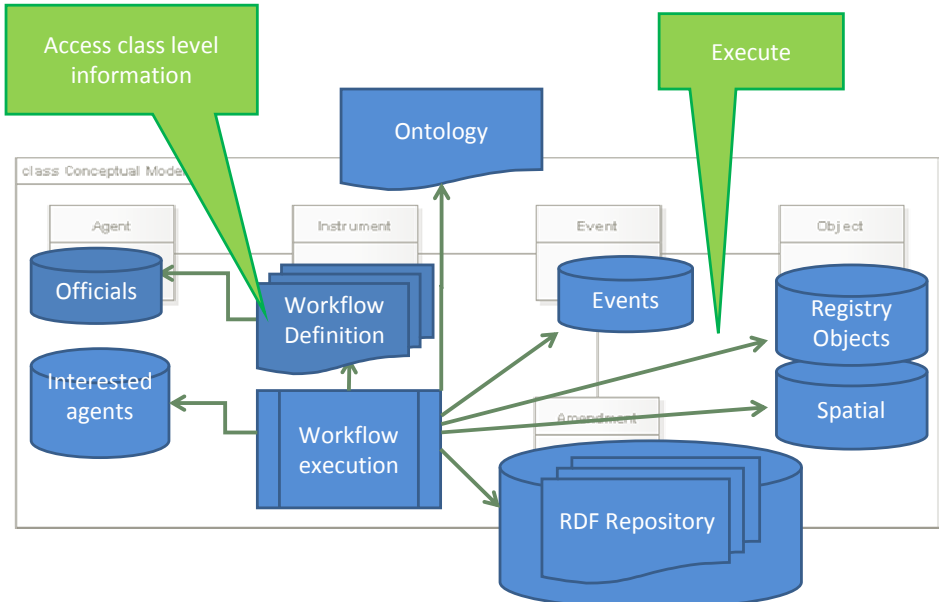

Figure 14: Workflow execution and data records access

The process shown in Figure 15 indicates that the execution creates new records which may be database records or repository records. The OSCAR event model is managed by workflow sub-processes. Long running processes would probably result in the generation of a number of events which signal changes in state of the registry objects (managing its state).

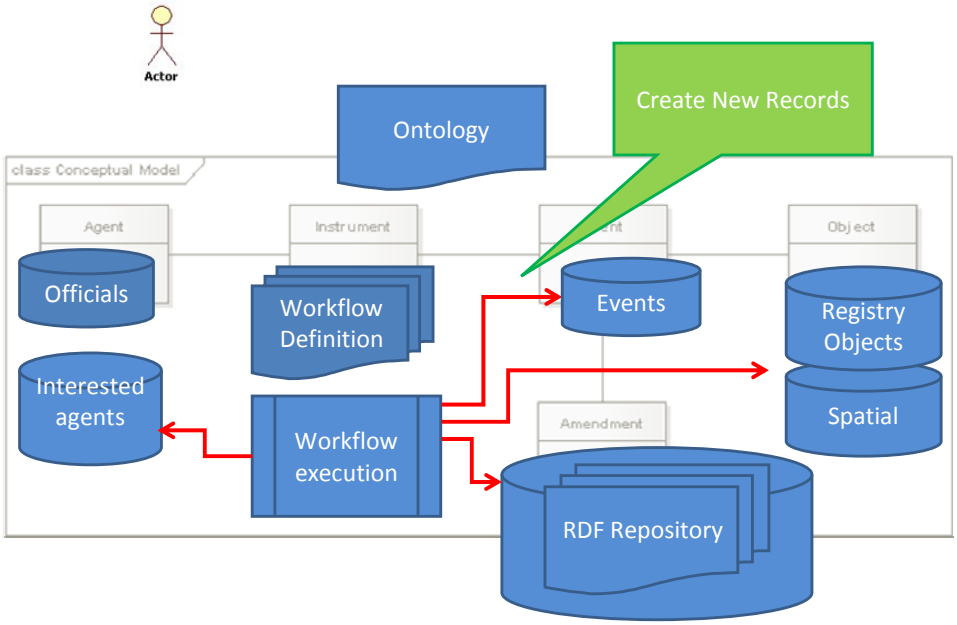

Figure 15: Creation of new records through execution

Relative to the above processes, Figure 16 shows the implied data model that is produced as new references between objects are created. These new references imply a data model and it is therefore emergent. However, OSCAR does not reply on this implied data model that is generated.

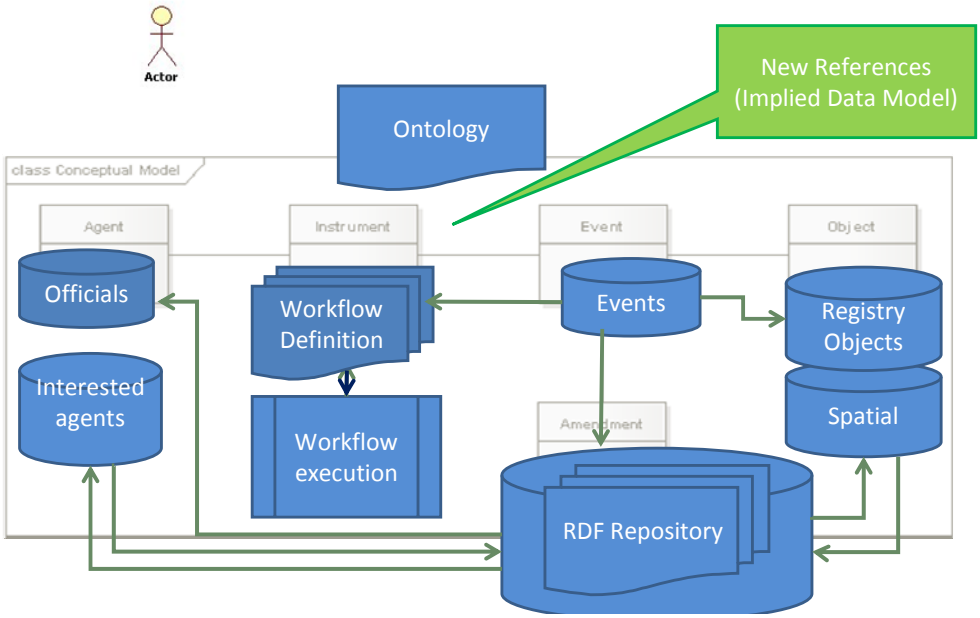

Figure 16: Implied emergent data model

5.4.1 OSCAR Ontology

The OSCAR core ontology is the starting point for the integration of specific domain terms and concepts. While it is likely that a more specific ontology will be defined as the implementation of

OSCAR advances (such as a land administration ontology for use in this domain) this is not required for OSCAR. Integration can be performed directly with the core ontology. Figure 18 shows a prototype core land administration ontology for which specific terms and concepts should be integrated.

In OSCAR concepts are types of 'things' including entities, abstract ideas etc. Rights, restrictions, responsibilities are concepts. In addition, parcels, events, and acts are also concepts that may differ from jurisdiction to jurisdiction and from tenure form (customary etc) to form. Concepts have a language and other properties some of which are encoded within the ontology that describes them and through which they are commonly understood. Usually global properties are encoded at the ontology level, e.g. instance value data are not encoded at this level. In generating the list of concepts for a domain (in the definition of its instruments), as much metadata about the concepts as possible should be gathered. For example a 'right' such as 'right of use' should include a detailed text description describing its meaning as well as references to legal documentation. Features of this description may be encoded as ontology associations later if this is required (or possible).

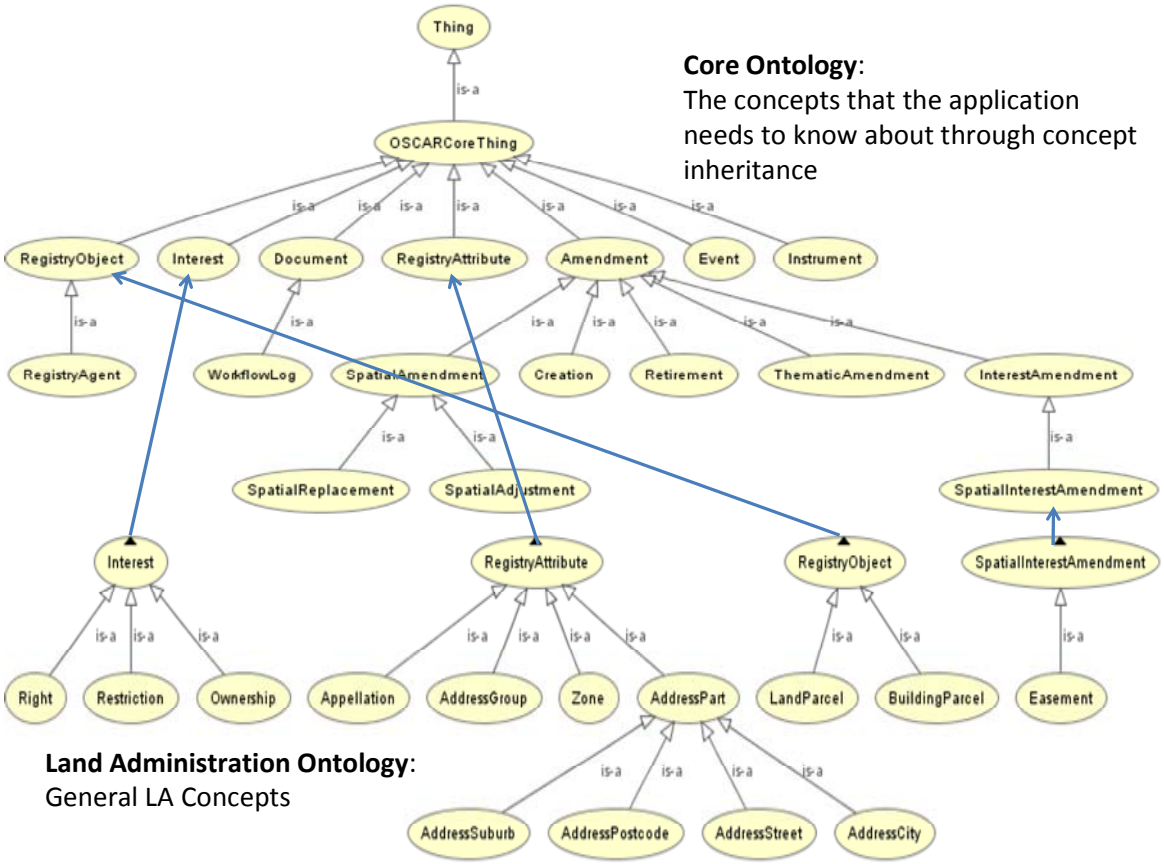

Figure 17: Prototype core ontology for OSCAR

Once the concepts and terms from the domain are gathered they should be integrated into the ontology. This can simply mean associating with an ontology parent (inheritance super-class). Each concept should have a set of standard annotation properties (which they inherit but would override as required). A simple example is *label* which is the label used for display in user interfaces or documents.

New concepts should provide their own label (and this can be in multiple languages). Other example annotation properties include *description, version, defined-date,* etc (also in multiple languages if required). An example concept definition (documentation) is given below for reference:

Concept: Parcel
Proposed URI: ghana.govt.la.parcel
SuperConcept: org.oscar.ontology.la.parcel
Version: 1.0x
Label: Parcel
Description: A block of land no smaller than $10m^3$ …..
Reference legal: Appropriate piece of legislation ….. etc.

6. Implementation Plan

6.1 Indicative Project Plan

An indicative project plan should contain three components, namely *phases*, *milestones* and *critical dates* across the life of the project. Since this project is projected to last for three years, each year serves as a convenient phase of work, namely:

- Phase 1, Year 1. Main activities: assessment, design and coding of OSCAR common core; recruitment and hiring of international programmers (one per country) and local programmers (2 per country) for a total of 10 project staff including the IPL (see below).
- Phase 2, Year 2. Main activities: Assessment and customization of local application built around the common code base; creation of Trac Web site with use Subversion revision control; training of local programmers by IP; creation and release of Alpha customized code base; recruitment and hiring of local information technology trainer (one per country), brining the total project staff to 13; preliminary development of training materials for use in Phase 3; create initial FLOSS project presence (target OS4Geospatial Conference – 2011).
- Phase 3, Year 3. Main activities: Beta code release for deployment in LSAs; full scale training program; revision of Beta code; release of version 1 code; establish FLOSS project online and invite use of / extensions to core code base (and customizations); conclude contracts for IP, LPs and LITT; IPL develop proposals for extensions to application to include valuation and planning uses.

Hence, in general terms Phase 1 covers assessment, design and coding of the common core code; Phase 2 covers assessment, design and customization in country; and Phase 3 covers deployment, testing and training. In addition to these general activities, there are more specific activities within each Phase.

In addition to the above three phases, that are outlined in detail in Table 9, it is recommended that the project also have a *Pre-implementation Phase*. During this phase which need last no more than 2 months maximum and be primarily internal to the FAO, the IPL should be recruited and hired and arrangements made for this person to settle in Rome. In addition, the TOR and job descriptions for

the IPs should be established, the project TOR should be set out in detail, and there should be liaison with local counterparts in each of the host countries so that activities are ready to commence in Quarter 1 (Q1) of Year 1 (Y1). Hence, formally the project will be completed after 3 years work. In a *Post-implementation Phase*, that will be largely up to the host country to pursue, there should be a review of the accomplishments of the OSCAR project and consideration of proposals developed during Q4 of Y3 to extend the national OSCAR application to include other areas of land development including valuation and planning, among others.

In the Table 9 the indicative activities differ quite substantially in some areas from the workplan presented in Annex 3 of the FAO project proposal draft document (dated May 15th). These differences are a result of considered opinion and also the reality of implementing the OSCAR project on the ground in Ghana. One of the main differences concerns the timing of activities. In particular, the project document suggests that the IPs will be hired on 18 month contracts, whereas the LPs are hired on 24 month contracts. There should be maximum overlap between the IPs and LPS for knowledge transfer and learning by doing *and* being (i.e. by observation and by tasks set by the IP for the LPs to complete). Hence, *it is recommended that the IPs be hired starting in Q2 Y1 for 24 months and they conclude their work at the end of Q1 Y3, i.e. 24 months rather than 18 months as specified in the proposal.* In addition, it is recommended that the LPs be recruited in Q4 Y1 to commence work at the start of Q1 Y2 and conclude their 24 months contracts at the end of the project, i.e. the end of Q4 Y3. This will allow there to be a total of 16 months overlap between the IP and LPs, for the whole of Y2 when the emphasis during Phase 2 covers assessment, design and customization in country and also for Q1 Y3 when attention is turned during Phase 3 to cover deployment, testing and training. This change will have budget implications, but this is necessary to maximize the time in country that the IP will be working with the LP staff. Moreover, *it is recommended that this 16 month period for the IP be spent entirely in country working with local staff in local conditions.*

A second consideration is that the period of core code development that will be undertaken in Rome by the IP staff (6 months of concentrated work by the 3 programmers) commence at the start of Q2 Y1 and conclude at the end of Q3 Y1. At this time the IP staff will relocate to their host country and commence the process of recruiting and hiring local programming staff and consulting with, in the case of Ghana, LC and LSA staff to assess the specific functions to be programmed into the customized application that will be created during Y2 of the project. The work during Q1 Y1 will focus on hiring the IP staff and undertaking general needs assessment within the three host countries.

Hence, the 3 phases of the project interlock with the three years of the project's duration. Milestones are unequivocal during this time period and are indentified at specific times in Table 9. Normally a milestone is attached to a specific deliverable that is a tangible and measureable achievement of the project (i.e. an output). However, there are one or two instances in Table 9 where milestones and deliverables are not twinned. Critical dates are also noted. These are especially important, as the volume of work required to achieve all milestones/deliverables is considerable and if deadlines or targets start to be missed early on in the project, these will have ripple effects which will ultimately diminish the likelihood of achieving the overall goal of the project (institutionalized use of customized open source software tools, built around a common data model, within the cadastral and land registry activities of the host countries).

Training activities are included in the indicative project plan, however these are discussed in more detail in Section 8 and a training plan including number and timing of courses and number of trainees by LSA is presented in Table 12.

6.2 Milestones and Deliverables

In total 9 milestones and 9 deliverables are listed in Table 9, the indicative project plan. The milestones are spread throughout the project a focus on Year 2, when both the IP and the two LPs will be working together for a full year in Ghana. In summary there are two milestones in Year 1, four in Year 2 and three in Year 3. Not all milestones have deliverables and vice versa. In fact the deliverables are spread with two in Year 1, three in Year 2, and 4 in Year 3 with the addition deliverable in Year 3 in the form of an overall project report from the IPL, at the conclusion of the project. This spreads activity throughout the three years and places some responsibility on local project leadership in Year 3 after the IP has concluded his contract. The deliverables are summarized as follows:

- **Deliverable 1**: A core code repository that is fully and professionally documented and that defines the central functions of the OSCAR software. Ideally, this code should comprise a library or set of libraries and an application programming interface (API) that developers will be able to call to customize business workflows and land records application processing in a given country.
- **Deliverable 2**: An indicative workplan for the development of customized routines to mirror the business processes and needs within the land administration / record records sector of the SMD and LRD in Ghana. This workplan should contain the same content as the overall indicative project plan and lay out clearly the routines and functions that need to be programmed to make the OSCAR core operational in Ghana.
- **Deliverable 3**: Creation of a Trac Web site that contains a complete summary of code updates to date and that contains a Subversion inventory of all code revisions. This site must be maintained religiously throughout the project and be available not only for developers in other countries but also for general OSCAR developers world-wide. This Web will be specific to work underway in Ghana. However, similar sites for each country will eventually be combined within a single OSCAR project web that will server as the main point of presence for the project on the Internet.
- **Deliverable 4**: Completion of Alpha code base for functions defined in Deliverable 2. Deployment of Aplha code on a limited access basis for System Managers and Systems Technicians within the LC, as well as for developers in the other two countries.
- **Deliverable 5**: Presentation of OSCAR project and demonstration of Aplha code at OSGeo Conference 2011. Use this opportunity to attract interest of potential new developers from within the international OSGeo community.
- **Deliverable 6**: Completion of Beta1 code for Ghana fully documented and all Alpha code bugs corrected. Deployment of Beta1 code to limited access group used for Deliverable 4.
- **Deliverable 7**: Follow up presentation at OSGeo 2012. Roll out a preview of OSCAR release software, to show its full functionality for land records management within the FLOSS4Geo community. Use this opportunity to recruit additional developers interested in adding

functionality, especially beyond the focus of the OSCAR tools for the current project. Creation of the final project website including the code repository and other information.

- **Deliverable 8**: Release of fully documented Version 1 release of OSCAR.
- **Deliverable 9**: Exit report from IPL on conclusion of the project. Assessment of the extent to which the project has achieved its goals in each country and a recommended path (including a proposal) for the extension of the current project into other areas of land administration such as valuation and planning.

6.3 Critical Dates

There are 10 critical dates for project milestones and deliverables noted in Table 9. *These dates are immutable and represent hard targets in the development of the project*. Should any of the work activities outlined in the indicative project plan exceed these critical dates the likelihood of the project reaching its goals will be diminished.

In addition to the milestones and deliverables noted in Table 9 *it is expected that all project staff will submit quarterly reports to the IPL summarizing work activities and the IPL will collate these into an overall quarterly project report for delivery to the overall project leader within the FAO*. In turn *quarterly reports will be summarized by the IPL into an annual report to be filed with at the FAO headquarters in Rome.*

The reports should contain as many metrics that signify work outputs as possible (e.g. lines of code written, number of bugs fixed, number of training materials produced, number of person hours of teaching completed, trainee evaluations of training courses, number of records added to and accessed in the OSCAR database once running centrally, number of queries executed, number of titles issued and printed, as well as general statistical reporting from within the functions of the OSCAR software tool itself (e.g. number of new land records processed, number of resurveys, number of legal challenges, number of land title transfers etc).

PHASES, MILESTONES AND DATES (by Year and Quarter)	YEAR 1				YEAR 2				YEAR 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 1: Assessment, design, coding of common code												
1.1 IPL hires IPs, consults with host countries, expert meeting in Rome with host participants (IPL, counterparts and experts)												
1.2 IPs hired for 24 month contracts												
1.3 IP Design and coding of core application in Rome, develop and test core functions in house. **Milestone 1/Deliverable 1.**				❶								
1.4 IPL and IPs develop TOR for LPs (2 per country)												
1.5 IPs leave for host countries												
1.6 IPs in liaison with IPL recruit, interview and hire 2 LPs per country to commence work in Q1 Y2 with IP for 24 months												
1.7 IPs undertake needs assessment within LSAs in country and develop workplan for implementation of custom code commencing in Q1 Y2. **Milestone 2/Deliverable 2.**					❷							
1.8 Purchase development computer hardware for IP, LPs, configure and install required OS software tools.												
Phase 2: Assessment, design, customization in country	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
2.1 LPs hired for duration of project												
2.2 IP and LPs create local code customization based on Deliverable 2.												
2.3 Trac Web site created in Ghana for local code with Subversion revision control for reference by other country coders **Milestone 3/Deliverable 3.** Site to be used to Q4 Y3.							❸					
2.4 IP engages in on the job training in coding style and techniques for LPs for 16 month overlap of positions												
2.5 Alpha code developed for in-house (programmer and selected technical staff) testing. **Milestone 4/Deliverable 4.**								❹				
2.6 IP and LPs commence training for System Managers and System Technicians in LC, focus on maintenance of application (Section 8, Table 12)												

2.7 IP and LPs commence training with Front Line staff of SMD and LRD, focus on purpose and use of application (Section 8, Table 12)												
2.8 Commence steps toward formal project within international FLOSS community. Target presentation and launch at OS4Geo Conference 2011. **Milestone 5/ Deliverable 5.**									❺			
2.9 Recruit and hire LITT to commence Q1 Y3. Organize training program and develop user manuals, end user documentation.												
2.10 Purchase, receive, install all hardware within offices of SMD and LRD ready for deployment of software in Phase 3. Milestone 6.										❻		
Phase 3: Deployment, testing, training	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
3.1 Consolidate Alpha code into Beta1 release and install application in all offices of SMD and LRD, stress and reliability test.												
3.2 IP completes contract, submits fully documented core and extension code to end Beta1 development for Ghana. **Milestone 7/Deliverable 6.**										❼		
3.2 Training of Managers and Front Line staff commences by LITT assisted by LPs. Continues throughout Y3 according to Training Schedule (Section 8, Table 12).												
3.3 Bug revision of Beta1 to Beta2 completed by LPs.												
3.4 Preparation for release of Version 1, OSCAR Ghana – Creation of technical and end user documentation release developed by LPs with assistance from LITT.												
3.5 Consolidate OSGeo project/SourceForge project; develop project Web site to encompass Trac and Subversion. Presentation by LPs at OS4Geo Conference 2012. **Milestone 8/Deliverable 7.**												❽
3.6 Full release of Version 1 OSCAR Ghana. LPs and LITT conclude contracts, each provide work reports summarizing their activities. **Milestone 9/ Deliverable 8.**											❾	

3.7 IPL evaluates achievements by consultation with counterparts in each country and conducts exit survey. Submits report to FAO. IPL contract ends. Project ends. **Deliverable 9.**											⑩	

Table 9: Indicative Project Plan
Note: Cross-reference Milestones and Deliverables to Section 6.2

Milestone and / or Deliverable *Work Activities* *Work Activities IP and LP combined*

① Critical date

7. Risk Analysis

The presentation of risks in Table 10 relate specifically to implementation of the OSCAR project in Ghana relative to local expectations and conditions and the prevailing situation within the land administration sector, which is currently undergoing restructuring. Apart from a potential lack of expertise within the LSAs to develop and maintain a tool such as OSCAR, the risks identified are broken into five categories, namely acceptance, software development, data availability and quality, organizational, and sustainability. The GoG has considerable experience in dealing with internationally funded projects and with expatriate consultants. Some very clear views have been expressed in the preparation of this report concerning the preferred approach to implementing international projects, and these are considered not only in the risk analysis, but also in the implementation recommendations (Section 4) and implementation plan (Section 6) of this report. Some sentiments that have implications for project risk are embodied in the proposed training and knowledge transfer policy and recommendations (Section 8).

Hence, risk is distributed throughout the various project components. Clearly, the level of risk is variable and the mitigation strategies or recommendations to overcome it varies according to the level and nature of risk identified. In general, though, as a predominantly systems development project designed to facilitate business processes/workflows in an efficient manner, adequate human resource capacity for the sustainable management and maintenance of the system is of paramount importance. The absence of requisite technical knowledge in systems development, programming and temporal database management within the LSAs presents a considerable risk in this regard.

In principle, there is strong interest and strong local support within the LAP for building the OSCAR framework into other land related project work that is currently underway in Ghana. While this is positive, it represents perhaps one of the most significant challenges identified for the project, namely taking the OSCAR approach and implementing this such that it fits within the context of the other applications currently under development. In the case of the COWI project, this is founded on a very different underlying conceptual approach and data model (namely the STDM of Lemmen and van Oosterom 2006). Though the risk associated with data availability for system implementation may be low given the number of separate data sub-systems in operation or under development at the moment, efforts should be made to standardize data collection methods and formats in Ghana. In this context, there is no wish to duplicate time, money and effort that have already been spent by doing essentially the same tasks multiple times. Rather, the challenge in Ghana is to find a path that integrates the OSCAR framework and the LIS framework while not rendering one or the other redundant. Achieving this goal is perhaps the biggest challenge the project will face.

Beyond the more general implementation issues that relate to contrasting approaches to address the same need, the issues of style and approach to project implementation are high risk in terms of local acceptance. There are very clear views in Ghana on the pitfalls of developing software applications out of country and then arriving for installation, cursory training for system administrators during installation, and later for end users in software functions and use. Training of trainers is only useful if it is undertaken carefully and over a protracted period of time.

Moreover, the trainees who are to become trainers of others must be carefully selected. This view is endorsed in this report. In the implementation recommendations and, especially, in the implementation plan, in-country development and significant opportunity for knowledge transfer and capacity building through training opportunities are explicitly recommended. In short, it is essential that software not be developed out of country and 'delivered' and installed without significant local input in the development process. If this in-country development does not occur, software acceptance and use will be low.

There is an implicit expectation that the relevant Divisions in the LSAs will be largely self-sufficient in support and maintenance tasks by the end of project. Should this be achieved, the LCS and relevant LSAs will be required to provide funds for local system support and maintenance, motivate staff sufficiently through good staff compensation schemes and ensure that a succession plan is developed for the LIU in addition to the strict enforcement of its training policy on IT systems development. In addition, institutional arrangements to facilitate inter-division data and information flow will provide a congenial communications environment for mitigating the risk associated with system sustainability.

These considerations and others are identified, their likely impacts specified, the probability of the risk affecting project success, and, finally, mitigation strategies to lower the risk likelihood are described in Table 10.

Risk	Impact	Probability	Mitigation
Acceptance			
1. The government does not actively support the introduction of a FLOSS-based land administration system. Priorities might change over time.	This might result in lack of cooperation during the customization and piloting of the software system.	Low	The goals and conditions for the project must be clear before the start of the project. A workshop outlining the process is to be held in the first year of the project to inform stakeholders.
2. Local counterparts involved are not fully committed	This would make local acceptability and ownership of the software application difficult	Medium	The local parties must be fully involved from the very beginning and in every phase of the project.
3. High expectations by the local counterparts	Loss of confidence in the project if expectations are not met during the project	Medium	User requirements analysis should present realistic scenarios to local counterparts. There should be realistic goals set at the start with the possibility of revising both goals and time frame during the project (i.e. flexibility that is driven by the host country.
4.The Open Source Geospatial (OSGeo) Foundation does not accept the OSCAR project for incubation	This would restrict the possibilities for building an online community and collaboration with other OS geospatial projects.	Medium	The project must actively seek to build itself around the best practices of OSGeo principles that are in line with other projects sanctioned by the OSGeo, and keep options open to join other geospatial umbrella organizations such as 52North.
5. Unwillingness to accept the OSCAR tool by local counterparts	This would be a setback to software implementation and in building of an efficient land registration system	Low	User interaction with OSCAR should be made as much as possible, consistent with existing processes.
Software development			
1. Local developers do not have sufficient technical capacities to maintain the developed system	System cannot be maintained by local counterparts beyond the end of the project, rendering the project unsustainable.	Medium/ High	Local IT experts with sufficient programming experience and knowledge on OSS products must be recruited and trained until they are able to maintain the system independently.
2. Incompatibility of the OSCAR data model with model drawn on by ongoing LIS development by LAP (i.e. COWI Project)	Benefits of investment made in LIS developed for LAP might not be realized and LIS may not be used to full potential due to functional confusion between the two products	High	The OSCAR model should be crafted to facilitate integration with LIS development by LAP
3. Overlap between the OSCAR software functions and the COWI LIS software functions, which may render one or the other redundant and therefore wasteful of human and financial resources in project development	Two pieces of software will be developed to perform basically the same functions. This will create confusion on the part of end users and may result in either of both of the tools falling into abeyance. It may also render the entire OSCAR project redundant in Ghana.	Medium/ High	Develop the OSCAR software in such a way that it does not compete with or seek to replace the LIS approach, but rather its functions can fit within the existing model. This mitigation effort will require careful examination of the LIS operationally and functionally.

Risk	Impact	Probability	Mitigation
4. International developers do not understand local conditions and requirements sufficiently to customize the OSCAR software to local needs	This would result in a system that is insufficiently adapted to local needs. Thus its uptake and widespread use would be very limited	Low	International and local developers must work closely together closely and consult with the GoG and its LSAs to ensure the fulfillment of local requirements.
5. LIS development by LAP project consultants could compete with the OSCAR approach	This would result in duplication of effort and resources and would ultimately produce two tools that seek to do very similar things	Medium	Developers must work together closely with the local partners and emphasize the pros and cons of OSCAR in relation to the LIS developed by LAP. Also efforts must be made to harmonize the data models used by the two software tools.
6. The software is developed too specifically for the conditions and needs in the target country, rendering it less useful for other countries where conditions are different	If the software is built too specifically for the target country and the general needs for other countries are ignored, there would be a lack of interest by the international community to participate in further development.	Low	The implementation in at least three countries will force developers to focus on common aspects of the software as well as specific needs in target countries
7. Number of programmers may not be large enough relative to the programming tasks	Sacrifices will have to be made in terms of what can realistically be developed during the project	Low/Medium	Use funds for academic partner institution to retain University-based developers to program specific aspects of the code for specific countries.
Data availability and quality			
1. Difficulties in providing digital data in a timely manner and the possible poor quality of the data	This could result in unnecessary delays during implementation	Medium	Schedule for system testing with real data must be communicated to the local partners well in advance
2. Digital data or information on the existing land administration system is not available to developers	This would impede the customization of the software and adaptation to local needs	Low	The requirements and preconditions for development of the system must be clear to stakeholders and developers at the start of the project.
3. Data formats will require translation	This will require time working with format translation. For open standards this will only take time. For proprietary formats, it may not be possible to convert these.	Medium	Program translation tools to convert all spatial and attribute data to open standards.
Organizational			
2. Delays with converting and linking existing attribute data held by the Land Registration Division to the digital parcel maps	This could frustrate full system implementation efforts	Medium	A structured approach/timetable should be developed for attribute data input. Involve private sector if possible

Risk	Impact	Probability	Mitigation
3. Unwillingness by divisions to share "Institutional" data	This might result in lack of cooperation during the implementation and piloting of the software system.	Low	Encourage the inter-agency interaction and use of the Unique Parcel Number (UPN)
4. Ambiguity in the nature and role of the Land Information Unit (LIU) in IT support	If the LIU does not play an active role in project development it is unlikely that they will know enough about the operation and implementation of the software to be able to support and sustain it beyond project end	Medium/High	As soon as the LIU (or its equivalent group) is clarified, roles and skills for staff should be considered by Government and the OSCAR project should dovetail its development effort with staff in this unit as primary technical participants
5. Actual design and operations of the LIS software are not clear (client/server ; Web readiness; Web functions etc)	Impacts on OSCAR project could be manifold – need to review implementation intention of LIS in detail in order to develop OSCAR accordingly	Medium/High	Receive source of LIS software and all technical documentation from COWI. Current reports do not fully explain the architecture of the software
Sustainability			
1. High staff turnover	Low human resource capacity to maintain the system	Medium	Government must make compensation package attractive to retain staff of the LIU
2. Vertical movement of technical staff	Shortage of technical expertise to maintain the system	Medium	Develop succession plan for LIU staffing
3. Low budgetary allocation for systems upgrade	Frustration with slow and inefficient system	Low	Annual budgetary requirements for system maintenance must be determined and factored into Lands commission's Land Information Unit operational budget
4. Local counterpart staff does not have sufficient knowledge of the concepts and use of relational database management software	The system cannot be efficiently used and maintained by local counterparts beyond the end of the project.	Medium	Local staff knowledgeable in databases must be recruited and adequately trained to be able to maintain the system independently

Table 10: Risk matrix for implementation of the OSCAR framework in Ghana

8. Knowledge Transfer and Training Policy

The OSCAR proposal indicates that "…by the end of the 36 month period of the project it is anticipated that the OSCAR shell has been produced and made available online. Moreover, this tool would have been fully tested and piloted. Detailed user and developer documentation will be available and continuously updated. *Skills and training will be sequentially built during the project starting with effort focused on the part of a small number of staff but expanding to train all involved land agencies staff in the use of the software*, which has been developed" (italics added for emphasis).

System sustainability, noted in the risk analysis in the previous section, requires that local expertise and capacity be developed to ensure the long-term usage and upgrade of the system by local professionals and technicians. The development of software is a continuous process, and therefore requires the development of needed human capacity to ensure its long term sustainability and use.

The dynamic nature of managing and delivering effective and efficient survey lodgment, parcel mapping and land tile registration services requires that formal training in the customization and use of software developed through the project be provided continuously. To ensure continuity beyond the project period, *it is recommended that a base level training in tandem with a process of training future trainers approach be adopted, where carefully selected key staff will be trained and provided with training manuals that can be used to train other staff*. Contrary to the expectation stated in the project proposal, it is unrealistic to suggest that all involved land agencies staff will be trained. Hence, *the approach proposed is more focused on smaller groups of key personnel.*

8.1 Training Requirements Definition

Capacity building of people through training requires capacity assessment through a training needs assessment. This should be the starting point for the development and implementation of a training program. Though existing personnel in the LSAs in Ghana have received prior computer and geographic information systems training, and who would be suitable to receive specific training in the use the OSCAR tool, *a complete training needs assessment should be undertaken during the initial stages of project implementation*. This should occur *during the 4th Quarter of Year 1 as a follow up to the general needs assessment to take place during the first quarter of the project*, rather than the much later date indicated in the current project proposal (Quarter 3 Year 2). This assessment will allow the knowledge and skill levels of trainees to be identified, and the capabilities of GoG staff to support and maintain the system after the project's conclusion to be established. Since, the LP and LDBD will also be hired during the 4th Quarter of Year 1, to commence work at the start of Year 2, this suggests that training will commence during the second year of the project, with a focus on the Systems Professionals and Systems Technicians, as well as the transfer of knowledge from the LP to the LP and LDBD (see Table 11 for an overview of the training to be delivered to five levels of trainees, falling broadly into two groups, namely technical and manager / end user).

Moreover, it is expected that training will be focused on more than just GoG staff including system managers, technicians and end users of the OSCAR software. In particular, it is important

that the LP and LDBD should also benefit from on the job training provided by the IP as the project unfolds. This strategy will reduce the possibility that development will become too focused on external activities and international personnel and increase the possibility that there is local capacity building and knowledge transfer during the project. It will also help to reduce the likelihood of disconnection between the IP and local participants.

Who	Content	Purpose	Approach	When
Senior LSA Managers	Overview	Awareness, uses and benefits as well as progress of development	Short PowerPoint presentations, demonstrations of functionality and results	Quarterly commencing Year 3
Division Managers	Overview, specific applications	Awareness, strategy, staff resources required	Seminars, PowerPoint presentations & hands-on classes	Quarterly commencing Year 3
Systems professionals	System maintenance and troubleshooting	Competencies for system operation and maintenance of day-to-day operations	Internal training courses delivered initially by IP and subsequently by LP and LDBD	Monthly commencing Q3 Year 2
System Technicians	Overview, coding concepts, code maintenance, system operations, applications	Competencies for tweeking and extending aspects of Ghana code base	Internal training courses delivered initially by IP and subsequently by LP and LDBD	Monthly commencing Q3 Year 2
Front Line Office Staff	Data processing at key stages of parcel survey and land registration process	To automate the workflow processes and ensure error free data input	PowerPoint presentations and hands on task oriented workshops	Quarterly commencing Q3 Year 2 and monthly during Year 3

Table 11: Training requirements, timing and recipients of training
Adapted from Johnson 2008

Hence, training requirements can be defined at two levels. The first is a *technical level* and relates to *building capacity in software and database programming knowledge*. Since the OSCAR framework is FLOSS-based there is a distinct need to introduce the fundamentals of working with FLOSS projects and languages. This will include, but not be limited to PostgreSQL, PostGIS, the uDig user layer, Java programming language, Web Ontology Language (OWL), the Eclipse Resource Client Platform (RCP), and Java Server Pages (JSP) among others. To achieve this, there is the need *to generate, through sequential, structured and hands-on learning programming techniques and data structures, provided by the IP, as well as a thorough understanding of the architecture and coding behind the core OSCAR platform*. Moreover, it will be expected that by mid-way of the project (end of Quarter 2, Year 2) local project programming staff will be sufficiently well versed in the above programming and development environments to be able to work relatively independently on enhancing the core OSCAR code for use in Ghana. Moreover, GoG local computing systems professionals and technicians will also start to receive technical training at this time.

The second level training is a *use level* and focuses on *daily business activities within the Ghanaian LSAs*. For the second level it is essential that *Divisional Managers have a sound understanding of the functions of the OSCAR framework* and that *front line staff are trained in all aspects of its use.* This can be achieved through presentations at regularly space intervals (quarterly from the end of Quarter 2 of Year 2) and monthly during year 3 (i.e. 14 sessions in all). These presentations will employ *Microsoft PowerPoint, live examples of the software at work, and gradually developed on the job tasks of software use (receive, process and transfer specific aspects of land parcel registration information).*

This approach ensures continuity and thoroughness in the training that all Ghanaian participants will receive. While specific aspects of the training (Systems Professionals, System Technicians) will be delivered by the 3 technical staff (IP, LP, LDBD), the majority of the front line staff and senior management training will be undertaken by the LITT (Senior LSA Managers, Divisional Managers, Front Line Office Staff). This is explained in more detail in the following section.

8.2 Training Policy

As mentioned elsewhere in this report, training and capacity building is an ongoing process, and as such it should be guided by an institutional training policy based on the following four principles:

- commitment;
- relevance;
- efficiency; and
- mission-driven.

There should be *commitment* on the part of management to the process of training and development of all staff, and more importantly, trainees identified by management at any point in time must have the necessary motivation and commitment towards the training programs offered to them. As much as possible all training programs should be *relevant* to the core business processes of the Division/Unit concerned and the tools used for training must be decided upon in advance by management. Clearly these tools must be relevant to the data and information processing tasks performed by the recipients of the training. This way common standards can be taught and enforced across Divisions ensuring data harmonization and "interoperability". It is a well known fact that increasing skills and knowledge will produce confident, highly qualified staff working as an effective and efficient team. The training program must therefore be geared towards effectiveness in work processes and *efficiency* in service delivery. A *team approach to staff training should be adopted* to ensure that the *mission and objectives of the LC should be kept in view and reflected in all training programs.*

As noted in Section 8.1, *the training needs should be identified through a training needs assessment and analysis to be undertaken no later than the fourth quarter of Year 1 of the project.* Training *should be provided locally to the maximum extent possible so that local constraints and conditions can be incorporated into the training program.* External short term courses where needed, especially for programming expertise, may be required and should be fully funded by the project. Staff should be encouraged to be responsible for their own development and as such may inform their line managers of their development needs, and take part in scheduled training programs.

To guarantee continued commitment to training and development, staff identified for training should complete an assessment on the value and effectiveness of each training session they attend and provide recommendations as to how future training sessions might be improved in the future. This information will provide a basis for gearing the training process toward producing a highly motivated and knowledgeable support and user group.

For implementing everyday use of the OSCAR tool the following policy guidelines should be adopted.

8.2.1 Purpose

8.2.1.i Technical staff
To ensure availability at all times, a highly skilled and efficient professional and technical staff must be created who are knowledgeable in the use, maintenance and upgrade of the OSCAR land title registration software system. Moreover, there must be sufficient technical knowledge locally to be able to extend the system to include new functions as required.

8.2.1.ii Front line office staff
Front line office staff must be sufficiently motivated and professional to attend training and ensure daily use of the software in their information input and processing operations. This will require building a strong sense of commitment to and understanding of the operations of the LC Divisions and LSAs with respect to the OSCAR software. Staff must have sufficient knowledge of system operations to be able to use the software without trouble, and to have the confidence in technical support to remedy problems if and when they occur in a timely manner so there is as little down time of the system as possible.

8.2.2 Minimum Requirements

8.2.2.i Technical staff
Minimum requirements for trainees shall be basic knowledge of programming principles, preferably in Java language, and in database management concepts and involvement in the management of data related to parcel boundary demarcations and land title registration.

8.221.ii Front line office staff
Minimum requirements for trainees shall be basic computer literacy and a good understand and use of English language.

8.2.3 Training Categories

Training categories will vary according to purpose and the skills of trainees, and will include but not be limited to programming concepts and procedures and software architecture and compilation for professional and technical staff; application use with relevant data; and hands on exercises in routine data processing, querying the database and problem solving for managerial and front line office staff.

8.2.4 Mode of delivery

Training for Senior and Division Managers and Front Line Staff shall include scheduled half day seminars with a mid-session break and take away tasks to be completed and returned to the trainer in a set time period prior to the commencement of the next training session. In all instances, training will be prefaced by a PowerPoint presentation outlining the content of the material to be covered. This will be followed by a live, hands-on demonstration, presented by the LITT, of the tasks to be mastered by the end of the session. The demonstration will be accompanied by work notes for the trainees with appropriate screen captures and written steps illustrating the knowledge required to complete the tasks being taught. For the System Professionals and Technicians training will be delivered primarily by the IP, LP and LDBD with the assistance of the LITT. Content will focus on operation of the system, maintenance and management of the database, troubleshooting and how to implement extensions to the custom code written for use in Ghana. In this training trainees will be given simulated trouble shooting scenarios that they have to remedy in class with advice and input from the trainers. The LITT will be responsible for the final preparation of training materials (handouts, course notes etc) in all cases.

In all instances, training must take place in a dedicated training facility with networked computer access for each trainee. If such a facility does not exist in the GoG offices, arrangements must be made with a local institute such as the Kofi Anan Centre of Excellence in ICT or the CERGIS at the University of Ghana, Legon. *The need to have individual access to computers to complete hands-on training during the training sessions is essential.*

8.2.5 Requirements and Enforcement

Trainees must make measurable and continuous progress in their training. There will be a short review/revision test at the start of each training session to ensure that the tasks taught in the previous training session have been retained by the trainees. If a trainee fails the test of recall in use of the instructions taught in the previous class, they will have to repeat the training and resit the test until they pass it in order to proceed. Line managers should be responsible for ensuring that trainees under their supervision make progress in the required training areas by passing all such tests of competency (to this end trainees must be given time and access to the software and teaching materials in order to revise what they have learned).

Since training is very important to the sustainability of the system, monthly reporting from line managers to the Local Project Leader shall be used as a mechanism to ensure that the training policy is being followed. Line managers should request subordinates to report on user friendliness and whether or not the system is responsive and working as suggested during training. Responses and variances from expectations should be passed back up the training and development hierarchy so these concerns can be addressed by the developers and trainers in future system changes and training respectively.

8.3 Training Plan

This training plan, elements of which are noted in the Training Policy in Section 8.2, addresses the requirements for training related to the use, maintenance and further development of the

OSCAR software in Ghana. To deliver a training program which focuses on practice for the effective, efficient and sustainable implementation of the OSCAR software by local staff of the LC the approach seeks to combine a systemic view of developing an understanding of how information moves within and between the LSAs, focusing on Unit and Division-specific information input, processing, output tasks within the business / workflow processes of the land registration process. Hence, staff are expected to understand the overall process of information flow within their Unit and how this Unit fits within the LC Divisions. In addition, staff are expected to gain from the training a complete understanding of how the OSCAR software works with respect to their own land information processing requirements.

The timing of training sessions is set forth in Table 12 so that there is continuity throughout the second and third years of the project and so all relevant staff within the LSAs will have the opportunity to become versed in the use of the new software.

8.3.1 Number of Trainees

It is difficult at this stage to ascertain exactly the number of staff who will be trained in total. However, excluding the LP and LDBD, who will receive training in programming skills from the IP, it is expected that *a total of at least 38 staff, 19 in each of the SMD and LRD, will be trained during the course of the OSCAR project*. This number is weighted toward front line office staff (8 from each of the two Divisions) and system professionals and technicians (also 8 from each Division). Hence, as noted earlier, facilities must be found that will seat a minimum of 8 trainees, each with access to their own networked computer for use during the training.

8.3.2 Modules and Duration

Also as noted earlier, each training session will last for approximately 4 hours in total including a break after the first two hours. The approach will employ several styles of presentation including PowerPoint overview of revision of previous tasks learned and new tasks to be learned in the current session, demonstration of new system functions with an explanation as to their role in the overall business / workflow process, hands on tasks for trainees with assistance from the trainer(s), and summary of tasks to be completed by trainees prior to the next training session.

Depending on the audience the following modules will form the basis of the training. The exact number of training sessions will be determined based on the training needs assessment, which will take place

System Managers and System Professionals:

- basic workflow/process tools;
- flexible spatial-temporal data model and database;
- data entry forms;
- basic GIS (parcel) editing tools;
- database maintenance tools;
- data query and output forms; and
- development tools and programming.

Managers and Front Line Trainees:

- basic workflow/process tools;
- basic GIS (parcel) editing tools (SMD only);
- data entry forms; and
- data query and output forms.

Consistent with the sequencing noted earlier, the number of individual courses to be taught are enumerated in Table 12. Training will be undertaken throughout Years 2 and 3 of the project, however in Year 2 this training will be exclusively focused on the technical support staff and the local programming staff. Training provided by the IP to the LP and LDBD are not enumerated in the table, as it is assumed that this training will be more informal than formal and will focus on very close mentorship and exchange of information through 'on the job' learning by doing overseen by the IP. However, in Year 2 the three technical project staff will start to impart technical knowledge to the local GoG technical staff as the software evolves and is ready for beta deployment at the end of Year 2 of the project.

LSAs & number of trainees	Number of Courses per Quarter								
	Year 2				Year 3				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	SUM
Survey and Mapping Division									
Senior Managers (1)					1	1	1	1	4
Division Managers (2)					1	1	1	1	4
System Professionals (4)			3	3	3	3	3	3	18
System Technicians (4)			3	3	3	3	3	3	18
Front Line staff (8)			1	1	3	3	3	3	14
Land Registration Division									
Senior Managers (1)					1	1	1	1	4
Division Managers (2)					1	1	1	1	4
System Professionals (4)			3	3	3	3	3	3	18
System Technicians (4)			3	3	3	3	3	3	18
Front Line staff (8)			1	1	3	3	3	3	14
Table 12: Number and timing of training courses									116

The total number of courses offered per month summed to courses per quarter equates to a maximum of two courses per week (a maximum of 22 courses in one quarter (e.g. Q2 Y3), with 3 months or approximately 12 weeks per quarter, equals slightly under 2 courses of 4 hours each per week). Since the LITT will be retained on a FTE basis during Year 3, this schedule coincides appropriately with this individual's work expectations defined in the TOR in the following section. This schedule will also provide more than ample time to prepare training materials in conjunction with the IP and the two local programmers and to follow up with review and marking of submitted materials from training sessions.

In total 116 training sessions each of approximately 3.5 hours duration equates to a total of 406 hours of classroom-based training during the project. This is expected to be more than adequate in terms of achieving the goals of the overall project relating to knowledge transfer and capacity building within the GoG. When the additional hours of technical knowledge transfer from the LP to the local programming staff are added to this number the total number of hours will likely easily exceed 600 hours in total.

9. Terms of Reference for Project Consultants

This section outlines the TOR for four project staff who will be recruited and retained for variable time periods during the OSCAR project in Ghana. The Ghana project staff, as outlined in the OSCAR project document, include:

- International programmer (18 Months Full Time equivalent (FTE))
- Local programmer (24 Months FTE)
- Local database developer (24 Months FTE)
- Local information technology trainer (12 months FTE).
-

In addition, the TOR are supplied for the overall project leader:

- International project leader (38 months FTE).

It is recommended that a Ghanaian project leader be appointed for the duration of the project. There are two possibilities for this. One is to recruit an additional Ghanaian funded by the GoG for this purpose. Alternatively, the IP could be retained in this dual capacity. *The second alternative is recommended and these functions are added to the TOR for the IP.* Hence, in addition to his/her senior role as one of the international level programming staff, this individual would be tasked with various management level responsibilities (see Sections 9.1 and 9.2) that ensure that local project targets are met, that reporting and communications are maintained, and that local work proceeds on schedule.

The project proposal calls for hiring an international QA/QC expert for up to 60 days FTE during the project. It is suggested in the proposal that this individual will work under the supervision of the International Project Leader and will primarily be responsible for assessing whether the core software developed in Rome during Q2 and Q3 of Y1 will meet the expectations of the recipient governments. In general it is felt that the term of retention (60 working days, or 12 weeks) is overly generous for this individual as the work should not require in principle more that 30 working days (6 weeks). However, notwithstanding this view, a set of TOR is also supplied here:

- International Quality Assurance Expert (60 days FTE).

There are obvious linkages between the process of implementing the OSCAR framework and staffing. Hence this section is closely aligned with Sections 4 (Statement of requirements for implementation) and 6 (Implementation Plan) of the Ghana project. The time frames for staff retention and the pattern of implementation activities are arranged so that the IP is present *in Ghana* for as much of the project as possible. However, based on the project proposal it is evident that the first year of the project is intended to be focused on work by the international staff and in year two the focus switches progressively to development in-country. Moreover, in the first year, apparently the intention is that the international staff members will spend six months in Rome working collaboratively on the code in conjunction with inputs from an academic institution. Hence, by the end of this time period it is expected that there will be a functional and well documented common/core code base (i.e. a generic code repository that will run OSCAR's core functions without customization for local data and/or locally specific needs). From this code base two local programmers, under the supervision of the IP, will work on in-country customization. Under these circumstances, which are taken to be given, activities in year one will involve local input to a very limited extent.

In addition to the above Ghanaian project staff, the project will recruit and hire a two international level staff, namely an International Project Leader (IPL) and a Quality Control/ Quality Assurance expert (QAQCE). Terms of reference are provided for these posts following the presentation of the Ghanaian positions.

9.1 International Programmer

9.1.1 Introduction and Scope of Work

The international programmer (IP) will take full responsibility for the initial development of the core or common system code for all aspects of the OSCAR software including database operations and implementation. This will require use of either the RUP or another mutually agreed upon (with the IPL) standard/method of software development. The IP will be responsible in general, in conjunction with the other two IPs (Nepal and Samoa) for the design, implementation, testing, debugging and documentation of all user interface and parcel geometry code, functional and stress testing of the database functions, responsiveness testing, debugging, and documentation of all database code written within the project.

It is expected that the IP will use the open source trac software project (http://www.trac.edgewall.org), which provides an excellent documentation system, for code revisions with an interface to the open source subversion revision control software (http://www.subversion.tigris.org). With these tools all changes to and developments with the code base can be easily tracked and added to the OSCAR code base. The code developed will be regarded as the trunk repository for in-country developers to work from as they customize specific instances of OSCARS's core functions during years two and three of the project.

9.1.2 Primary Tasks

The responsibilities for the IP are as follows:

- to write functions to manage input of parcel coordinates from land surveyors and to build parcel geometry;
- to write data entry forms for coordinate input and functions for download/import of files from GPS/Total Station data loggers;
- to write code to manage all workflow processes for parcel-based geometric operations including but not limited to coordinate adjustment and edgematching, parcel sub-division and dataset update, parcel amalgamation (polygon merge), and coordinate and datum transformations for internationally relevant datums and projections using appropriate open source tools;
- to write code to check the parcel fabric for slivers (overlaps and holes) and adjust all errors accordingly;
- to write code to access the OSCAR database and to assign, verify and retrieve (when and where relevant) unique parcel identifiers;
- to write functions for highly customizable map output (map content, page size orientation etc);
- to design and develop a friendly generic graphical user interface (GUI) for end users to access all cadastral-related functions and access to database calls (but not to write the database GUI components). The GUI should include the use of highly functional wizards to assist users with more complex tasks;
- to generate accessible and detailed help files including the use of tutorials for all cadastral functions;
- to generate full code documentation including naming of all procedures, functions and calls, extension points, application programming interface (API), and software development kit (SDK);
- to develop and implement a flexible spatio-temporal, event-driven data model and database schema in PostgreSQL;
- to integrate this schema into spatial operations programmed by the IP and LP using the PostGIS extension to PostgreSQL;
- to integrate into the generic database schema replication of all relevant business processes/workflows for cadastral and land registry records management;
- to program using Java code, in conjunction with the IP, generic forms for database entry of and access to land title registrations and all associated land processing needs;
- to develop powerful spatial, temporal and general attribute query tools to extract parcel information, including history, on parcel boundaries and titles;
- to write customizable database reporting functions to summarize transactions for user defined points in time (start and end). Transactions reports should be further customizable by fields and criteria;
- to create appropriate levels of database security according to the sensitivity of information;
- to develop efficient indexing of database documents to optimize query and retrieval;
- to develop database mainteance tools including backup and disaster recovery and integrity checking at the record level (on entry), on build, and on operation;
- to ensure through progressive input from end users that all forms in the GUI are user friendly and acceptable for operational use;

- to generate accessible and detailed help files including the use of tutorials for all database functions;
- to generate full documentation of the database code including naming of all procedures, functions and calls;
- to document all code changes in the trac open source code tracking software as well as version control in subversion in the OSCAR Web-based wiki; and
- to manage quality control and assurance, and adherence to international standards at all stages of land registration, mapping and database programming at all stages.

9.1.3 Responsibilities and Outcomes

In addition to the above tasks it is expected that the IP will work in close co-operation and in a mentorship role with the LP and LDBD and as well as with local representatives of the GoG including the MLNR, LAP, LCS (especially the SMD and LRD) to ensure that all local needs are incorporated into the final product. In his/her mentorship role it is expected that the IP will transfer knowledge and programming skills to the LP and LDBD through on the job training. It must be guaranteed that by the end of the mid-point in year two that the LP and LDBD are sufficiently knowledgeable in the languages used in OSCAR, the architecture and implementation of the tool, and to be able to customize the application professionally and independently for use in Ghana.

The IP shall organize in conjunction with the LP and LDBD regular end user training sessions (at monthly intervals in the first half of year two) for local IT support staff within the MLNR (LAP, SMD and LRD), including the LIU if formed, as well as for front line OSCAR users. The IP must, in conjunction with the IDBD, LP and LDBP, develop by the end of the third quarter of year two, a draft plan for maintenance and support of the software with all relevant units and have this plan submitted and formally accepted by the IPL and counterpart senior officials in the MLNR and the LAP.

Finally, the IP may, depending upon the successful candidate, be called upon to serve, in addition to the above tasks, responsibilities and outcomes, as the local project leader in Ghana. The role of project leader will assume responsibility for providing direct management and assurance of timely completion of all project work in-country including that of the LP and LDBD. The local project leader will be responsible for submitting quarterly progress reports to the IPL and to local counterpart officials in the GoG. The local project leader will establish and maintain in conjunction with other IPs, the LP and LDBD develop a Web site and wiki for OSCAR Ghana to which general project information (objectives, participants etc) and code updates and revisions can be posted. This wiki should also contain a secure, password protected forum for user and developer discussion, and act as a general repository that can be linked to an overall project presence registered on sourceforge.net. In addition, the local project leader will formally review at six monthly intervals the performance of all OSCAR/Ghana staff, identifying areas where improvements are required in on the job performance.

9.1.4 Reporting

The IP will report directly to the IPL and indirectly to the Director of the LAP in Ghana. Regular meetings must be scheduled within Ghana where quarterly progress reports will be tabled and

discussed. All reports will be circulated by the IPL to OSCAR project staff in Nepal and Samoa as well as to the collaborating academic institution.

9.1.5 Skills

The IP must have an advanced degree in computer science or geomatics engineering , preferably with associated knowledge of spatial data progressing, geographic information systems (GIS) and database development. The successful candidate should have a minimum of two years practical workplace programming and database experience in Java language (and especially the Eclipse RCP), practical experience of the PostgreSQL object relational database system, and the ability to learn quickly interacting with the PostGIS spatial data extension. Management and knowledge of database versioning and record-level locking for editing is required, as is the ability to link tables distributed between Divisions across a local area network. In addition the IP should have demonstrable experience of implementing client-server software and deployment of software on the Internet. Knowledge of cadastral land administration systems is an asset, as is knowledge of C# language and Microsoft. NET.

The successful candidate must have leadership skills and be able to communicate effectively by spoken word and in writing in English.

9.1.6 Duty Station and Length of Contract

The IP will be retained for a period of twenty four months FTE. Six months of this contract will be spent in Rome working at FAO Headquarters (likely during quarters two and three in year one of the OSCAR project), and the remaining eighteen months will be spent working with other members of the OSCAR team at MLNR headquarters in Accra. The IP will attend one senior developer meeting in Rome shortly after the project's commencement. Beyond this and the six month period of joint application development (JAD) programming design in Rome, all work will be undertaken in-country.

9.2 Local Programmer

9.2.1 Introduction and Scope of Work

The LP will be responsible for implementing components of the core/common code base developed by the IP, customized to meet the specific needs of cadastral parcel management in Ghana. In particular, the LP will generate a customized GUI front end by modifying elements of the generic OSCAR GUI and implementing generic and customized parcel management functions honed to Ghanaian conditions and requirements. This customization will carry with it the responsibility for design, implementation, testing, debugging and documentation of all code written by the IP. Similarly to the work of the IP, the LP will not develop beyond function calls will not develop beyond function calls to and from the OSCAR database. The LP will also adhere to the use of the RUP or the software development model determined by the international developers during their initial project meeting at the FAO in Rome.

It is expected that the LP will also use the open source trac software project (http://www.trac.edgewall.org), which provides an excellent documentation system, for code

revisions with an interface to the open source subversion revision control software (http://www.subversion.tigris.org). However, the contributions to this environment will be restricted to the Ghana branch code from the OSCAR core trunk. With these tools all changes to and developments with the code base for Ghana can be easily managed.

The LP will be the primary point of contact, in conjunction with the LDBD, for arranging procurement and installation, in conjunction with computing support staff from the GoG MLNR (and the LIU assuming it is formed) of all computing hardware and peripherals used for implementing the OSCAR application in Ghana. This will also include developing a support and maintenance plan for all hardware and peripheral devices, and all software tools.

9.2.2 Primary tasks

The responsibilities for the LP are as follows:

- to utilize OSCAR generic functions to manage input of parcel coordinates from Ghanaian land surveyors and to build parcel geometry for Ghanaian cadastral parcels;
- to customize generic data entry forms for Ghanaian coordinate input and functions for download/import of files from GPS/Total Station data loggers;
- to adapt generic OSCAR code to manage all workflow processes for parcel-based geometric operations in Ghana including but not limited to coordinate adjustment and edgematching, parcel sub-division and dataset update, parcel amalgamation (polygon merge), coordinate and datum transformation to WGS1984 from the Ghanaian War Office projection and datum);
- to utilize generic OSCAR code to check the parcel fabric for slivers (overlaps and holes) and adjust all errors accordingly;
- to utilize generic code to access the Ghanaian OSCAR database and to assign, verify and retrieve (when and where relevant) standardized unique parcel identifiers;
- to write functions for highly customizable map output (map content, page size orientation etc) according to needs for output specified by the SMD;
- to customize from the generic OSCAR graphical user interface (GUI) a Ghanaian inteface for end users to access all cadastral-related functions and access to database calls (but not to write the database GUI components). The Ghanaian GUI should include the use of highly functional wizards to assist users with more complex tasks;
- to generate accessible and detailed help files for OSCAR Ghana including the use of tutorials for all cadastral functions;
- to generate full code documentation including naming of all procedures, functions and calls, and extension points;
- to assist the IP in documenting all Ghanaian code changes in the Ghana branch of the trac open source code tracking software as well as version control in subversion in the Ghanaian OSCAR Web-based wiki;
- to assist the IP in ensuring the use of quality control and assurance, and adherence to international programming standards at all stages of land registration and mapping;
- to procure and install, inconjunction with the LDBD, all computer hardware and peripheral devices to be utilized in the OSCAR project in Ghana;

- to develop a support and maintenance plan for computer hardware procured and software developed through the OSCAR Ghana project.

9.2.3 Responsibilities and Outcomes

In addition to the above tasks it is expected that the LP will work, under the direction of the IP (and the local project leader), in close co-operation with the LDBD as well as with local representatives of the GoG including the MLNR, LAP, LCS (especially the SMD and LRD) to ensure that all local needs are incorporated into the final product. The LP is responsible in conjunction with the IP for adapting the architecture and implementation of the generic OSCAR software for use in Ghana.

The LP shall assist in conjunction with the IP and LDBD regular end user training sessions (at monthly intervals in the first half of year two) for local IT support staff within the MLNR (LAP, SMD and LRD), including the LIU if formed, as well as for front line OSCAR users. The LP must assist in conjunction with the IP and IDBD in the development by the end of the third quarter of year two, a draft plan for maintenance and support of the software with all relevant units and have this plan formally accepted by the IPL and counterpart senior officials in the MLNR and the LAP.

Finally, the LP may, upon conclusion of the IP's contract, be prepared to assume the role of local project leader for the balance of the OSCAR project in Ghana. Under these circumstances, the LP will also assume responsibility for providing direct management and assurance of timely completion of his/her work and that of the LDBD in-country.

9.2.4 Reporting

The LP will report directly to the IP. Regular meetings must be scheduled with the IP to assign and review progress in meeting the above work tasks. In addition, reports generated from regular progress points will be circulated by the IP to other project staff in Ghana, to the IPL and to OSCAR project staff in Nepal and Samoa as well as to the collaborating academic institution.

9.2.5 Skills

The LP must have an undergraduate degree in computer science. Knowledge of spatial data progressing and geographic information systems (GIS) is an advantage but not essential. The successful candidate should have a minimum of two years practical workplace programming experience in Java language (and especially the Eclipse RCP), knowledge of object relational database systems, and the ability to learn quickly interactions of software environments with spatial data. In addition the LP should have knowledge of and preferably experience with implementing client-server software and deployment of software on the Internet. Knowledge of C# language and Microsoft. NET is also an advantage.

The successful candidate must have leadership skills and be able to communicate effectively by spoken word and in writing in English.

9.2.6 Duty Station and Length of Contract

The LP will be retained for a period of twenty four months FTE working in country with other members of the Ghanaian OSCAR team at MLNR headquarters in Accra.

9.3 Local Database Developer

9.3.1 Introduction and Scope of Work

The LDBD will take responsibility, under the mentorship and in collaboration with the IP, the implementation through coding and the load of all relevant Ghanaian land information into the OSCAR database. In this context, the work of the LDBD will interface closely with the LP at the point of database calls to and from the OSCAR core functions when executing queries, adding data, removing data, editing/modifying land data from Ghana. The LDBD will work closely in the first instance with the IP to utilize the RUP or another mutually agreed upon software engineering model for the customizing and developing the OSCAR database in Ghana. In conjunction with the IP, the LDBD will be responsible also for the functional and stress testing of the database functions, responsiveness testing, debugging, and documentation of all database code written within the Ghanaian project. It is expected that the LDBD will use the open source trac tool for documenting Ghanaian code changes and the open source subversion revision control software to facilitate easy maintenance of OSCAR's Ghanaian code base for other developers to access and use. The trac application will reside on an OSCAR Ghana wiki Web site which the LDBD will also help to maintain. This code will be regarded as a branch for the Ghanaian implementation of OSCARS's functions to be developed and implemented during years two and three of the project.

9.3.2 Primary tasks

The responsibilities for the LDBD are as follows:

- to develop and implement a flexible spatio-temporal, event-driven data model and database schema in PostgreSQL for the specific case of Ghana;
- to integrate the Ghanaian schema into the generic spatial operations programmed by the IP and applied to Ghanaian needs by the LP using the PostGIS extension to PostgreSQL;
- to integrate into the Ghanaian database schema replication of all relevant business processes/workflows within the Ghanaian LSAs;
- to customize generic Java code, in conjunction with the IP, forms for database entry of and access to land title registrations and all associated Ghanaian land processing needs in the SMD and LRD;
- to utilize and customize generic spatial, temporal and general attribute query tools to extract Ghanaian parcel information, including history, on parcel boundaries and titles;
- to utilize genereic database reporting functions to customize transactions for user defined points in time (start and end) in Ghana. Transactions reports should be further customizable by fields and criteria defined by Divisional staff and by senior officers within the Ghanaian LAP and relevant LSAs;

- to create appropriate levels of database security according to the sensitivity of information as defined by the GoG;
- to apply generic database indexing of documents to optimize query and retrieval;
- to customize generic database mainteance tools including backup and disaster recovery and integrity checking at the record level (on entry), on build, and on operation;
- to ensure through progressive input from end users in Ghana that all forms in the GUI are user friendly and acceptable for operational use within the SMD and LRD;
- to generate accessible and detailed help files for database operations of OSCAR Ghana including the use of tutorials;
- to generate full documentation of the Ghanaian database code including naming of all procedures, functions and calls;
- to document all Ghanaian code changes as a branch of the generic trunk code in the trac open source code tracking software as well as version control in subversion in the OSCAR Web-based wiki;
- to assist the IP in ensuring the use of quality control and assurance, and adherence to international database programming standards at all stages;
- to procure and install, inconjunction with the LP, all computer hardware and peripheral devices to be utilized in the OSCAR project in Ghana;
- to develop a support and maintenance plan for computer hardware procured and software developed through the OSCAR Ghana project.

9.3.3 Responsibilities and outcomes

In addition to the above tasks it is expected that the LDBD will work in close co-operation with LP as well as with local representatives of the GoG from the MLNR, LAP, LCS (and especially the SMD and LRD) to ensure that all local database processing needs are incorporated into the final product.

The LDBD shall organize in conjunction with the IP and the LP regular end user training sessions (at monthly intervals in the first half of year two) for local IT support staff within the MLNR (LAP, SMD and LRD), including the LIU if formed, as well as for front line OSCAR users. The LDBD must, in conjunction with the IP and LP develop by the end of the third quarter of year two, a draft plan for maintenance and support of the software with all relevant units and have this plan submitted and formally accepted by the IPL and counterpart senior officials in the MLNR and the LAP in Ghana.

Finally, the LDBD may, upon conclusion of the IP's contract, be prepared to assume the role of local project leader for the balance of the OSCAR project in Ghana. Under these circumstances, the LDBD will also assume responsibility for providing direct management and assurance of timely completion of his/her work and that of the LP in-country.

9.3.4 Reporting

The LDBD will report directly to the IP and indirectly to the Director of the LAP in Ghana. Regular meetings must be scheduled where quarterly progress reports will be tabled and

discussed. All reports will be circulated by the IPL to project staff in Nepal and Samoa as well as to the collaborating academic institution.

9.3.5 Skills

The LDBD must have a degree in computer science, with a focus on database development and preferably with some knowledge of spatial data processing. The successful candidate should have a minimum of two years workplace database programming experience and have experience at building multi-user and networked database applications in a client-server environment. Excellent database management skills including structured query language (SQL) and stored procedures are required. Management and knowledge of database versioning and record-level locking for editing is required, as is the ability to link tables distributed between Divisions across a local area network. Practical experience with the PostgreSQL object-relational database is an asset as is experience with the Java programming language.

The successful candidate must have demonstrable leadership skills and be able to communicate effectively by spoken work and in writing in English.

9.3.6 Duty station and length of contract

The LDBD will be retained for a period of twenty four months FTE working in country with other members of the Ghanaian OSCAR team at MLNR headquarters in Accra.

9.4 Local IT Training Expert

9.4.1 Introduction and Scope of Work

In order to ensure that the software developed locally in Ghana for management and processing of cadastral and land registry records is used to the maximum extent, it is essential to provide effective training in all aspects of use of the software for local employees within the MLNR, and especially for staff working within the SMD, the LRD and the LAP. This training will provide a sound platform for knowledge building in software use and will propagate knowledge of the OSCAR software tools throughout all relevant branches of the GoG. Hence, it is important to employ an individual in this capacity not only with a solid grounding in the technologies used, but also with excellent communications skills both in written and oral presentation of concepts and procedures in software use. It is also advantageous but not essential if the LITT has some pre-existing knowledge of the substantive domain that OSCAR addresses.

In terms of scope, the LITT will be responsible for interacting with the IPL, the LP and LDBD to generate the materials required for creating the required training materials and delivering this training in focused and hands on small group training seminars for GoG staff. Under the current implementation plan in the project proposal it will not be possible for this individual to interact with the IP as he /she will have finished his / her contract before the LITT commences his/her duties. This perhaps is an area of the proposal that needs further consideration. It is expected that the LITT will assist the LP and the LDBD in generating online help and tutorials which will be used as a supplement to the end user training.

9.4.2 Primary Tasks

The responsibilities for the LITT are as follows:

- to develop a training plan, to be approved by the IPL, the Director of the LAP and a appointed representative from the MLNR of the GoG, at the commencement of duties and to build this into the programming workplan so that functions can be built into training as they are completed;
- to develop in conjunction with the LP and LDBD training materials including workbooks, exercises, and Microsoft PowerPoint presentations for use in small group, focused and hands-on use of the OSCAR software as it is developed in Ghana;
- to assist the LP and the LDBD in developing and extending online help within the OSCAR software. This help should be context sensitive within the software and provide clear examples of the use of functions in the software as well as tutorials or 'how tos';
- to organize training venues and access to computers for all trainees and to schedule training within the time frames identified in Section 6 (Implementation Plan) and below in Section 9.5.3, subject to the availability of staff (note that under no circumstances can any training be cancelled or postponed due);
- be responsible for delivering all training with the assistance of the LP and the LDBD to relevant staff within the GoG;
- to post all training materials to the Ghana OSCAR wiki web site for download by staff of the GoG;
- to report to the IPL following the conclusion of each scheduled training session identifying tools learned and providing clear trainee feedback generated from all trainees;
- if time permits between training and the preparation of training materials to assist the LP and the LDBD with testing of system functions as they are developed and deployed.

9.4.3 Responsibilities and Outcomes

In executing the above tasks it is expected that the LITT will work in close co-operation with the LP and LDBD as well as with local representatives of the GoG from the MLNR, LAP, LCS (and especially the SMD and LRD) to ensure that training expectations and needs are met to the mutual satisfaction of all.

The LITT shall organize in conjunction with the LP and LDBD regular end user training sessions (at two monthly intervals commencing at the end of year two of the project and running every two months through to the start of the last quarter of year three) for front line OSCAR users within the Divisions of the MLNR as well as local IT support staff within the MLNR (LAP, SMD and LRD), including the LIU if formed. The LITT must, by the end of his/her contract in year three, have developed sufficient materials and reached a level of training in the use of OSCAR with trainees that lead users can be identified as future trainers in the use of the system. All training materials developed during the twelve month contract by the LITT can be reused for these purposes.

The essential outcome of the work functions of the LITT are that a cadre of well trained users of the OSCAR software is created within the ranks of the staff of the MLNR in Ghana. For the

overall project to succeed a great deal hinges on the success of this training, hence it must be professional, timely and very well executed. Moreover, it must be well received by the trainees as if new software is not introduced properly and fully to staff it is unlikely that it will be used and they will revert to previous modes of operating. Hence, the outcome of the work of this individual will, to a large extent, be a yardstick of the outcome of the overall project in Ghana.

9.4.4 Reporting

The LITT will work in conjunction with the LP and the LDBD and report directly to the IPL and indirectly to the Director of the LAP and an appointed representative of the MLNR of the GoG. Regular meetings must be scheduled within Ghana where progress reports submitted after each training session will be tabled and discussed. These reports will be provide information in numbers included in training, topics trained in, and provide the results from training assessments provided by trainees at the end of each training session. Comments from these assessments must be incorporated in subsequent training sessions. All training reports and assessments will be summarized and circulated by the IPL to project staff in Nepal and Samoa as well as to the collaborating academic institution.

9.4.5 Skills

The LITT must have a degree or advanced diploma in a field of information technology that includes hands-on experience in the use of multi-user and client-server relational databases. In addition it is required that the LITT have knowledge of GIS and experience in training non-expert end users in their day to day use. This must include evidence of preparation of professional quality instructional materials including class notes, tutorials, exercises for trainees to complete, and Microsoft PowerPoint slides that provide clear step through presentations of operations of the OSCAR Ghana application. The LITT must be a fast learner, able to assimilate new concepts and new software environments quickly and become proficient in their use.

The successful candidate must have excellent communication skills in written English and in small group and highly focused presentations in English.

9.4.6 Duty Station and Length of Contract

The LITT will be retained for a period of twelve months FTE starting in the first quarter of year three and terminating at the end of the project (4th quarter of year 3). The LITT will work exclusively in country with other members of the Ghanaian OSCAR team at MLNR headquarters in Accra.

9.5 International Project Leader

9.5.1 Introduction and Scope of Work

The international project leader (IPL) will develop a detailed indicative project implementation plan for each OSCAR pilot country. This plan will contain work tasks, milestones and deliverable work products. He/she will also take full responsibility during Q1 and Q2 of Y1 for overseeing the initial development of the core or common system code for all aspects of the OSCAR software including database operations and implementation. The IPL will also be responsible for

ensuring that all project activities in the three pilot countries stay on schedule and meet all milestones and deliverables outlined in the timeline of each indicative project plan. In addition the IPL will be responsible for obtaining and reviewing scheduled reports from the all project staff in each of the three pilot countries and compiling these reports into quarterly reports and an annual report for each of the three years to the Head of the NLRA of the FAO in Rome.

9.5.2 Primary Tasks

The responsibilities for the IPL are as follows:

- to manage all project activities in each of the three OSCAR pilot countries;
- to facilitate the recruitment, interview and hiring of the three IPs and in conjunction with the IPs to recruit, interview and hire the two LPs in each country;
- in conjunction with the local staff, to recruit, interview and hire the LITT in each country;
- to ensure that collegial and productive working relationships are maintained in each of the 3 pilot countries;
- to ensure that all work produced is in accordance with best practice and, where relevant, international standards cadastral surveying, land registry practice, software development, and end user training;
- to ensure that local needs are met by the development of the local customization of the OSCAR core software;
- to receive, assemble and compile into a consistent format all reports from project field staff and to provide these reports as well as his/her own regularly scheduled reports (at the end of each quarter) to the Head of the NLRA in Rome;
- to monitor the risk mitigation strategies in each of the three pilot countries and to ensure that latent risks are accounted for and overcome to the maximum extent possible;
- to work in conjunction with the IP in country, the LITT and the two LPs to develop and ensure that the training and knowledge transfer aspects of the project are running smoothly and to monitor the production of all training materials in each country as well as participant feedback on training implementation;
- to take primary responsibility for ensuring that all project documentation production is current and that it maintains high standards. This will include code repositories; Web sites (including the FAO knowledge network website); end user documentation including training materials; and software maintenance and management manuals;
- to establish outreach to the OSGeospatial community and to help shepherd the OSCAR core code and significant aspects of its customization (via additional plug ins) into this arena by encouraging the participation and uptake of the OSCAR project by other software developers internationally;
- to ensure that the project budget is not exceeded in any instance in any of the three countries and that all expenditures are receipted where relevant, all hardware and other materials procurement are handled using standard FAO practice; and that all financial reporting and transactions are completely transparent and are maintained using FAO accounting standards; and

- to maintain close contact with the Chair of management committees (i.e. non-project staff) in each of the three pilot countries to ensure that counterparts are not experiencing problems, and in the event that they are to intervene in order to problem solve quickly and efficiently.

9.5.3 Responsibilities and Outcomes

In addition to the above tasks it is expected that the IPL will serve to promote the project within the international community through regular conference presentations that alternate between technical aspects of developments in general or in specific countries and procedural in terms of meeting the goals of greater efficiency and transparency in land records management. In addition it is expected that the IPL will be able to liaise with counterparts from other projects and other international multi-lateral projects funded by but not limited to the World Bank, national aid agencies and other branches of the United Nations.

The IPL is expected to serve both as a mentor to the three IPs as required and as a bridge between in-country staff, their work and local beneficiary coordinators within the government of each country, and the sponsoring agency in Rome. This function will require the IPL to be an outstanding communicator on many levels (international, national and local), across many domains of project work (technical, staffing, managerial, financial etc), and across very diverse cultural environments.

The IPL is expected to maintain and manage a project that stays on track, produces scheduled work products on time, that are of high quality and that are well received by the beneficiary governments. It is also essential that all activities remain at or within budget for the duration of the project. The final products should be three customized, functional and well documented installations of OSCAR core software that are being routinely used through a process of institutionalization in the beneficiary countries and that meet the needs of the land sector agencies.

9.5.4 Reporting

The IPL will report directly to the Head of the NLRA in Rome and will liaise with the Technical Officer and with the local project leaders and management committee chairs in each country. In addition the IPL must maintain good collaboration with the Chair of the project committee in each of the beneficiary countries. All reports shall be submitted to the IPL who will review them and request modifications where necessary before compiling them and adding his/her own reports for submission the Head of the NLRA and eventual circulation to all beneficiary countries.

9.5.5 Skills

The IPL must have extensive knowledge of cadastral and land tenure systems, both in terms of their technical implementation through software and their management functions. He should alo have demonstrable person management skills, especially in the context of project management. He/she should have an advanced degree, preferably a Doctorate, specializing in one of more of the following fields: geomatics engineering, spatial data progressing, land tenure and land records management, international development. The successful candidate should have a minimum of ten

years demonstrated experience in managing large multi-lateral country projects and of living and working in diverse cultural backgrounds including Africa and Asia.

The successful candidate must have clear leadership skills, command the respect of others, and be able to communicate effectively by spoken and written word in English.

9.5.6 Duty Station and Length of Contract

The IPL will be retained for a period of thirty eight months FTE. The duty station will be Rome, however it is expected that the IPL will make regularly scheduled work visits to the three recipient countries for lengthy periods of time and that of the 38 month contract up to 24 months will be spent working with international and local project staff in the field (8 months per year).

9.6 International Quality Assurance/Quality Control Expert

9.6.1 Introduction and Scope of Work

The international quality assurance/quality control expert (IQAQCE) will review the output of the OSCAR core software development work of the three IPs and the IPL during Q2 and Q3, Y1 in Rome. This review must use a documented and international standard software quality assurance plan (SQAP) such as IEEE STD 730-2002 or ISO/IEC-9126, that will contain a software design report and a software implementation report. These reports will include but not be limited to a thorough analysis of the following quality characteristics of the developed code:

- Functionality: whether the software performs the required functions.
- Reliability: maturity, fault tolerance and recoverability.
- Usability: effort required to understand, learn, and operate the software system.
- Efficiency: performance and resource use behaviour.
- Maintainability: effort required to modify the software.
- Portability: effort required to transfer the software to another environment.

The IQAQCE will be provided at the start of the contract with a CD containing all uncompiled application code and either instructions for installation or a CD containing an installation package which will contain OSCAR core code and all dependencies for automated installation on a host computer.

9.6.2 Primary Tasks

The responsibilities for the IQAQCE are as follows:

- to review the developed core or common code for OSCAR;
- to use the above noted standards and incorporate these into a software design and a software implementation report incorporating standard software quality characteristics;
- the IQAQCE will also assess the quality documentation within and external to (in support of) the code;

- any and all instances of substandard coding will be returned to the IPs and IPL for adjustments as prescribed in the report of the IQAQCE;
- the IQAQCE shall also review the code relative to the user and systemic needs identified in the individual country assessment documents; and
- these assessments will be presented to the IPL for action.

9.6.3 Responsibilities and Outcomes

The IQAQCE is charged with ensuring that the core code developed for the OSCAR project is consistent with international standards in software coding quality. His/her task is to review all code and extract from the code base relevant metrics and characteristics of assessment and to incorporate these in a report for action to the IPL. This report, which should be provided in electronic *(using a standard word processor such as MS Word) and in hard copy format, should not only contain instances of substandard coding but also a remediation strategy that will allow the deficiencies to be corrected rapidly. The report will serve not only as a remediation document for the core code, but also as a benchmark for implementation in the extensions to OSCAR developed in each of the beneficiary countries. The reports should be submitted to the IPL no later than the end of the Q4 of Y1.

9.6.4 Reporting

The IQAQCE will report to the IPL.

9.6.5 Skills

The IQAQCE must have a graduate degree in Computer Science, preferably with knowledge of cadastral and land records database management systems. In addition the IQAQCE must have 5 – 10 years experience in software quality assessment and operational knowledge of current international standards in software QA/QC. He/she should have good writing skills in English, with the ability to communicate technical requirements in straightforward language.

9.6.6 Duty Station and Length of Contract

The IQAQCE will be retained for 30 (or 60) working days FTE. Duty station is not relevant as the code review can take place anywhere, hence presence in Rome is not required for this person.

10. Hardware and Equipment Specifications and Cost Estimates

Recommendations for hardware and related equipment to support the OSCAR project depend on the architecture that is deemed most suitable for Ghana. In this context, it is possible to have two main configurations, one of which can be developed from the other without necessarily having to purchase new hardware

In the first configuration different components of the OSCAR software would be installed on a server in each of the SMD and LRD with networked workstations running across a LAN in the SMD and another LAN in the LRD. Each LAN would process information specific to each of the two Divisions as it moves through the workflows that define their business functions. In the

SMD this would primarily involve use of the uDig and PostGIS spatial data management components of OSCAR (create a new parcel, modify / adjust an existing parcel, retire a parcel, print a parcel, annotate a parcel etc). In the LRD it would involve the land title functions of OSCAR primarily involving PostgreSQL functions (query a title and / or a parcel, create a new title, transfer an existing title, retire a title, etc). As explained in Sections 3 and 5 of this report, in essence this information captures the basic cadastral and land title workflows (from lodgment of an application for survey of a new parcel and approval of title; resurvey of an existing parcel and confirmation of title; or change of title on an existing an unchanged parcel) through to receipt of a new title or reconfirmation and reissue of an existing title, etc.

With this architecture data are created, queried, extracted and output on the workstations and updated only on the server at each of the respective Divisions. There is no *direct* transmission of data between either of the two installations. Hard copy documents would be generated (printed) upon the completion of relevant tasks within each Division's tasks and these can be conveyed by the land title applicant to the other Divisional office. It is possible with this architecture that information could be exchanged across a WAN /Internet link between Divisional offices notifying the other office of the completion of requirements within a given Division and synchronizing and updating the complement database in real time. However, there would be no central and common database. The databases in each Division could be backed up nightly to a large capacity external drive available at each location. In addition, universal power supply units would be required to provide continuity of service in the event of power failure.

The hardware requirements under this scenario would include two servers and as many workstations as required in each Division (in this case the workstations would not require significant local processing power as most of the processing work would be done on the servers in each Division). In support of the move to a FLOSS environment the servers and workstations would be configured to run a standardized version of the Linux operating system (e.g. Kubuntu with the KTE desktop) and all software would be a FLOSS product (i.e. no proprietary software at all unless it can run under Linux).

Under the second scenario, it would be possible to migrate from this configuration to full and centralized client-server mode once staff in the SMD and LRD have become sufficiently familiar with the functions and use of OSCAR software in their own Division. However, in general the feasibility of the second scenario depends on when the LIU (or an equivalent unit) is created and IT staff are able to host an integrated OSCAR database and a centralized application server (and possibly also a file server) for access by client workstations available in the SMD and LRD (and potentially as well as all other relevant LSAs).

In centralized client-server mode, OSCAR would run from a main server to workstations in each of the front line LSAs (SMD and LRD in the first instance, others later). There could be as many workstations linked either through a secure WAN across the Internet for Web-based processing as well as electronic application lodgments and browsing of information by land conveyancers, lawyers and others who pay to have secure access to the land records database. In addition, it is possible to establish public kiosks within the LCS and other GoG offices to automate aspects of the business processes outlined in Section 3.1. In all cases the client computers in the SMD and LRD would access the same OSCAR server and file system located in and managed by the LIU.

Under scenarios one and two, typical hardware configurations for the server and client workstations are shown in Table 14 and 15. Purchase of any similarly configured hardware for the OSCAR project should be tendered through the release of a specific request for quotations and responses evaluated as to their reputation for reliability and importantly for their local support reputation as well as price competitiveness. Indicative estimated pricing is provided in United States dollars.

Under scenario one it would be expected to purchase two quad core workstation/servers, each with dual 24 inch flat screen monitors, high speed on-board memory and large volume hard disk space, as well as access to two large volume external drives, to be attached to each of the machines for nightly backup purposes. It should be noted that the configuration listed below is a 'high-end' configuration. It is probable that the machines could be reduced to dual core rather than quad core with less ram per core (if quad 8 mb per core, if dual 16 mb per core) and 20 inch rather than 24 inch monitors. The disk volumes should remain the same. This would reduce the overall cost by approximately $1000.00 US.

Option 1 Workstation / Server Configuration
Operating System
Kubuntu for the KTE desktop; Apache Web Server
Processors
Intel® Core™ 2 Quad Processor Q9650 (3.0GHz, 12M, 1333MHz FSB)
Security Hardware
Chassis Intrusion Switch
Memory
16GB DDR2 Non-ECC SDRAM, 800MHz, (4 DIMM)
Video Card
256MB ATI RADEON HD 3470 (Dual DP), or equivalent
Monitor (main)
24 inch Widescreen Flat Panel, Green Efficient
Monitor (secondary)
24 inch Widescreen, height adjustable stand
Keyboard, mouse
Hard Drive (boot)
250GB 2.5, SATA 3.0Gb/s, 8MB DataBurst Cache™
Hard Drive (secondary)
250GB 2.5, SATA 3.0Gb/s, 8MB DataBurst Cache™
Hard Drive Module
Raid 1
CD/DVD Drive, Wireless OptiPlex, 1 Gbit Net Card

Table 13: Workstation / Server Configuration Price: $4327.00US*2

In addition to these workstations, which would initially act as servers, up to 4 lower end workstations would be purchased for each Division. The configuration and approximate pricing for the workstations are listed in Table 14.

Option 1 Workstation Configuration
Operating System
Kubuntu for the KTE desktop or Debian Linux; Apache Web Server
Processors
Intel® Core™ 2 Duo Processor E7500 (2.93 GHz, 3M, 1066MHz, FSB)
Security Hardware
Chassis Intrusion Switch
Memory
2.0GB DDR2 Non-ECC SDRAM, 800MHz, (2DIMM)
Video Card
Integrated Video, Intel® GMA3100
Monitor (main)
22 inch Widescreen Flat Panel, Green Efficient
Monitor (secondary)
22 inch Widescreen, height adjustable stand
Keyboard, mouse
Hard Drive (boot)
250GB 2.5, SATA 3.0Gb/s, 8MB DataBurst Cache™
CD/DVD Drive, Wireless OptiPlex, 1 Gbit Net Card

Table 14: Workstation Configuration Price: $1055.00US*8

In scenario two, in addition to the two server/workstations and the 8 workstations noted above, purchase of an enterprise level server is required. In this case a rack mounted quad core server would is recommended with sufficient disk to store a large quantity of scanned documents, not to mention digital orthophotos and other GIS data layers. However, depending on the actual volume of information projected to be maintained on the system it may be prudent to purchase, in addition to the server, a file system capable of storing multiple terabytes. An initial estimate, based on the GoG's objective to scan and store in excess of 2 million pages of scanned land registry documents alone, this would potentially amount to a minimum of 2 terabytes, conservatively, of data. Hard drives are now becoming available in terabyte capacities. Hence a file server (separate machine) with multiple disks running a RAID configuration would provide the necessary hard disk capacity. This, however, would itself need to be backed up somewhere in the event of catastrophic system failure and data loss. Hence, under ideal circumstances, a server *and* a file system for holding the data only would need to be purchased. Clearly, one of the two workstation / servers under Scenario 1 could be used as a file server without modification and the other workstation / server could be deployed in the SMD as a heavy duty spatial data server within that Division (where data processing needs are more specialized).

A typical server configuration could be a Quad Core processor with up to 10 terabytes maximum of internal disk and up to 4 GB Fully Buffered DIMMs (FBD) in matched pairs, running RAID level 6 (up to two disk failure tolerance) and a primary controller and secondary RAID controller. This configuration is almost certainly significantly more than is needed initially for land records management in Ghana and would provide a highly responsive server hardware configuration for up to 4 – 5 years. However, an alternative configuration could be obtained for substantially less (up to half of the price indicated in Table 14), but it would not continue to meet local needs for as long. *It is emphasized that this is not necessarily the hardware configuration that should be purchased, but*

merely the type of configuration that would be required for enterprise level operations involving server-based software applications and database access.

Option 2 Server Configuration
Operating System
Debian Linux
Primary Processor
Quad Core Intel® Xeon® E5405, 2x6MB Cache, 2.0GHz, 1333MHz FSB
Secondary Processor
Quad Core Intel® Xeon® E5405, 2x6MB Cache, 2.0GHz, 1333MHz FSB
Memory
16GB 667MHz (4x4GB), Dual Ranked DIMMs
Chassis
Rack Chassis Orientation, No Rails Included
Monitor (main)
24 inch Widescreen Flat Panel, Green
Power Supply
Redundant Power Supply with Y-Cord
Keyboard, mouse
Hard Drive Configuration
Integrated SAS/SATA RAID 5, PERC 6/i Integrated
Primary Controller
PERC 6/i Integrated Controller Card
Primary Hard Drive
1TB 7.2K RPM Universal SATA 3Gbps 3.5-in HotPlug Hard Drive
7 Additional Similar capacity and configuration drives
2nd Controller and HBAs
PERC6E SAS RAID Controller, 2x4 Connectors, External, PCIe 256MB Cache
Network Adapter
Dual Embedded Broadcom® NetXtreme II 5708 Gigabit Ethernet NIC
Bezel for rack configuration
16X DVD-ROM Drive
Uninterrupted Power Supply
3000VA UPS 120 Volt, Battery Backup & Protection ,2U Rack Mount

Table 15: Server Configuration Price: $11996.00 US

In terms of the server's operating system, Debian Linux has the reputation of being a stable and mature installation for server-based configurations. A more detailed specification would need to be carefully established during the first phase of the project when data processing expectations of the software become clearer. Sufficient backup disk is required as well as universal power supplies for both the server and, if required, a file server system. It might also be necessary to purchase a dedicated network switch for general network traffic management, additional security and information routing purposes, but since the specific details of what might be required at this point in time require further discussion with the GoG (physical location of the system, integration with existing networks, volumes of information to be accessed, processed and routed

between workstations and the server, accessibility etc) are unknown there is little time in providing specific hardware recommendations or price estimates.

In addition to the above hardware, four notebook computers should be purchased in Ghana for use by the local developers (IP, LP and LDBD). The first should be purchase in Y1, the second and third in Y2 and the fourth in Y3 for the LITT. During system development, it is expected that the local software developers will also work with the deployment machines in a sandbox environment. The notebook configurations and approximate price is shown in Table 16.

Additional Hardware	
Developer Notebooks	
Kubuntu with KTE Desktop or Debian Linux; Apache Web Server	
Intel® Core™ 2 Duo P8600 (2.40GHz, 3M L2 Cache, 1067MHZ) Dual Core	
17" UltraSharp WXGA+ (1440x900) LCD Display	
NVIDIA Quadro FX 2700M, 512MB Graphics Card	
2.0GB, DDR3-1066MHz SDRAM, 2 DIMMS	
250GB Hard Drive, 7200RPM	
8X DVD	
Intel® WiFi Link 5300 802.11a/g/n Mini Card	
	$2100.00*4
Printers	
A3 Max Media BW, 50 ppm, 1200 x 1200 Max Resolution, Duplex and Network Ready, Parallel, USB, Ethernet 10Base-T/100Base-TX/1000Base-T Networking.	
	$3000.00*2
A3 Max Media Colour, 50 ppm, 1200 x 1200 Max Resolution, Duplex and Network Ready, Parallel, USB, Ethernet 10Base-T/100Base-TX/1000Base-T Networking.	
	$3750.00

Table 16: Additional Hardware

In addition to the computer specifications noted in Table 16, a high volume and networkable printer in each LSA office should be purchased through project funds as well as a colour network printer for the SMD so they can produce high quality parcel map output for filing and also for acquisition by purchase upon title creation. The printer prices are also shown in Table 16. It is assumed in this section that provisions will be made for office space and office furniture to house the project staff in Accra, including well appointed and properly lit desk space, secure filing drawer / cabinet space, and ergonomic office chairs.

Taking all financial costs into account, the computing hardware budget described above sums to $47,044.00 United States dollars. It should be noted that this can be reduced quite substantially by trimming hardware in certain areas (such as the number of workstations in each Division, or by adoption the central server model from the outset).

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12. Ghana Mission Report

12.1 Objective

The objective of the mission to Ghana was **to perform an initial assessment and prepare a detailed plan for the implementation of the OSCAR framework and FLOSS tools project in Ghana**.

12.2 Scope of Work

From August 4th through to August 18th, the international consultant worked in Accra in collaboration with a local consultant, Mr. Foster Kwame Mensah, retained by the FAO for the purposes of the mission and its deliverables, and Mr. Benjamin Armah Quaye, Head of the Planning Unit of Land Administration Project within the Ministry of Lands and Natural Resources, who was assigned to assist by Dr. Larbi, Head of the Ghanaian Land Administration Project.

Thirteen activities were undertaken under the direction of the international consultant. Specifically, the work during the mission formulated a detailed **baseline review** (Section 2 of this document) of the current state of land records administration, management and operations in Ghana; a **statement of requirements** (Section 3) for the successful implementation of the OSCAR framework and tools in Ghana; a set of **implementation recommendations** for Ghana (Section 4); a set of **general input requirements for the design of the core functions** of the OSCAR framework in Ghana (Section 5); an **implementation plan** for Ghana (Section 6); **a risk analysis** (Section 7) of

the success of the project in Ghana; a **knowledge transfer and training policy and a training requirements definition** for Ghana (Section 8); a set of **TOR for project consultants** to be recruited through the project in Ghana (Section 9); the **technical specifications and approximate costs for hardware and other equipment** required to undertake the project in Ghana (Section 10); this **mission report** (Section 12); and the final **project document** (this document). It was not possible to hold a concluding seminar as senior staff in the MLNR were travelling in other parts of Ghana during the last several days of the mission.

12.3 Observations

I would first like to express my thanks to Dr. Larbi and the colleagues in Ghana for making the visit both enjoyable and productive. Preliminary arrangements made by the LAP were more than satisfactory in terms of workspace, Internet access and local transportation.

Several points can be made regarding the present terrain of land information in Ghana relative to the objective of the mission. There are both positives and negatives to take from these observations. The former auger well for the development and implementation of the OSCAR framework in Ghana. However, the latter raise a number of challenges, none of which are insurmountable providing the correct approach is taken to the project.

After having spent a period of time reviewing local conditions and learning about the nature and state of land records processing in Ghana it is fair to note that there are a number of aspects of the draft FAO project document date May 15th, 2009 that should be reconsidered. This document was prepared in the absence of detailed knowledge of conditions on the ground in any on of the host nations (Ghana, Nepal and Samoa) and while it is generally well constructed, there are some areas that need to be reconsidered.

First, the proposal states under **Section 4.2.1 Component 1: Development of the OSCAR Shell** that a detailed description of (generic) user requirements will be prepared by a small group of experts (assigning a land administration expert and a systems architect are noted in the footnote). This exercise will be conducted in Rome and will be used as the guiding framework for OSCAR developers in each country.

Second, my general observations in Ghana regarding strategy and methodology in the OSCAR project proposal suggest two important considerations. First, *there must be a strong local presence in this project for the Ghanaian counterparts to accept it and for it to succeed*. Second, *the timing for work in Rome on the part of the IPs and the visits by the IPL are complex, and with a high potential for communication lapses in the host countries*. It is important to keep fully engaged with each country otherwise the project will possibly get shelved locally and it will be difficult to recover from this.

Currently, there are a number of projects underway within the lands sector in Ghana. Several of these are being undertaken by external consultants, some are funded through the World Bank and others are funded through national foreign aid agencies. The projects relevant to this report are diverse but converge on evolving standards that the GoG is putting in place for lands management in general and spatial data holdings that relate to land in particular (for example the use of a common and unique universal identifier for all each land parcel). The more significant

projects are mentioned in Section 1 and elsewhere in the report. The most relevant project has been in progress for a year and is now reaching the end of its first stage. From reading the consultant's reports and speaking to the Ghanaian counterparts it is apparent that various aspects of this project have been less than successful. There appears to have been conflict over the tasks called for in the initial terms of reference, relative to the work that the consultants were eventually asked to do and expected to deliver. In fact, in the first draft of the final report (Johnson and Bennekom-Minnema 2009) it is evident that the consultants are unhappy with the extent of project creep (being asked to do things that were not requested in the initial terms of reference). On the other hand, the Ghanaians are unhappy primarily with the fact that the software was developed entirely offshore without any local input, and that the training in use of the system was cursory and short. As a result, not many, if any, of the locals know how to use the software properly. Hence, there is a high likelihood that the system will not achieve its goals.

Where this leaves the OSCAR project in Ghana remains unclear. Overall, it is difficult to reconcile having two tools under active development (not to mention available for actual use) that address essentially the same need, albeit from different underlying database models and implementation approaches. The experience with the COWI project seems to have been a valuable learning experience both for the LAP and the COWI Group. However, my general feeling is that it would be imprudent to abandon what has been achieved (and at not inconsiderable expense) in the way of software with the LIS project and consider starting again. Hence, where OSCAR might fit into the LIS picture needs to be clarified.

In this context, given the relatively limited initial scope of OSCAR (the LIS is intended to deal with multiple aspects of land information management and processing in all Divisions of the LCS), it may be possible to integrate OSCAR's functions and data model into the LIS environment. Both tools share the same underlying FLOSS database software (PostgreSQL), but not the same data model, and both use the same spatial data layer for handling geometries and spatial operations (PostGIS). Hence, in theory it should be possible to draw on data from the LIS/STDM schema and repackage this information in OSCAR. The OSCAR approach would manage cadastral mapping and changes to the parcel fabric as well as the associated land registry records input, processing and outputs. OSCAR's ability for an agent to query historical data (such as an ownership change and the parcel fabric associate with that change) on parcels and to recreate event-based instances of change (both in the fabric and in title) could then be put to good effect.

This, of course, assumes that the historical information required to drill through an events-based database either already exists or is created and can be accessed by the software. Currently, there is relatively little historical data for land records in digital form in Ghana. The idea is for the LAP to commence creating this information *de novo* and to work backwards in time building the available data records and documents. Hence, there may have to be a period in the OSCAR project committed to building new data combined with a strategy for generating historical data from paper records and adding these to the data store. Initially OSCAR will have to be customized to accommodate local data types and documents, and functions for storing and accessing historical records will have to be created. This work will comprise significant overhead beyond taking the proposed tools and further customizing them to work with local information, i.e. it could

potentially be a lot of additional work that is not accounted for in the current OSCAR framework.

In order to design an integration strategy for OSCAR and the LIS software, it is essential to obtain the source code for the latter. The design documents already exist and are thorough. However, not having the code and the actual implemented database to work with would make this strategy somewhat infeasible. *Unless access to these resources can be made available prior to project start it does not seem wise to proceed with the development of OSCAR in Ghana.* Even if these resources are made available, time must be allocated to determine technically how best to integrate the two tools in a totally transparent and efficient manner. Possibly rather than using the current uDig for OSCAR's 'front end', SharpMap's front end and functions can be used and customized to achieve a common and friendly user interface. If this is the case it will be necessary to add C# as a programming language that local developers will need to be trained in (and in fact any OSCAR developer will have to have the ability to program first in C# and then in other languages such as Java). Alternatively, the sharpmap front end can be abandoned in favour of the Java-based uDig software.

The programming and development environment has additional implications for the Internet/Web readiness of the software and also for the modular 'plug in' approach currently used in OSCAR, where new modules can be integrated with the need for relatively little programming overhead. uDig software, which is completely Java-based, can run either in standalone mode or via the Internet as a Web map Service (WMS) without the need for a great deal (or in fact really any) customization. Hence, the OSCAR environment has the distinct advantages of being build largely around a single development language, namely Java, and also being part of an already very large FLOSS community via its plug in approach, utilizing well established FLOSS components that are widely used and well supported. In contrast, SharpMap is reported to have WMS functionality but details of this are unknown, as SharpMap, although open source, runs under the Microsoft .NET environment and this is not familiar a familiar development environment to the developers of OSCAR or the broader world of FLOSS applications (.NET falls under Microsoft's codiplex open source initiative). Moreover, SharpMap basically will likely (although this will have to be determined) require extensions and plug ins also to be developed under the .NET umbrella and this is limiting relative to the many excellent Java-based software plug ins available within the general and geospatial open source communities.

Hence, generally, *the best development path for OSCAR in Ghana is not clear at this stage.* In this report it has been assumed that there has to be some cross-over between the two tools, but exactly what the nature of that cross-over might be cannot be determined at this point in time. Clearly this will require *investigation of the Sharpmap/LIS solution developed by COWI which requires access to the source code and some test data from Ghana to work with.*

Beyond this obstacle several other issues emerged during the mission. The first of these concerns the recruitment of personnel for the project, and how these are dealt with in the project proposal. Under Section 4.2.1 Component 1of the proposal it is stated that a detailed description of (generic) user requirements applicable in any given context will be prepared by a small group of experts. It further suggests that the results of this exercise will be presented in Rome and will be used as the guiding framework for OSCAR developers in each country. However, the formation

and function of this small group of experts, which is likely to be of primary importance for the project, is only considered in passing under 'other experts' and their expected qualifications. This needs to be clarified. It is also suggested in the proposal that TOR for a Land Administration IT expert and a Systems Architect, who will be recruited for the user requirements exercise, are included in Appendix 4 of the proposal. However, I see no further reference to these individuals (e.g. they are not mentioned in Section 4.4 other than under the 180 days of short-term experts, local and international, who will be hired). Moreover, I do not see mention of their jobs in the TOR listed in Appendix 4. In fact, I find Section 4.4 and Appendix 4 to be rather confusing and in need of revision and clarification prior to implementation of the project.

Since currently OSCAR exists only in prototype form and it has not been tested with real data there will have to be some significant development effort invested in the early stages of the project to produce a code package that the international developers and local developers can work with. This does not seem to be taken into account adequately in the budget, but the first year in the workplan is fully immersed in developing the current prototype framework. Hence, there may be good grounds for engaging a University partner for this purpose and increasing this component of the budget.

Overall, it is the view of this initial assessment that OSCAR could be developed for use in Ghana, however the path forward is blurred considerably by the LIS software developed by COWI. This has made the proposed implementation recommendations for OSCAR more complex than would have otherwise been the case. However, an integration path has been taken into account in the recommendations (Section 4 of this report). It was noted earlier in this section, but must be reiterated here that *the feasibility of implementing an integration path can only be determined after the LIS software has been systematically reviewed.* This will require time and careful attention prior to signing any project agreement with the GoG. It is also important to note that *there will have to be substantial assessment (and likely some cleaning) of cadastral parcel and land registry data to determine the amount of work that initial data assembly will require*. These data could perhaps be provided on DVD under an initial non-disclosure/confidentiality agreement, subject to the laws and regulations of the land. This *data assessment should also be undertaken prior to embarking on a multi-year project*, i.e. the data should be assessed thoroughly prior to building the software.

Appendix 1 Key Pieces of Land Legislation in Ghanaian Law

TITLE OF LAW	PURPOSE/SUMMARY OF CONTENT
Administration of Lands Act, 1962 (Act 123)	The Act empowers the Minister of Lands among other things to manage all stool lands in the country. The Act consolidates with amendments the enactments relating to the administration of stool and other lands. Its provisions deal with the administration of stool lands, grants of leases of Kumasi Town Lands, vesting of lands in the President in trust, occupation and use of land for public purposes and collection of revenue from stool land, among others. Section 10 of Act 123 empowers the State to acquire land in the interest of the public in return for the payment of annual rentals.
State Lands Act, 1962 (Act 125)	An Act to provide for the acquisition of land in the national interest and other purposes connected therewith. The Act deals mainly with compulsory acquisition of land and the powers to be exercised by the President (or Head of State) as well as the legal procedures to be followed for the compulsory acquisition of land. It also makes provision for claims to any interest in land so acquired to be submitted to the Minister, who is authorized under the Act to pay compensation in respect of the land having regard to the "market value of the replacement value of the land or the cost of disturbance or any other damage thereby". Upon completion of the procedures for compulsory acquisition, the only right that the previous owner of the land has is to apply for compensation. All applications for compensation are processed by the Land Valuation Board (Now Land Valuation Division of the Lands Commission).
Lands (Statutory Wayleaves) Act, 1963 (Act 186)	An Act to provide for entry on any land for the purpose of the construction, installation and maintenance of works of public utility and for the creation of rights of way and other similar rights in respect of such works and for purposes connected with such matters. The Act empowers the President to make executive instruments declaring any land to be the subject of a statutory wayleave for the purpose of construction, installation and maintenance of public utility works and provides for the payment of compensation to any person adversely affected by such declaration.
Land Registry Act, 1962 (Act 122)	The Act consolidates with amendments the law relating to the registration of instruments affecting land. The Act provides that any instrument other than a will or a judge's certificate shall be of no effect unless registered. The Act also establishes Registry offices to be supervised by a Chief Registrar (appointed by the President) and a registrar for each Registry Office. The Act further states that registration constitutes notice of the instrument and the fact of registration to all persons and for all purposes as from the date of registration and prescribes the mode for registration. The Act provides that a Registrar may refuse to register an instrument if it is inconsistent with a previously executed instrument, or if the grantor does not appear to be entitled to deal with the land in the way proposed, if the instrument is made in violation of any enactment or if it contains any unverified alterations, interlineations or erasures.

TITLE OF LAW	PURPOSE/SUMMARY OF CONTENT
Land Title Registration Law, 1986 (P.N.D.C.L. 152).	The Land Title Registration Law, 1986 (P.N.D.C. L 152) was enacted to provide a machinery for the registration of title to and interests in land. The Act provides for the registration of title to land and nearly all existing interests in land including Allodial title, customary law freehold, estate of freehold vested in possession leasehold interest, lesser interests in land, i.e. interests in land held by virtue of any right under contractual or share cropping or other customary tenancy arrangement including *abunu* and *abusa*. P.N.D.C. L152 also establishes the Land Title Registry which is tasked with the responsibility of registering titles and interests in land and the Land Title Adjudication Committee, which is mandated to determine any disputes relating to registering of titles and interests.
State Property and Contract Act, 1960 (CA 6)	Makes provision for the compulsory acquisition of land and other property and guarantees extensive compensation and established the procedure for such acquisition and payment of compensation. The Act provides for the declaration of areas as industrial areas and the allocation of land to industrial concerns via leases for industrial development.
Public Conveyancing Act, 1965 (Act 302)	It empowers the President by executive instrument, to declare any area of state or stool land to be a 'selected area' for certain restricted purposes and to grant titles to such lands to persons displaced by natural catastrophes, rendered landless by reason of compulsory acquisition of land, readjustment of boundaries under Town and Country planning laws etc.
Office of the Administrator of Stool Lands Act, 1994 (Act 481).	The Office of Administrator of Stool Lands Act, 1994 (Act 481), which implements Article 267(2) of the constitution, establishes the Office of the Administrator of Stool Lands and states its responsibilities to include the establishment of a stool land account for each stool into which shall be paid rents, dues, royalties, revenues or other payments, whether in the nature of income or capital from the stool lands, the collection of all such rents, dues, royalties, revenues or other payments and to account for them to the beneficiaries specified in the Act and the disbursement of such revenues as may be determined in accordance with the Act.
Survey Act, 1962 (Act 127)	Act 127 consolidates with amendments the law relating to geological, soil and land survey. The Act provides that the Director and Officers of the Geological Survey Department have power to go onto any piece of land and conduct geological survey works, that the Minister may appoint official surveyors and the Chief Survey officer may license private surveyors and only such persons may survey land and certify plans. Act 127 also provides for a system of survey work and empowers the Minister by Legislative Instrument to make Regulations governing survey work.
Stool Lands Boundaries Settlement (Repeal) Act, 2000 (Act 587)	Act 587 repeals the Stool Lands Boundaries Settlement Decree, 1973 (N.R.C.D. 172) and gives the High Court original jurisdiction to determine disputes relating to stool land boundaries. The Act transfers to the High Court all cases pending before the Commissioner before the coming into force of the Act, but allows the Commissioner to determine cases in which evidence has already been given.
Chieftaincy Act, 2008 (Act 759)	
Town and Country Planning (Gold Coast) (CAP. 84)	Cap 84 establishes the Town and Country Board, which is responsible for the orderly and progressive development of land, towns and other areas whether urban or rural, and the preservation and improvement of amenities

TITLE OF LAW	PURPOSE/SUMMARY OF CONTENT
	in these areas. The Ordinance also provides for a set of planning and building regulations that creates the basis and standards for land use planning.
Local Government Act, 1993 (Act 462).	Act 462 is an Act enacted to establish and regulate the local government system in accordance with the Constitution and to provide for other connected purposes. Act 462 makes provision for the planning functions of District Assemblies by establishing each District Assembly as the Planning Authority for its area of authority. For the purpose of executing its planning functions under the law, Act 462 establishes for each District Assembly a District Planning Coordinating Unit. With regard to land use planning, Act 462 stipulates that all development, particularly in urban centres, requires both planning permission and development permits from the District Assembly, and for urban areas, from the Metropolitan Assemblies
National Development Planning Commission Act, 1994 (Act 479)	Act 479 is an Act to establish the National Development Planning Commission under the constitution, provide for its composition and functions relating to development planning policy and strategy and for connected purposes. The Act establishes the National Development Planning Commission, its composition, membership and functions of the Commission. Section 2(1) b of Act 479 provides that the Commission shall make proposals for the protection of the natural and physical environment with a view to ensuring that development strategies and programmes are in conformity with sound environmental principles. The Act also provides that the Commission shall formulate comprehensive review national development planning strategies and ensure that the strategies, policies and programmes are effectively carried out.
National Development Planning (System) Act, 1994 (Act 480)	Act 480 is an Act to provide for a National Development Planning System, define and regulate planning procedure and provide for related matters. Act 480 provides that the decentralized national development planning system shall comprise District Planning Authorities at the District level, Regional Coordinating Councils at the Regional level and sector agencies, Ministries and the National Development Planning Commission at the national level. The Act spells out the functions of the District Planning Authorities, the District Planning Coordinating Unit, the Regional Coordinating Councils, the Regional Planning Coordinating Units, the Ministries and Sector Agencies and the National Development Planning Commission.
Conveyancing Act, 1973 (N.R.C.D. 175)	It regulates the modes of transfer of interests in land in Ghana. In general, the law requires transactions of three years duration or more to be in writing, save customary grants and other exceptions contained in the said section A transfer of an interest in land which is not in writing by the person making the transfer or by his agent duly authorised in writing confers no interest in the transferee, unless relieved against the need for such a writing by the provisions of Section 3. Schedule 1 of the Act prescribes the form or content of a customary grant. Once certified by a registrar as conformable to the requirements in the schedule, it is prima facie evidence of the matters stated therein. The requirement for writing together with certain implied covenants by the transferor and transferee under sections 22 and 23 of the Act make for certainty and predictability in land transactions.
State Property and Contract Act, 1960 (CA	The State Property and Contract Act, 1960 (CA6) makes provision for the compulsory acquisition of land and other property and guarantees extensive

TITLE OF LAW	PURPOSE/SUMMARY OF CONTENT
6)	compensation and established the procedure for such acquisition and payment of compensation. The Act provides for the declaration of areas as industrial areas and the allocation of land to industrial concerns via leases for industrial development.
Public Lands (Leasehold) Ordinance (Cap 138)	The Public Lands (Leasehold) Ordinance, which is an ordinance to provide for the acquisition of lands for public purposes for a term of years, makes provision for the Minister to acquire any land for any public purposes for such term of years as he may think proper and pay such compensation as may be agreed upon or determined.
Public Lands (Protection) Decree, 1974 (N.R.C.D. 240)	N.R.C.D. 240 makes it an offence for any person to occupy or convey public land without reasonable excuse.
Rent Act, 1963 (Act 220)	Consolidates and amends the law relating to the control of rent and the recovery of premises.
Mortgages Act, 1972 (N.R.C.D 96)	This is the governing law on mortgages in Ghana. Under the law, a mortgage is a contract charging immovable property as security for the due repayment of debt and any interest accruing thereon or for the performance of some other obligation for which it is given, in accordance with the terms of the contract. A mortgage constitutes only an encumbrance on the property charged; it does not operate so as to change the ownership, right to possession or other interest in the property charged. A mortgage may be created in any interest in immovable property which is alienable (section 1). To simplify the law, all manner of credit transactions involving immovable property whether expressed as a mortgage, charge, pledge of title documents, outright conveyance, trust for sale on condition, lease, hire-purchase, conditional sale, sale with right of repurchase or in any other manner, are deemed to be a mortgage of immovable property governed by the Act.
Stamp Duty Act, 2005 (Act 689)	AN ACT to revise the Stamp Act 1965 (Act 311); to incorporate amendments relating to stamp duties and to provide for related matters. The Act does not only address land transactions but all documents subject to payment of stamp duty or exempted from stamp duty payment in Ghana. Section 14 makes stamping of all instruments and title registered in the land or title registry mandatory.
Land Development (Protection of Purchasers) Act, 1960 (Act 2)	Act 2 was enacted to protect purchasers of land and their successors, whose titles are found to be defective after having erected a building on the land. The Act provides that where the titles of bona fide purchasers of land and their successors are found to be defective after a building has been erected on the land the Court has power to order that the conveyance taken by the purchaser operated to confer good title on him. The Act provides further that where hardship may be caused by the order, the Court may further order that the person in whose favour the order is made pay compensation to the one adversely affected by the order.
Head of Family (Accountability) Law, 1985 (P.N.D.C.L. 114)	P.N.D.C.L. 114 was enacted to hold Heads of families accountable for the management of family property. The Law provides that any member of the family with beneficial interest in the family property may bring an action in court for an order compelling the Head of family to render account of his management of family property.

Appendix 2

Part 1 – Land Administration/Service Agencies of Lands Commission

AGENCY	FUNCTION	LEGAL
Survey and Mapping Division (SMD)	*(a)* supervise, regulate and control the survey and demarcation of land for the purposes of land use and land registration; *(b)* take custody of and preserve records that relate to the survey of any parcel of land; *(c)* direct and supervise the conduct of trigonometric, hydrograhic, topographic and engineering surveys; *(d)* coordinate the preparation of plans from the data derived from survey and any amendment of the plans; *(e)* coordinate the production of photogrammetric surveys including aerial photography, orthophotomapping, and remote sensing; *(f)* survey, map and maintain the national territorial boundaries including maritime boundaries; *(g)* supervise and regulate operations that relate to survey of any parcel of land; *(h)* develop and maintain the national geodetic reference network for the country; *(i)* supervise, regulate, control and certify the production of maps; and (;J other functions determined by the Commission.	Survey Act 127 of 1962 (as amended by the Lands Commission Act, Act 767) Land Title Registration Law, PNDCL 152 of 1986. Survey (Supervision and Approval of Plans) Regulations, LI 1444 of 1989 Lands Commission Act, Act 767
Land Registration Division (LRD)	*(a)* publication of notices of registration upon receipt of an application for registration; *(b)* registration of title to land and other interests in land; *(c)* registration of deeds and other instruments affecting land in areas outside compulsory title registration districts; *(d)* maintaining land registers that contains records of land and other interests in land; and *(e)* other functions determined by the Commission.	Land Title Registration Law, PNDCL 152, 1986 (as amended by the Lands Commission Act, Act 767 Lands Commission Act Land Registration Act, Act 122 Conveyancing Decree NRCD

AGENCY	FUNCTION	LEGAL
Land Valuation Division (LVD)	*(a)* assessing the compensation payable upon acquisition of land by the Government; *(b)* assessment of stamp duty; *(c)* determining the values of properties rented, purchased, sold or leased by or to Government; *(d)* preparation and maintenance of valuation list for rating purposes; *(e)* valuation of interests in land or land related interests for the general public at a fee; *(f)* valuation of interests in land for the administration of estate duty; and *(g)* other functions determined by the Commission	Lands Commission Act Local Government Act State Lands Act, Act 125 Stamp Duty Act, 2005 Act 689 Immovable Property Rate Regulations, 1975 (L.I 1049)
Public and Vested Lands Management Division (PVLMD)	*(a)* facilitating the acquisition of land for Government; *(b)* managing state acquired and vested lands in conformity with approved land use plans; and *(c)* other functions determined by the Commission.	State Lands Act, Act 125, 1962 Administration of Lands Act, Act 123, 1962 Lands Commission Act, Act 767, 2008

Part 2 – Additional agencies involved in land administration

AGENCY	FUNCTION	LEGAL
Office of the Administrator of Stool Lands (OASL)	*(a)* Collection of stool land revenue and account for same; *(b)* Disbursement of stool land revenue; *(c)* Co-ordinate with other relevant agencies, advise and participate in preparing a policy framework for the rational and productive development of stool lands; *(d)* Development of a database and carrying out research into stool lands; *(e)* Consultation with stool land communities and traditional authorities on matters relating to the administration of stool lands; and *(f)* Facilitating the demarcation of farmlands of tenant settler farmers.	1992 Constitution Office of the Administrator of Lands Act, 1994 (Act 481)
	(a) The formulation of goals and standards relating to the use and development of land, particularly in areas of rapid urban growth; *(b)* The design of plans and proposals to direct the orderly growth and development of urban and rural settlements in the country; *(c)* The co-ordination of the diverse types of physical development promoted by various agencies both Government, quasi government and private developers; *(d)* Provision of various forms of planning services to public authorities such as District Councils and private developers aimed at securing the highest possible measure of health, efficiency and order in the physical environment; *(e)* Examination of development plans and approval provision of development permits	Planning Ordinance, 1945 (CAP 84) Local Government Act 1993 (Act 462)

Appendix 3 Status of current spatial datasets

Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
Topog Base Maps							
	Survey and Mapping Division (SMD)	Producer	Often	Digital/Analog	Field data from official surveyor/licensed surveyor Aerial photos Satellite data	Urban Planning, land title registration, land use maps, environmental resource maps etc.	Large scale base maps (1:50,000, 1:2500) covers only major towns and cities
	Public and Vested Land Management Division (PVLMD)	User	Periodically	Analog	SMD	Use for recording land transactions in the form of leases, assignments, mortgages	Poor state of the sheets due to lack of update
	Town and Country Planning Dept. (TCPD)	User	Often	Analog	SMD	Used for planning scheme preparation	Non-availability resulting in inaccurate layouts
	Utilities	User	Periodically			Used for providing services	Affects the provision of services to the public
Land Use/Zoning							
	TCPD	Producer	Often	Analog	SMD, Fieldwork SSD	For orderly development activities to take place	Lack of base maps affect quality coverage of planning schemes produced. Not supplied to user

Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
							agencies
	SMD	User	Periodically	Analog	TCPD	Set out schemes on the ground for development	Non supply of layout – in ability to implement layout
	PVLMD	User	Often	Analog	TCPD	Granting of Concurrence and Consent	Delays in concurrence and quality of recorded data
	District Assemblies	User	Often	Analog	TCPD	Provision of services	
	Utilities Co.	User	Periodically	Analog		For proper provision of services to communities	Affects expansion of services to the communities
Parcel Information							
	SMD	Producer	Often	Analog	Fieldwork Private Surveyors		Provide Survey description, size (acreage) and location of plot and cadastral/registry plan
	TCPD	Producer	Often	Analog	Fieldwork		Creates plots in planning schemes and determine their use
	Land Valuation Division (LVD)	User	Periodically	Analog	PVLMD Land Documents	Requires Acreage, Location and Use for valuation purposes	
	Office of the Administrator	User	Occasionally	Analog	Land Documents	Requires Acreage, Location and Use	Requires Acreage and Location for

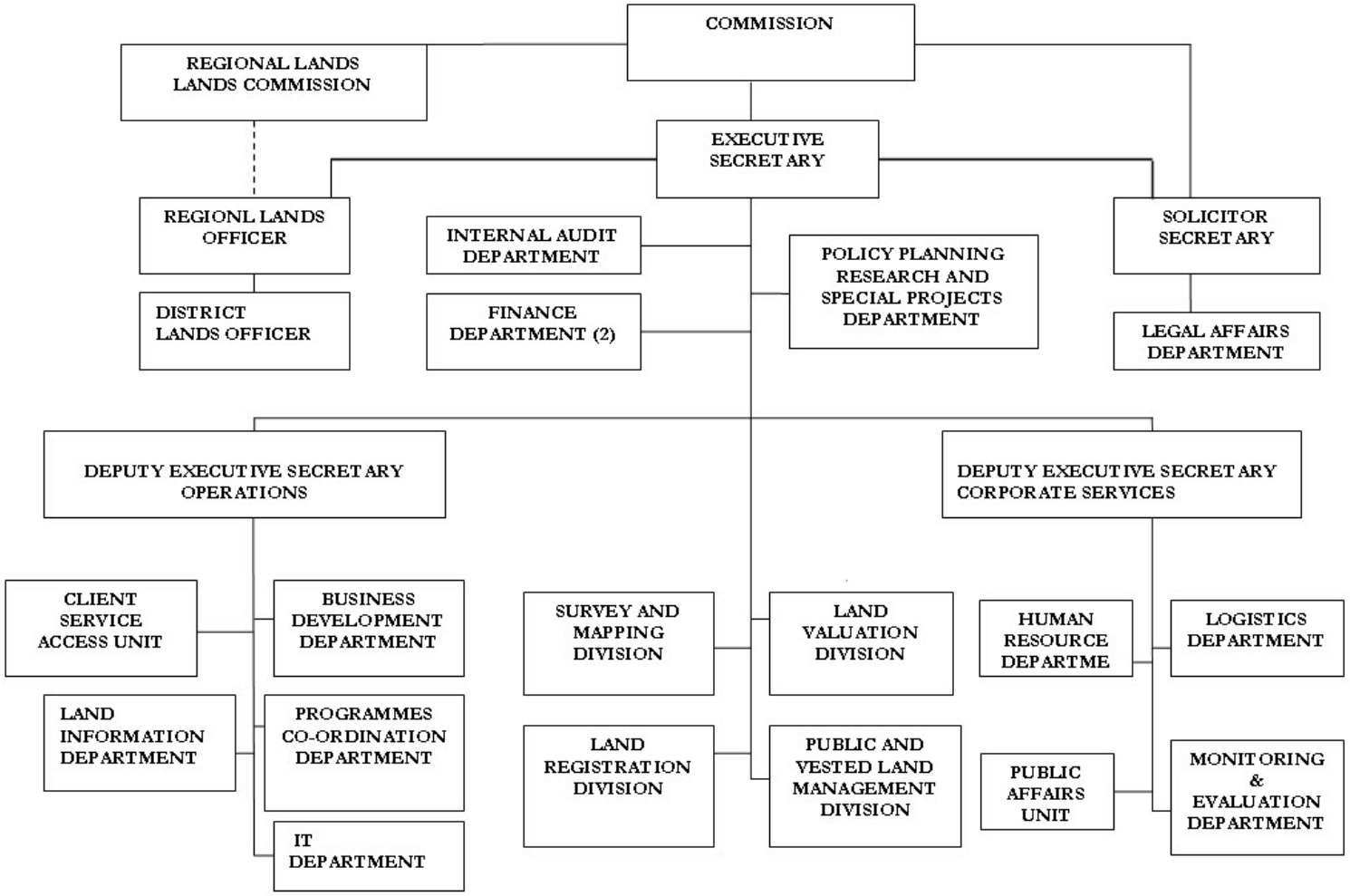
Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
	of Stool Lands (OASL)					in carrying out rent reviews	assessment and disbursement of funds
	PVLMD	User	Often	Analog	Land Documents SMD	Records Acreage, Location and Use acreage and use. Uses it for rent assessment and determination of processing fees	
	Land Title Registry (LTR)	User	Often	Analog		Cadastral plan for Title Certificate	
Land Tenure							
	PVLMD	Producer	Daily	Analog	Clients	Records type, term, rights, restrictions as well as parties to a transaction.	
	LRD	Producer	Daily	Analog	Clients PVLMD	Records type, term, rights, restrictions	
	LVD	User	Periodically	Analog	Clients PVLMD LRD	Requires type, term, rights, restrictions for valuation purposes	
	OASL	User	Periodically	Analog	PVLMD	Requires type, term, rights, restrictions for assessment of rent payable	

Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
Land value							
	LVD	Producer/User	Often	Analog	Clients, Private sector	To assist in carrying out valuations	Responsibility to create a land value database based on assessments made and lodgement of values by the public/private sector.
	PVLMD	User	Periodically		Clients LVD	Relies on data to assess ground rent and other charges	
	OASL	User	Periodically	Analog	PVLMD LVD	Relies on data to assess ground rent and other charges	
Buildings and other construction data							
	LVD	Producer/User	Often	Analog	Fieldwork	Uses data to determine value of properties	
	TCPD	Producer/User	Periodically	Analog	Field work SMD	Take data into consideration in designing planning schemes	
	SMD	Producer/User	Periodically	Analog	Field work	Picks this data as part of topographic map production	
	District	Producer/User	Often	Analog	Building Plans	Uses data for	

Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
	Assemblies					provision of services and assessment of property rates	
	Utilities		Periodically	Analog	SMD TCPD	Uses data for provision of services	
Infrastructure							
	Utilities	Producer	Often			Supply of Services to customers	
	TCPD	User	Periodically	Analog	Utilities	Take it into consideration in plan layouts	
	LVD	User	Periodically	Analog	Utilities	Helps in determining he values in an area	
	District Assemblies	User	Often	Analog	Utilities	Maintenance and development	
Demographic Data							
	Statistical Service Dept.(SSD)	Producer	Often	Textual and Analog	Census	Socio-economic indicators	From population census
	LVD	User	Periodically		SSD	Determination of values	Used in valuation
	District Assemblies	User	Often		SSD Field work		Distribution of development activities etc.
	Utilities	User	Periodically		SSD Fieldwork	Level of Service to Communities	Assessment of service levels
Administration Data							

Data Type Spatial/Attribute	Stakeholders	Role	Frequency of Update	Format	Sources of Data	Purpose	Remarks
	District Assemblies	User	Periodically	Textual, Spatial and Analog		Geographic extent of jurisdiction	
	Utilities	User				Service of bills	
	PVLMD	User					
	SMD	User					
	LRD	User					
	OASL	User				Assist in the apportionment of revenue to District Assemblies	
	TCPD	User					
	LVD	User					

Appendix 4 Organizational Chart for Proposed Re-Structuring of Lands Commission


COMMISSION
REGIONAL LANDS LANDS COMMISSION
EXECUTIVE SECRETARY
REGIONL LANDS OFFICER
DISTRICT LANDS OFFICER
INTERNAL AUDIT DEPARTMENT
FINANCE DEPARTMENT (2)
POLICY PLANNING RESEARCH AND SPECIAL PROJECTS DEPARTMENT
SOLICITOR SECRETARY
LEGAL AFFAIRS DEPARTMENT
DEPUTY EXECUTIVE SECRETARY OPERATIONS
DEPUTY EXECUTIVE SECRETARY CORPORATE SERVICES
CLIENT SERVICE ACCESS UNIT
BUSINESS DEVELOPMENT DEPARTMENT
LAND INFORMATION DEPARTMENT
PROGRAMMES CO-ORDINATION DEPARTMENT
IT DEPARTMENT
SURVEY AND MAPPING DIVISION
LAND REGISTRATION DIVISION
LAND VALUATION DIVISION
PUBLIC AND VESTED LAND MANAGEMENT DIVISION
HUMAN RESOURCE DEPARTME
PUBLIC AFFAIRS UNIT
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