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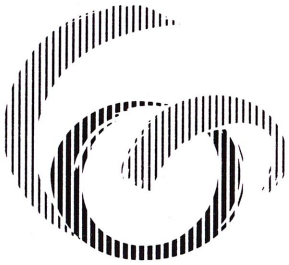
Guidelines to establish a National Land Information System for Bahrain (NLISB)

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By

Ali Al-Ansari

September, 1994



INTERNATIONAL INSTITUTE FOR AEROSPACE SURVEY
AND EARTH SCIENCES

THE NETHERLANDS

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Guidelines to establish a National Land Information System for Bahrain (NLISB)

By

Ali Al-Ansari

Supervisor
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Prof. R. Groot

This Thesis is submitted to the International Institute for Aerospace Survey and Earth Sciences (ITC) in partial fulfilment of the requirements for the award of the Master of Science Degree in Geographical Information Systems for Cadastral Applications (GIC.2).

Enschede, The Netherlands
September, 1994

Abstract

Land information includes all information of objects having a permanent place in, on or under the earth's surface, like cadastral parcels, buildings, cables and pipelines, roads, addresses and all other geographic units. Land information will become more and more important because of the growing number of governmental responsibilities, the increasing complexity of society and the advancing role of information in our society.

The need to obtain fast, reliable, accurate, up-to-date, and integrated information on land from different organizations has become a challenge for almost any responsible government. To accommodate this need a National Land Information System (NLIS) needs to be established.

Each country will have its specific structure and land management problems, thus it will try to find the most suitable solution for its problems. However, there may be common problems to many countries.

This research is an attempt to identify land information management problem in selected government organizations in Bahrain and identify the constraints of land information flow between them, and finally give guidelines to develop, implement, and maintain a NLIS for Bahrain.

The study begins with the review of the principles of LIS and investigate the need for a NLIS. Models from other developed countries have been studied as existing alternatives for the NLISB. A specific model for NLISB is proposed, based on the current situation analysis of the information infrastructure in Bahrain and the users' requirements.

Institutional, technical, legal, social, and economical issues related to the development and maintenance of the NLISB, plus the required changes in the participating organizations (selected organizations) are discussed.

The study focuses on the establishment of the NLISB in a federated database environment. The design of such a system requires a basic understanding of Federated Database Systems (FDBS), Multi-Database Systems (MDBS), and land information management.

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My gratitude to my main supervisor, ***Mr. C. Paresi****, who also the Director of studies for the course, for his directive instructions, generous comments, availability and encouragement without which it be difficult for me to finish this thesis in time.*

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To my co.supervisor, ***Prof. R. Groot****, I must express my gratitude to him for passing to me and my colleagues, some of his knowledge and experience on the issue of introducing of new technology in governmental and private organizations. I also thank him for his very useful comments on institutional, technical, legal, and economical issues relating to the establishment of a NLIS.*

I would like express my lot of thank and appreciation to the Minister of Housing ***Sh. Khalid Bin Abdulla Al-Khalifa****, to his Under Secretary* ***Dr. A.Latif Kanoo****, and to my Director the Survey Directorate Director* ***Mr. Ibrahim Al-Jowder****, for their support, encouragement, and for providing a scholarship without which I could not have been able to attend this MSc. course.*

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Chapter 1

Introduction

1.1 Background

We are living in a world of growing interdependence. Terms such as cooperation, networks, distribution, sharing of resources, etc., all manifest the need for growing communication between organizations.

For a long time, communication between organizations has been based on manual operations and means, even in cases where the organizations have had sophisticated internal information systems. Of course different kinds of technical tools (telephone, faxes, physical transfer of data, etc.) might have been used to make this communication easier, but a distinctive characteristic of such manual systems was, and is, the redundant data existing in many computer installations caused by the frequent re-keying of information into different organization computer systems.

Information is a commodity ; we need all kinds of information to go about our daily lives; information is needed in all sectors of society and in particular for the provision of essential services by national and local governments and for the management of the city. Information is, therefore, an immensely valuable commodity, and governments should aim to make efficient and effective use of it, and provide easy access to it.

Information is a commodity which has value, can be bought and sold like any other, and like most commodities, value can be added to the raw material at various stages of processing. Information is a particular valuable commodity : almost uniquely it can be sold and retained at the same time. Information can have different values for different types of customers, and can be manipulated by the application of technology for very many different purposes. Examples of value added to information raw materials include :

Accessibility : Accessibility can make information available which was simply inaccessible before or only accessible with great difficulty.

Agglomeration : Information can increase in value by its proximity to other information. The ability of users to search in the databases of two or more organisations at the same time increases the value of information.

Structure : Value can be added to raw information by the way it is structured, the way it is stored, by geo-coding and the complexity of the software used to retrieve it electronically in varied or sophisticated ways.

Transaction : In some instances information gains value in a trading process. In other instances, information is required within a network in order to facilitate a decision-making process or a trading activity. Travel industry reservation systems support a trading process

which ends in booking taking place through the system.

Re-utilization : Often information collected for one purpose can acquire a different value in another context. The information collected by the Ministries of Transportation for fiscal and regulatory purposes in connection with licensing drivers and vehicles, has completely different values to a researcher working on consumer demand trends in vehicle purchasing, than to the designers of a new range of car models. Information valuable in itself in hard copy can have different and valuable uses in digital form [Vector B.Glickman, 1990].

Land information is a primary resource for making land investment and management decisions. By helping to identify problems, patterns, and possible alternative strategies, land information may reduce uncertainty in the decision making process.

M.J.M. Bogaerts has classified land information into two groups :

a) ***Topographic information*** : This kind of information refers to the geographic units (parcels, buildings, roads, bridges, etc.) themselves. They consist of the name of the unit, the dimension, the limitations, and the material it consists of. Certain provisions also belong to the topographical information, such as the drainage of a plot ground.

b) ***Thematic information*** : In principle this kind of information refers to any information that can be coupled to a geographic unit. For instance : the percentage of unemployment in a certain area; or the average milk production of a grassland.

The following can be concluded from it : Land information is information about the geographic units themselves (topographical information) and thematic information which is very connected with them.

Land Information System (LIS) may be defined as : A tool for legal, administrative and economic decision-making and an aid for planning and development which consists on the one hand of a database containing spatially referenced land-related data for a defined area, and on the other hand, collection, updating, processing, storage and distribution of the data. The base of a land information system is a uniform spatial referencing system for the data in the system, which also facilitates the linking of data within the system with other land-related data [Ken N. Toms, Ian P. Williamson and Don M. Grant, 1987].

All land information need not of course to be stored within one location as long as access to it can be obtained when necessary. For this, networking facilities and distributed databases are necessary whereby data can be collected from several sources as and when needed. Many different government departments need land-related data; the control and exchange of these data require interdepartmental technical and administrative cooperation and some degree of surrender of departmental autonomy in the way data is classified and organized.

Land information, like some other types of information, suffers from duplication and redundancy as a result of its existence in many systems in a country. They can be fully utilized, when kept in a single information system (LIS) where the distributed databases are

shared by many users.

Currently in Bahrain, isolated dedicated information systems have been established by different government and semi-government organizations with, it appears, little of consideration for the coordination of production, sharing and use of geographic information.

Bahrain as a small developing country, needs a *National Land Information System (NLIS)*, to provide the planners and decision makers with a good tool to support their (legal, social, administrative and economic) decisions, to prevent the duplication of works between the different departments and to facilitate the processes of data exchange and data supply within a time frame that meets the needs of the user. For example the Survey Directorate (SD) supplies land information through its cadastral and topographic databases to government and semi-government departments, and uses land information produced by utility, planning and land registration directorates. So there is a land-related data exchange between a number of organizations in the country. In most cases the land-related information is exchanged between the governmental organizations as hard copy or in a form which the producing organization can provide, not necessarily in a form which the receiving organization needs.

The data (spatial and non-spatial) for the NLIS need to be collected from several sources with different data formats; some data such as the details of ownership are held by the Land Registration Directorate (LRD); the municipality may hold data on land use while data on sewers, water and electricity are collected and stored by Ministry of Works Power and Water.

Survey Directorate (SD), as the national mapping organization is responsible for the collection, processing and dissemination of up-to-date geodetic, cadastral and topographic information over the whole country.

The development of a National Land Information System for Bahrain (NLISB) should enforce information integration, decentralization and customization, which in turn will permit effective planning by a variety of governmental organisations and will foster a much higher level of cooperation between them.

In Bahrain a large number of government and semi-government organizations produce different types of land information for their own needs . These include :

1. Ministry of Housing
2. Ministry of Works Power and Water
3. Central Municipal Council
4. Land Registration Directorate (LRD)
5. Central Statistics Organisation (CSO)
6. Ministry of Information
7. Ministry of Development and Industry
8. Ministry of Commerce and Agriculture
9. Bahrain Telecommunication Company (BTELCO)
10. Bahrain Petroleum Company (BAPCO)

And due to inadequate planning and lack of communication and integration between organizations there is a duplication of data acquisition, no standards for data exchange and difficult access to data.

There is a need for cooperation between all producers and users of land information. Unfortunately, interdepartmental rivalry occurs in almost every country. Even within a land survey department the cadastral staff may not know or cooperate with what the topographic branch is doing. There is a conflict of interests and lack of cooperation between those maintaining land records, such as land registration, those keeping utilities records and those involved in land survey. Each, however, has a role to play in the development, implementation and management of the NLIS.

Due to time limit and research complexity, the study will focus on the key organizations only (Ministry of Housing, Ministry of Works Power and Water, Central Municipal Council, Land Registration Directorate and Central Statistics Organisation) which in the opinion of the auther form the major components of the proposed NLISB, due to the fact that their information systems are rich of land-related data.

1.2 Prior Work

The idea of sharing and exchanging information between organizations through a wide area network (WAN) facilities has been successfully implemented in many information technology fields such as banking and travel business. In banking, any data on money can be transferred from one bank account to another whether they are within the country boundaries or outside the country boundaries in a few minutes. Also the personal identification number (PIN) code payment machine where by the individual can pay the shopkeeper by just keying his/her PIN and pass the card through the PIN code payment machine; and as a result of those simple actions a debiting of the individual account at a specific bank and a payment action to the shopkeeper will take place in a matter of minutes.

All of this of course can not be done without a host of technical, financial and legal agreements and protocols between participating banks, stores and information utilities (special organizations who designed, established and maintained the arrangement of computer system software and hardware, and communication links) to protect the integrity of the system and to share the cost to the participating banks and shops.

In travel business, ticket reservations can be done easily and quickly at any travel agent on any specific airline. The reservation is registered in the airline's database which is linked to a numerous travel agent offices over the world through the computer or telephone network; this has ensured the reservation integrity and validity.

The infrastructure of ticket reservation systems has facilitate access to and use of airlines huge central databases in a very efficient manner. Ticket reservation systems can be a key income resource, as it has been declared by an american airline company that 80% of its income is

from renting its ticket reservation system to other airlines and only 20% come from selling air tickets.

NLIS are currently in embryo in many different countries all over the world. At the national level successful attempts have been done in some developed countries such as Sweden, Great Britain, New Zealand and Australia. The Swedish Land Data Bank System has been developed in order to rationalize handling of data on real properties and land. The system replaces earlier manual systems for property and land registration. It interacts regularly with other electronic data processing (EDP)-based information systems and serves as a land information system (LIS) in a broad sense. In UK a proposal has been made to develop and implement by the year 2000 a NLIS for Great Britain, containing up-to-date information on land and property ownership, value and land use. It is proposed that the system will make use of distributed databases connected over a wide-area network; the development of the NLIS is predicated on the creation of a national wide-area network so that different computer terminals in organizations in different parts of the country can be connected together and data can be exchanged between them. Land Information New Zealand (LINZ) and the LANDATA system in South Australia based on the Land Ownership and Tenure System (LOTS) are both well developed.

In the current status of land information systems throughout the world, it is notable that there are very few systems which are fully developed and working. On the other hand, there are many countries where systems are in the development stage, and even more where they are being contemplated.

A number of lectures have been delivered by Dr. Amer on 'National Information Infrastructure'; Dr. Radwan during his lectures has emphasised on the importance and advantages of 'Distributed Database Systems'. Study visits have been made to the 'Danish Coordinated Information System' and the 'Dutch Cadastre'. The Danish approach is of a multi-level and multi-purpose system; it is more of a land information system with more emphasis on detailed urban data. The Dutch Cadastre has a central database for the AKR (Automated Cadastral Registration System) and a distributed database for the LKI (Land Surveying and Cartographic Information System) with offices all over the country which are connected on-line. Data obtained on-line is mostly attribute information.

The role of the GIS/LIS within a corporative environment has identified the Distributed DBMS as the key element for future, fully integrated solutions. A distributed database is a database that does not stored the entire data at a single physical location, but rather is spread across a network of locations that are geographically distributed and connected via communication links. The distributed system should be able to cope with heterogeneous, i.e. multi-vender environments and can be viewed as a partnership among a set of independent, but cooperating centralised systems [Dàte, 1985].

Distributed database system technology is one of the major recent developments in the database systems area. There are claims that in the next ten years centralized database managers will be an " antique curiosity " and most organizations will move toward distributed database managers [Stonebraker, 1988,p.189].

Commercially distributed DBMS products are still in their very early stages of development. The major areas of current weakness include: All DDBMS are based only on the relational model; There is still no standard SQL within the industry; Initial emphasis has been placed on distributed reading of information, with the problems of update being ignored.

Up to my knowledge this research is the first of its kind in Bahrain. It is an attempt to find solutions to some of the problems related to the establishment of a NLIS, and it can be seen as a first step in the process of developing a NLIS. At the ITC a number of research projects have been done on design and implementation of a multi-purpose cadastral in a distributed database environment.

1.3 Research Problem

Given the situation in Bahrain, the following research problems can be formulated as, what are the critical success factors of developing a NLIS for Bahrain (NLISB), and in particular what are:

1. The land information requirements of the individual departments at the selected organizations.

2. The infrastructure needed to coordinate the production, integration, decentralization and customization of land-related information in a distributed database environment by using the concept of Federated databases in the context of a National (Global) Server to develop an information infrastructure model for NLISB.

3. The constraints for data exchange between the organizations concerned and in particular the :
   - Legal (access, use, copy rights and ownership of data),
   - Economical (cost recovery, and pricing of information products),
   - Social (awareness, training),
   - Technical (standards, user interfaces),

issues that have to be addressed for an effective development of the NLIS of Bahrain, and for its sustanaible operation.

1.4 Research Questions

Given the above research problem, the following fundamental questions need to be addressed in the development of a NLIS for Bahrain (NLISB) :

1. Why do we need a NLIS for Bahrain ?
2. What are the expected benefits from having a NLIS ?
3. Who are the main users of the proposed NLISB ?

4. What kind of land-related information will it contain ?
5. What conceptual model could be adopted for the NLISB (alternatives) ?
6. What are the key issues in the design and implementation of the proposed NLISB ?
   - Legal issues
   - Technical issues (in particular, constraints for data exchange)
   - Institutional issues
   - Economical issues (cost and benefits of developing a NLISB)
   - Social issues (in particular education and training)

1.5 Research Objectives and Methodologies

Task 1 : Through a comprehensive literature review and field work analysis, ascertain the necessity for a NLIS in Bahrain

Methodology : - Identify long/short term objectives of a NLIS.
- Identify the critical success factors of implementing a NLISB.
- Identify the potential users of a NLISB.

Task 2 : Through a comprehensive literature review, analyze the different alternatives for developing a NLISB.

Methodology : - Study examples of development in some developed countries.
- Analyze the factors which have influence the choice of alternatives.

Task 3 : Study of Federated databases (through litterature study) to understand the principles, potentials and limitations of this concept

Task 4 : Carry out a functional analysis for each selected organisation (in Bahrain) through formal meeting with personals, data collection, processing analysis and evaluation.

Methodology : - Identify the organisation information requirements.
- Identify the land-related data produced and used by the organisation.
- Study the organisation structure to coordinate the production, sharing and use of land-related information in a distributed database environment.
- Identify the constraints to land-related data exchange, and how to overcome them ?
- Study the existing information system; identify bottlenecks; derive global new system requirements.

Task 5 : Establish guidelines for the development of a NLIS in Bahrain (NLISB).

Methodology : - Identify the main components of NLISB.
- Design a conceptual model.

- Identify the phases in the development and creation of NLISB.
- Consider the key issues in the design and implementation of NLISB :
  * Legal issues (access, use, copy rights and ownership of data, data exchange legislations)
  * Technical issues (standards, system architecture)
  * Economical issues (cost recovery, information pricing)
  * Institutional issues
  * Social issues (awareness, training)
- Make recommendations for setting up a NLIS in Bahrain.

1.6 Thesis structure

This thesis is made up of six chapters, as follows :

Chapter One **: Introduction**
Gives an introduction to the research; topics discussed in this chapter are, the background to the study, prior work on the subject of this research, the problem of this research, the corresponding research questions and the methodologies to be used to carry out the research work.

Chapter Two **: Necessity for a NLIS and Constraints to develop/maintain it**
Defines the National Land Information System (NLIS) and explains its benefits to a country. This chapter discusses also example of development in some developed countries and what alternative infrastructural solutions for a NLIS are possible.

Chapter Three **: Situation analysis of the information infrastructure in Bahrain**
Analysises the current situation in Bahrain regarding data exchange and data flow between the selected organizations. It also discusses the current problem and deficiency areas and justifys the needs for NLISB.

Chapter Four **: Federated Database System (FDBS)**
Discusses the concept of the federated database system and issues related to it such as standards, integrity and user interface. It also explains how a FDBS can be used to support the concept of NLISB.

Chapter Five **: Guidelines for the development of NLISB**
Discusses the architectural model of the proposed NLISB in a federated database environment. Also explains the design aspects of the system and phases for the development of NLISB. The critical success factors (CSFs) for the development, implementation and sustainable maintenance of the system are discussed in some details. Key issues in the design and implementation of NLISB are discussed as well.

Chapter Six **: Conclusions and Recommendations**
Gives conclusions and recommendations derived from this research.

Chapter 2

Necessity for a NLIS and Constraints to develop/maintain it

2.1 What is a National Information System (NLIS) ?

All information systems are designed to increase efficiency in managing resources and to reduce risk in decision making. Land is arguably the most valuable resource other than its people that a nation possesses, because land is neither inexhaustible nor indestructible, and it is related to many human activities such as building on, living in, eating from, etc. In many human societies, land possession means wealth and pride.

Governments over a considerable period of time have built a large number of land information systems (registers and administrative systems). In most cases those system are related to different government functions such as land registration, land taxation, utility planning, urban planning, etc.

Most departments of local government support and maintain their own records, each using their own work-flows, procedures, and computer systems. Though much of the information needed in one department could be useful to others, the evolution of separate "solution" for each department usually makes data sharing a major problem. Without efficient means to link land-related information such as parcel, tax, utility and ownership data, proper land information management becomes difficult; one can only manage available information.

On this background it is appropriate to link all departments which hold land-related information in one national system called *National Land Information System (NLIS)*. The data for the NLIS will come from a variety of sources. For example, data such as the details ownership, are held by the land Registry while others are collected and stored by bodies such as Electricity, Gas and Water Companies. The underlying mapping at the basic scales (in Bahrain 1:1000 & 1:2000) can be produced by the country national mapping agency, to provide a spatial framework for the whole country.

It would in theory be possible to compile all the records in one enormous database but this would give rise to difficulties in database management and especially in ensuring that the data are kept up-to-date as updating is better in hand of the one producing the data. The technology is, however, available to link computers together so that even if they are of different type and construction, data can be exchanged between them. A series of computers can be made to 'talk' to each other in what is called a network.

Certain types of land information relate to areas defined by human activity, such as the ownership or use of land; others relate to naturally defined space, such as soils boundaries. The NLIS for a country may contain one (or more) categories of information and integrate data from different sources using GIS technology and a wide area computer network.

Four categories of national land information system may be identified :

1. ***Physical Environment*** : Those systems are concerned with attributes of the physical environment, such as the soil, geology or hydrology.

2. ***Infrastructure*** : Those systems are concerned with infrastructure such as the utilities, transport and communication.

3. ***Cadastral*** : Those systems are concerned with cadastral information such as land ownership, land use and property values.

4. ***Socio-economic*** : Those systems are concerned with socio-economic data such as census statistics, health, welfare, and taxation.

5. ***Topographic*** : Those systems are concerned with topographic information of the geographic units such as buildings, roads, bridges, etc. The information consist of the name of the unit, the dimension, the limitations, and the material it consists of. And those information are associated with topographic base maps at different scales.

Each of these systems has four functions - to help in monitoring the environment by providing the necessary information, to determine where action is needed; to help in planning by providing a facility whereby alternative courses of action can be analyzed; to help in decision making by providing factual support to the decision makers; and to help in the implementation and management of those decisions.

National land information systems may be designed to serve one primary function or they may be multi-functional. Some have been designed to support strategic planning, some for management control and the attainment of organizational objectives, and others for operational control so that specific tasks can be carried out efficiently and effectively. Each objective requires its own set of information and data. There is no system which can serve all purposes, but there is one map (topographic maps) or database, which will serve all types of user.
For many land management purposes, the most suitable basic spatial unit around which to build a system is the land parcel.

2.2 A NLIS - Who benefits ?

The main idea of NLIS is to create an institution in which land related data (spatial and non-spatial) from various sources is used to help in decision making, planning, maintenance, and management of land. The benefits which can be gained by establishing a NLIS depend on the purpose for which it is developed. The following benefits can be recognized as general NLIS's benefits :

1. ***Land Management*** : We all need land to live on, to build our shelter on and to extract our food from. In this context land includes also water bodies as the sea, which are becoming

more and more important with respect to marine resources.

Particularly in developing countries, land cannot be treated as any other commodity; it is very significant and thus valuable commodity. Besides its pure economic value it has often serious social and religious implications; also in developed countries the idea that they should hold the land as stewards for generations to come, is more and more expressed.

Governments should demonstrate commitment to provide an adequate supply of land in order to meet the ever increasing needs by design and implementation of a land policy. This land policy includes that for all kinds of uses there should be a sufficient amount of land available which is suitably located and provided with adequate infrastructure, balanced between environmental requirements, at a reasonable price. Within the framework of those ideas, a NLIS can be used as a tool to manage, utilize and conserve land resources and to support the country land policy.

It is necessary to connect a number of land information systems with each other to make the exchange of data possible so as to be able to integrate various land related data in order to derive specific information needed for a variety of purposes.

2. ***Planning*** : Land information systems and appropriate geoprocessing technology can be utilized to assist the planning efforts in many fields :

a) *Planning as related to utility operations* : NLIS can assist the utility companies to provide better quality services. Utility planning, with the assistance of an integrated land information system, means that the utility can immediately be knowledgeable of who the present customers are, where they are located, what services are provided to them, the type of services sustaining the general neighbourhood of the customer, and the ability of the existing service system to meet additional requirements.

Adaptation of sophisticated geoprocessing technology will enable the utility company planners to determine precisely the locations and type of services to be installed to meet future requirements.

b) *Planning as related to public safety* : Assume that a land information system consists of an identifier for each street segment, street intersection, and each parcel. Associated with each identification is a location description based on a common geographic reference scheme such as the UTM reference system. Assume also that relative data files are computerized, and maintained, and that they contain information relative to presence of hazardous materials on geographic location basis, i.e, a parcel, a warehouse on a parcel, a basement, drums behind a building, a larger area contaminated with hazardous materials, etc. Further assume that the Police Department maintains an incident file which contains details relating to acts of violence referenced to a geographic location such as an address.

Given these simple items it is now possible for an operator at a fire department to receive an emergency call on the 999 system and to have the address location immediately displayed on a graphic display terminal (along with other distinguishing background features such as streets

and street names). In addition the presence or absence of hazardous materials can be displayed for the incident location itself as well as all adjacent areas. Finally, a violent crime location overlay can be displayed immediately to determine if there is a record of concern at or near the incident location which might influence the approach or handling of the incident by fire department or other public safety personnel.

c) *Planning as related to physical planning* : For both planners and administrators, cadastral and individual's information can of course, be of great use. NLIS can have the ability to combine cadastral and personal registers and lends itself to the easy acquisition of information on households and people of different ages living in an arbitrarily chosen area, and thus provides a valuable basis for the planning of roads, highways, gardens, sport areas, hospitals, schools, airports, new towns, and other types of public and commercial services.

3. ***Decision Making*** : NLISs give, as their name implies, information about land. Information which is a basis for problem identification, for decision-making and for the implementation of these decisions. It is presented in a cartographic and descriptive form. NLIS is an important issue of the land management concept.

Comprehensive information on land capability, characteristics, tenure, use, and legislation should be collected and continuously updated so that all citizens and levels of government can be assisted in determining the most beneficial land use allocation and control.

The decision makers (i.e., managers, administrators, politicians, tribunals, councils, ministers, etc.) are the key offices/personnels in the use, organization, development, and effectiveness of land information systems. Their questions must be answered and their problems solved. If they are not interested, success is unlikely and probably there would be no need for the system. Therefore, decision makers must be involved from the beginning in the development and use of the systems, particularly as they start to replace their largely intuitive or rule of thumb methods by a reliance on information obtainable from the various information systems. Information selected from one or more information systems can be used for modelling and developing scenarios or alternatives in preparation for management decisions. Two-way communication between the information specialists and the decision makers, who generally are experts but not in Information Technology (IT), is vital in formulating future land and resource policies.

4. ***Communication*** : Many organizations need to communicate with each other. Clearly it is going to be beneficial to them to be able to pass information as quickly and easily as possible. Communication between organizations occur on a daily basis. For example a number of utilities are ahead of municipalities in the capture of their underground plant. It would be foolish and wasteful for local authorities to capture the same information. Communication is also needed because agglomeration of information (added value to information).

5. ***Individuals*** : Consider the case of a married couple wishing to buy a property in a less crowed city. From their municipality (or estate agent) they would be able to 'log in' through the NLIS to a series of databases, for instance those held by property agents, and examine the details of all relevant 'desirable residences' currently on the market. This will include picture

of the property and the views around it. They would be able to display a base map showing details of the area such as the location and type of local shops or the public transport network. They will then enquire from Land Registry about any restrictive covenants and details of the proprietorship. For all this information they would be charged (or billed). Finally they may decide that it is worth visiting the city to see their preferred choice before making a bid for the property.

6. ***Key Personnel*** : By similar means, government officials and projects managers can ask the NLIS by a structured query languages (SQLs) questions such as 'Where in the country can I find X square metres of surplus land, within Y kilometre from city centre, within Y kilometre from hospital, within 1 kilometre of a motorway exist ?'. The computer will scan through all the databases linked to the network and display all relevant sites.

2.3 Constraints to develop/maintain a NLIS

With the advent of information technology, land information can be retrieved, analyzed, shared, and presented efficiently. But before developing any land information system which can do so and can fulfil the requirement of many users, issues such as legal and political, administrative, technical, institutional, economical and social must be considered and the associated problems must be solved in order to guaranty the success of the system and its sustainability. Those issues are highlighted hereafter :

2.3.1 Legal Issues

a) *Legality* : The computer record cannot be guaranteed to be correct in the same way as a legal document. At the moment this problem up to my knowledge has not been resolved anywhere in the world. In the meantime the Survey Directorate (Ministry of Housing - Bahrain) has installed a computer system in order to monitor survey documents (survey job file) movements and hence maintain the various indices on a daily basis.

b) *Copyright and Security* : If information is to be treated as a resource then there must be access to it by interested parties. Two factors that may prevent the free exchange of data are copyright and security. Land information may be subject to copyright; therefore communicating land-related data to the public may cause legal or financial problems if the copyright laws are to be enforced. In the case of paper maps it can be exercised in the same manner as it is with books and other published material. In the case of digital maps, extracts can be made more easily and transferred between systems electronically, for example over telephone lines. The policing of copyright is much more difficult for digital maps than for paper copies. If government policy is to distribute land information freely then it will be missing an opportunity to recover its costs. If it charges for the data, then it will need to establish mechanisms to control its resale.

Copyright covers the products or information generated by an individual or organization. The

copyright laws protect the producer of a product or information from having it copied without their permission, thereby preventing other individuals or organizations from making a profit out of someone else's work. Copyright can be breached legally by adding or omitting items from the original product and sale it as a new product. For example a topo map produced by A and used by B, who adds his own information to the map and sale it as new map. To stop this kind of copyright breach, loyalty right can be enforced to protect the original product from misusage by others.

The relationship between owners and users of geographic information gives rise to a number of complex legal issues. These include the intellectual property rights which may exist in geographic data, what protection is enjoyed by the owners of those rights and how those rights may effect potential users (AGI, 1992a). Intellectual property rights cover the rights of an individual or organization to claim copyright of a piece of information because of the knowledge and expertise invested in collecting or creating that piece of information.

In UK, the Association for Geographic Information established a working party to look at those complex issues as they relate to spatial data in order to help clarify areas of concern to both suppliers and users of geographic information (AGI, 1992a). A number of UK laws relate to the protection and use of spatial databases :

* Copyright Designs and Patents Act 1988
* Data Protection Act 1984
* Computer Misuse Act 1990
* Law of confidentiality, which is largely based on legal judgements
* Contract Law

The most important of these is the Copyright, Designs and Patents Act 1988, which specifically protects certain types of work, including literary works, artistics works (which encompasses maps) and cable programmes or any item in a service by which information is sent by means of a telecommunications system, which includes a computer. To be included a work must be recorded in some form, such as on paper, tape or computer disk.

c) *Security* : In some countries, paper maps and aerial photos carry a security classification and may in consequence be unavailable even to other government departments. There may be implicit or explicit regulations governing the access to government-held land-related data by other state authorities and by the public. In some countries the public may have a degree of protection against the divulgence of personal information, whilst in others, rights to privacy may be set at nought.

d) *Information quality* : If an individual or organization contributes data to a centralized system then there needs to be agreement about the legal responsibility for the quality of those data.

2.3.2 Technical Issues

The developers of a land information system to serve the corporate needs of government face the daunting task of system management of huge amounts of information. Such was a technical limitation a decade ago. But today computer systems are designed for the efficient management of incredibly large volumes of data. We take for granted the efficiency of banks and airlines companies. Behind the scenes, computers are doing all the hard work. Such systems are not one large system but a whole series of computers communicating with each other.

So why should the development of a land information system, in a technical sense, be any different or more difficult ? It is certainly no different in computing terms. When conceived as a decentralised system, each agency responsible for source data becomes a node in a telecommunications network.

A land information system is certainly more difficult to develop because of the need to transcribe huge volumes of data from old paper records and, as well, to record the data in a graphical, or map, form. The convergence of conventional textual data with graphical data is a major technical problem area. Dimensions and areas will be calculable from the digitised information, accurately enough for most applications. This accuracy depends upon the source of the digitised information, such as the age of the original map or plan and its scale.

Every user accepting data from other users has to deal with '*Data Transfer*', '*Data Quality*' and '*Networking*' :

a) *Data Transfer* : means bringing data from one system to another. This requires agreements on data definition and format. Standardizing these agreements avoids many misunderstandings and result in a Standard Exchange or Standard Transfer Format (STF).

b) *Data Quality* : means knowing the quality of the imported data to judge whether or not the imported data is appropriate enough for a certain applications in terms of positional accuracy, attribute accuracy, completeness and up-to-dateness.

c) *Networking* : The potential need to integrate, share and exchange digital geographic information between organizations to support geographic data management and applications in a federated environment required a host of communication agreements, protocols and networks between participating organizations (components). Wide Area Networks (WAN) commonly have to accommodate equipment that have been manufactured by different companies. This requires that the transmission media be able to handle the heterogeneity of equipment. There might be differences in equipment in term of speed, word length, coding scheme used to represent information, or any other criteria. If such heterogeneous machines are to be interconnected and are to support transmission of data among them, some standardization is obviously necessary. This standardization for WAN is provided by the open systems interconnection architecture of the International Standards Organization (commonly referred to as the ISO/OSI architecture) [ISO, 1983].

2.3.3 Institutional and Political Issues

Institutional issues, more than any others, determine the effectiveness and pace of development. They directly affect the design and implementation of any system and are themselves affected by its development.
Since a land information system should serve a wide variety of users, both in government and in the private sector, it is essential to understand their requirements.

Many professions and associations will be directly involved in the collection of information for use in a land information system. As reforms in the land information arrangements may require changes in the standards and procedures of these groups, their active support should be obtained. Parcel-based systems, for example, can entail extensive changes in land tenure, conveyancing, and land registration.

According to Williamson (1987) there is a real lack of fundamental research concerning LIS. This is an issue which should be taken up with the tertiary institutions as a matter of urgency. Partly as a result of this, governments, computer vendors, academics and educational institutions have been caught up in the euphoria of LIS without fully understanding their own needs. Because there are few qualified personnel in the area of LIS management, many organizations are attempting to develop systems without qualified staff. Academic institutions can provide basic principles and an appropriate environment for research and development but, unfortunately, both the government and private sectors attempt to develop systems without drawing on the resources of the academic sector and universities.

The traditional role of government is to assign a statutory responsibility to a particular department. That department generates information which is then assumed to be owned by the department. The truth of the matter is that government, as a corporate body, has the ownership of information and should not be beholden to the individual departments. The absence of a corporate infrastructure, however, leaves departmental management with little option but to foster exclusive self interest.

In order to respond to the global problems of the management of land information, government needs to take a corporate view of the problem. It needs to identify original sources, rather than secondary sources of information and to build the infrastructure of a land information system to act as a concentrator and disseminator of that information to others. In achieving this, redundancy in record keeping is eliminated. Where duplication of records must exist, the integrity of those duplicated records is assured through an integration with the land information system. The duplicated records are, therefore, temporary copies of the original source.

2.3.4 Economical Issues

Implementation of GIS/LIS involves a substantial commitment of resources by the sponsoring agency. Economic evaluation of the proposed GIS/LIS is an important step in the implementation process. The economic evaluation of the implementation of a GIS/LIS

involves comparing two items, benefits and costs, for a specific instance of a GIS/LIS. Evaluations may be carried out at any time during the development of a GIS/LIS - from the proposal stage through ongoing operations, but preferably as early as possible.

The basic aim of any benefit cost analysis of a government program is to determine if benefits exceed costs. If so, the use of scarce resources in the programme is consistent with the social goal of economic efficiency [Epstein and Duchesneau, 1984].

Key questions such as 'Who is going to pay the total bill of the proposed system ?', 'What would be the mechanisms for cost recovery ?' and 'How information can be priced and what are the factors which determine the information prices ?' . These questions must be answered prior to any GIS/LIS development.

2.3.5 Organizational and Social Issues

a) *Unprepared society* : Due to "technological push", it is now technically possible to create very sophisticated information systems. Unfortunately many sections of society (institutional, legal, administrative, social and economic) have not kept pace with these developments and cannot accommodate the technology. Sometimes this leads to vendors and consultants selling "a solution". This can cause an organization to see the technology as the answer to all their problems whereas, usually, nothing could be further from the truth [Williamson, 1987].

b) *The impact of changes* : Introduction of Information Technology (IT) has some impacts on the organisation's structure, activities and people working at it. In this section those impacts will be discussed in more details.

Organisation : The most common justifications for the implementation of the new information technology has been to increase productivity, and to manage, process and store information in an organized manner.

Introduction of IT in an organization entail some constraints for the organization such as re-organization of departments to cope with the new information system and change of management structure (from functional to problem/project orientation).

In *Survey Directorate (SD)*, survey information management and control is one of the essential roles of the Survey Directorate. The management, after realising the defects of the laborious manual survey information control and management, decided to benefit from the new technology assistance. As a result, a contract was made with a Swedish firm to design and introduce an automated system to be used as a tool for information management and control.

SD, has the task to supply the up to date survey information to other directorates within the Ministry of Housing (i.e. Physical Planning Directorate and Technical Affairs Directorate), and also to some external directorates such as Water Directorate and Electricity Directorate.

By implementing the new information technology those organizations can get the up to date survey information in digital form as well as in hard copy within a time frame that meets their needs.

Also as a result of the new information technology implementation at the Survey Directorate, productivity has increased to a very satisfactory level. For example, citizens can get their land certificates within one week of the application date, where five years ago they have to wait almost a month to get it.

This of course has increased the confidence of the users on Survey Directorate as a main supplier of the up to date survey information, and give the Survey Directorate the required tools to meet the setted jobs target and to support the decision making process.

People : Whenever we speak of organizations we are implicitly speaking about people. The introduction of information technology often has a significant impact on people who are not directly involved with the technology itself.

In some organizations, there is a group of people who feared computers and avoid dealing with them as much as they possibly can, because they have the idea that computers are very complicated machine and they need very clever people to deal with them. Other group see themselves as very skilful staff, having spent years developing the skills to do their current jobs, and by using computers in their work they think that they might loss some of their skills; besides they are comfortable with the way their working life is organized.

As a result of innovation, those people will find themselves, suddenly in face to face with computers, this is one of the reasons why people resist change (development) because they are not confident that they know what the effect of the change will be on them. It is therefore very important that all those people who think that they will be effected by the change are informed of what it means for them and what exactly their new roles will be.

In an organization there are people with differing degrees of power. A person's power can be either formal (resulting from their position) or informal (resulting from things such as their membership of an old boy's network) or a combination of both. The introduction of new information technology often is associated with significant changes in the organization. Some of those people will welcome the new changes because it will give them more power, and others will resist the new changes because it will reduce their power.

From experience, the best group of people, the management can depend on to achieve a successful innovation are those who see the innovation process as an opportunity to upgrade themselves to achieve their personal and organization's goals. For example, they like to work with computers, and know more about them, they asks questions related to their new jobs, they like to play a more important role in the organisation. This group of people take less time and effort to train and to convince with the new role they have to play within the organization.

2.4 Existing Alternatives for NLISB

In this part the state of art of establishing National Information System in some countries will be reviewed briefly. The selected countries are ***The Netherlands, Sweden,*** and ***Australia***. The benefits and limitations of the selected national information systems will be discussed in framework of the proposed NLISB.

2.4.1 Alternative No. 1 (*The Netherlands*)

a) System Review

The Dutch Cadastral LIS is split in two parts, namely :

1. ***AKR*** *(Automated Cadastral Registration) System* : This is the descriptive part, containing the administrative and legal aspects of the registration. AKR is a centralised database system; all databases are physically in one computer centre in Heerlen in the south of the country; however, each of them is accessible in real time (on-line) from its corresponding office.

2. ***LKI*** *(Land Surveying Cartographic Information) System* : This is the cartographic part, containing the geometric aspects or the maps. LKI is a distributed database system; each of the 15 provincial offices have their own central database. Direct data-input in the database is not possible, every activity is handled through so called workfiles (reason : safety and data management).

Each of the above systems is established according to a set of national regulations which are standard and therefore applicable for the whole country. Access to both systems and connection between these systems is performed through the cadastral *Parcel Number*.

Approx. 10,000 of cadastral maps are still in a local coordinate system, and of poor map-quality. These maps need to be improved and stored in the LKI database.

Approx. 20,000 of cadastral maps need to be converted to digital form, either by scanning or digitizing.

b) System Benefits

1. AKR is a centralised database system; the advantage of a centralised database is that all the data is in one place, and is modelled according to one conceptual model. Access to single logical data objects is relatively easy. Everything is homogeneous and compatible. Centralised computing equipment running a single DBMS, with access from remote nodes via terminals and communications lines, is generally cheaper and easier to maintain than computers at each node in the network running their own DBMSs.

2. LKI is a distributed database system, the advantage of a distributed database is that remote nodes can still be partially operational even if there is a central node hardware/software or communications failure. The distributed approach should also avert a possible communications bottleneck, which might arise in the centralised case if data communications lines becomes clogged by large amount of traffic.

3. Connection between AKR and LKI is performed by the cadastral parcel number. There are several interface between AKR and LKI to guarantee that the updating of cadastral information is consistent.

4. The Dutch cadastral system is one of the most complete cadastral systems in the world. It includes completely automated administrative database of owners, parcels, land use and legal rights (ownership, mortgages, etc), and spatial database, with data on boundaries of parcels and topographic data.

5. There is a topological relation between parcel boundaries and cadastral parcel number for the automated process of area computation.

6. The Dutch cadastral system is an open book system, where the public can investigate ' who owns what' at their local land register. And of course they will be charged for that service.

7. Local estate agents can log-in to the system and make queries. And they will billed for the service.

8. The system is expected to return the investments (approx. 150 million Dfl) gradually after 10 years from the starting day of its full operation.

c) System Limitations

1. There is no link or cross referencing mechanism between the cadastre LIS and other LISs in the country such as Utility and Municipality systems.

2. There is no topological relation between neighbouring topographic objects.

3. The system is unable to handle query and data-transport between two systems which operate in different computer environments. AKR runs on IMB-hardware and LKI is build in a VAX-computer platform (Digital).

d) Dutch Model suitability to Bahrain

The Dutch model is found not suitable for Bahrain, for a number of reasons : First, the Dutch model is purely a cadastral model with very little consideration for integration with other LISs in the country. Therefore this model is unable to support data flow and data share operations between various land-related databases. Secondly, the cadastral databases are physically in one

computer centre, access and querries to each of them can only be done from the database corresponding office and from the main cadastral office in Apeldoorn. This means that the model unable to support access and querries between the cadastral databases themselves. Thirdly, The Cartographic model of the Dutch LIS, does not support any sort of topological relation between neighbouring topographic objects.

2.4.2 Alternative No. 2 (*Sweden*)

a) System Review

The *Swedish Land Data Bank System* is an on-line system built up around a central computer. The structure of the database is, however, decentralized; i.e data from different regions (counties) are stored in physically separated databases which operate independently. The primary users - the Real Property Register and Land Register Agencies - use display terminals and printers connected to the computer via leased telephone lines.

Information retrieval from display terminals is possible for banks, municipalities, property formation agencies, brokers, insurance companies and major users of land information.

Only the Real Property Register and the Land Register Agencies are permitted to update the register contents and they are only permitted to change data concerning their own jurisdiction; information retrieval is not limited in this way; each display terminal has access to any part of the system.

The contents of the Land Data Bank System are mainly based upon documents and records kept at the Real Property and Land Register Agencies. The contents are a selection of the information that is most frequently used.

Formally, the contents of the Land Data Bank System are divided into a real property register and a land register. The real property register contains facts on such items as area, location, land use plans etc. Responsible for the contents of the real property register are the Real Property Register Agencies.

The land register contains information on legal-economic matters concerning the real property units, for example information about owner and mortgages. The responsibility for the register contents rests with the Land Register Agencies. The Land Data Bank System also contains information on taxation derived from the real property taxation register.

b) System Benefits

1. Property registration is performed by two independent operators. The system checks that the registered data are identical and plausible; there is no need for manual checking.

2. The computerized registers and procedures of the Land Data Bank System have the same

legal validity as the manual ones, and the State guarantees the correctness of its registers.

3. The Swedish Land Data Bank can be used not only for purposes of registration but also to aid other activities which use information on real property, such as planning, banking and real estate brokerage. Interested parties can obtain data from the data bank in several ways:
a) by direct access on terminals.
b) by ordering extracts or maps.
c) by subscribing to the data bank's system of notifying changes.

4. The system has made the process of property registration faster, cheaper and more efficient. The Land Data Bank would, at the same time, serve as a land information system (LIS), storing easily accessible data on land.

5. Information collected by Statistics Sweden (such as census information and statistics on population, housing and farming) are linked with the Land Data Bank System.

c) System Limitations

1. The system is not integrated with any external land-related information systems such as physical planning and utilities.

2. It is a basic principle in Sweden legislation that citizens have the same access to information as authorities. The entire register contents is open. The same rules apply to the Land Data Bank System as to the earlier manual registers.

3. The system does not include detailed information on buildings. And buildings are not assigned unique identifiers to make it possible to link information to the unique object.
The Land Data Bank contains information on buildings already, for example on assessed value, usage and coordinates, but the information cannot be assigned to a particular building.

4. In changing from manual systems to computer systems, there were a reduction of staff (job lose) by 50 to 70 percent (relative to the country).

d) Swedish model suitability to Bahrain

Although the swedish model is a very well design LIS model, it is not suitable to Bahrain for the following reasons : First, it is mainly designed to support property registration, where different users such as Banks, Municipalities, and Estate Agents can get information on real property via direct access on terminals or ordering extracts. Secondly, the Swedish model does not support integrating with other LISs such as municipalities LIS, utilities LIS, or planning LIS.

2.4.3 Alternative No. 3 (*Australia - New South Wales*)

a) System Review

By the time the State Government decided to establish an integrated land information system in 1985, New South Wales had a number of agencies with well developed land information systems of their own. While there were fairly advanced of their type (including a leading edge electronic titling system and a graphics-based utility management system) they were on different computers with incompatible operating systems.

The solution adopted to the State's land information management problems was to establish an integrated state-wide land information system. As a first step towards this goal the State created a 'State Land Information Council' which has the following functions :

* To develop and control the state land information system in the form of a linked network of individual subsystems introduced gradually.

* It has the responsibility of setting principles, standards and promotion of orderly development of the system.

* It should control and coordinate further developments such as modifying an existing system or developing a new one.

The model adopted for the integrated land information system is called '*A Hub network model*' where the Hub would operate as an 'LIS Centre' by having a central database containing an integrated information from different databases. This model is diagrammatically portrayed in Figure 2.1 .

Each agency has a copy of its database in the 'NSW LIS Hub' which will be integrated with other information from different agencies. Those copies are updated automatically by the owners every night.

With LIS Hub as a core computer system a one-to-many approach was adopted instead of the many-to-many approach.

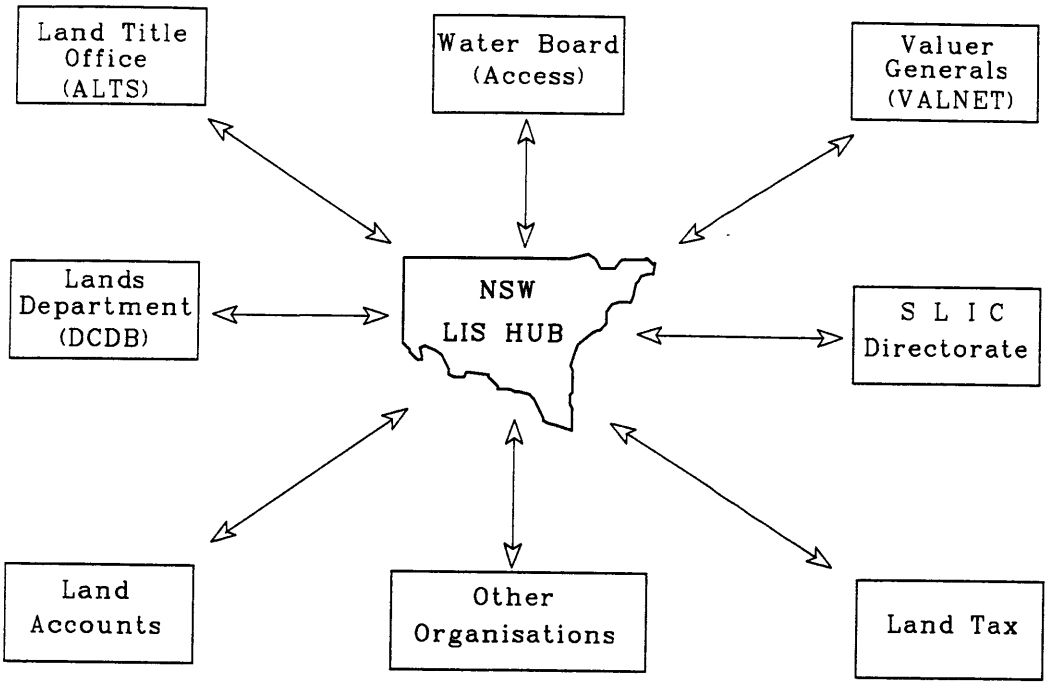


Figure 2.1 : A Hub network model

b) System Benefits

1. Instead of the many-to-many data sharing relationship between land information systems in the state, a one-to-many relationship was adopted with LIS Hub as the core computer system designed to manage and redistribute the state's key land data. Because it gives the agencies the facility to contact one body to obtain composite land-related data.

2. Clearly, the integrated data in the LIS Hub was a very useful commodity because it obviated the need to contact a number of agencies to obtain composite data about a single (or many) parcels of land.

3. Changes in the data items occuring in the agencies databases are electronically transmitted to the LIS Hub the night following the change.

c) System Limitations

1. It appears that LIS Hub would duplicate rather than reduce data storage.

2. Although a number of agencies in the State have already established significant

computerised land data or land information systems of their own, no one system covers all parcels of land in the State. Further, each system uses different methods of identifying the land parcels and data items held within them.

3. Difficulties in modifying existing systems to supply data to and receive data from the LIS Hub.

d) Australian model suitability to Bahrain

The Australian model with its LIS Hub operates as LIS Centre in which information from different databases are integrated and stored in a central database, can be consider as the best alternative among the foregoing alternatives (No.1 and No.2), but it is not good enough to suit the situation in Bahrain for a number of reasons : First, the Australian model is based on users' requirements which for sure are different than the users' requirements in Bahrain. Secondly, it seems that LIS Hub is duplicating rather than reducing data storage. Thirdly, this model requires modifying existing systems to supply data to and receive data from the LIS Hub.

2.4.4 Conclusion

From the foregoing and considering the Bahrain situation's (as described in Chapter 3) no one of the alternative models will suits Bahrain 100%, because each country has its own unique problems, difficulties, and requirements. System's benefits in one country could be a limitations in another and vice versa. A land information system (LIS) is unique to individual countries. The approach of copying a NLIS model from one country to another is a big mistake which every country must avoid, because simply it would not work due to different user requirements, problems and environment (social, political and economical).

Therefore we need a new NLIS model which suits the situation in Bahrain, and be a solution for some of land management problems in Bahrain.

Chapter 3

Situation Analysis of the information infrastructure in Bahrain

3.1 Introduction

The success of a Geographic Information System (GIS) will be measured by its capability to meet the users needs comprehensively and consistently. Any failure of the GIS to meet its objectives may not be due necessarily to technical reasons, but more probably to the fact that the real needs and the working environment of the user community are poorly defined or understood. Once the proposal to develop such a system is approved, the information requirement forms the essential first step in development.

3.2 Fieldwork

To determine information requirements and to validate the concept of a National Land Information System, a fieldwork of 3 weeks was arranged to Bahrain. The fieldwork had two main stages of investigation: the first, involving over 5 interviews, with key personnels at the selected governmental departments :
- Survey Directorate (SD)
- Land Registration Directorate (LRD)
- Physical Planning Directorate (PPD),
- Central Planning Unit (CPU),
- Central Population Registration (CPR),
- Central Municipal Council (CMC),

to identify the character and extent of geographically related data held and used by them; the second, based on a detailed questionnaire (Appendix A), focused on the information flow (data in - data out), processes, frequency of use and availability of the principal data sets utilized within the organization. The main duties and responsibilities of the above organizations are shown in Appendix B section 1.

3.3 Difficulties

The task of defining user requirement was a difficult one due to the following reasons :

a) The limited time of the fieldwork compared to the tasks it has to cover.
b) The uncertainty of some departments about their requirements.
c) The conservative attitude of some departments (for political or behavioral reasons) to provide information about their requirements.
d) The limited interview time (max. 1hr) by key personnels at the selected governmental departments.
e) Some answers are outside the scope of some questions.
f) The majority of key personnels could not answer the questionnaire due to their busy

schedules.

g) The absence of some key personnels (annual leaves) during the fieldwork period.

For these reasons, the fieldwork was not successful as expected. However, key questions such as what is the mandate of the selected organizations ? their functional responsibilities, were answered in some detail. This will help to identify the data type needed, and operations to be performed by each organization in order to fulfil their mandate.

3.4 Problem and Deficiency Areas

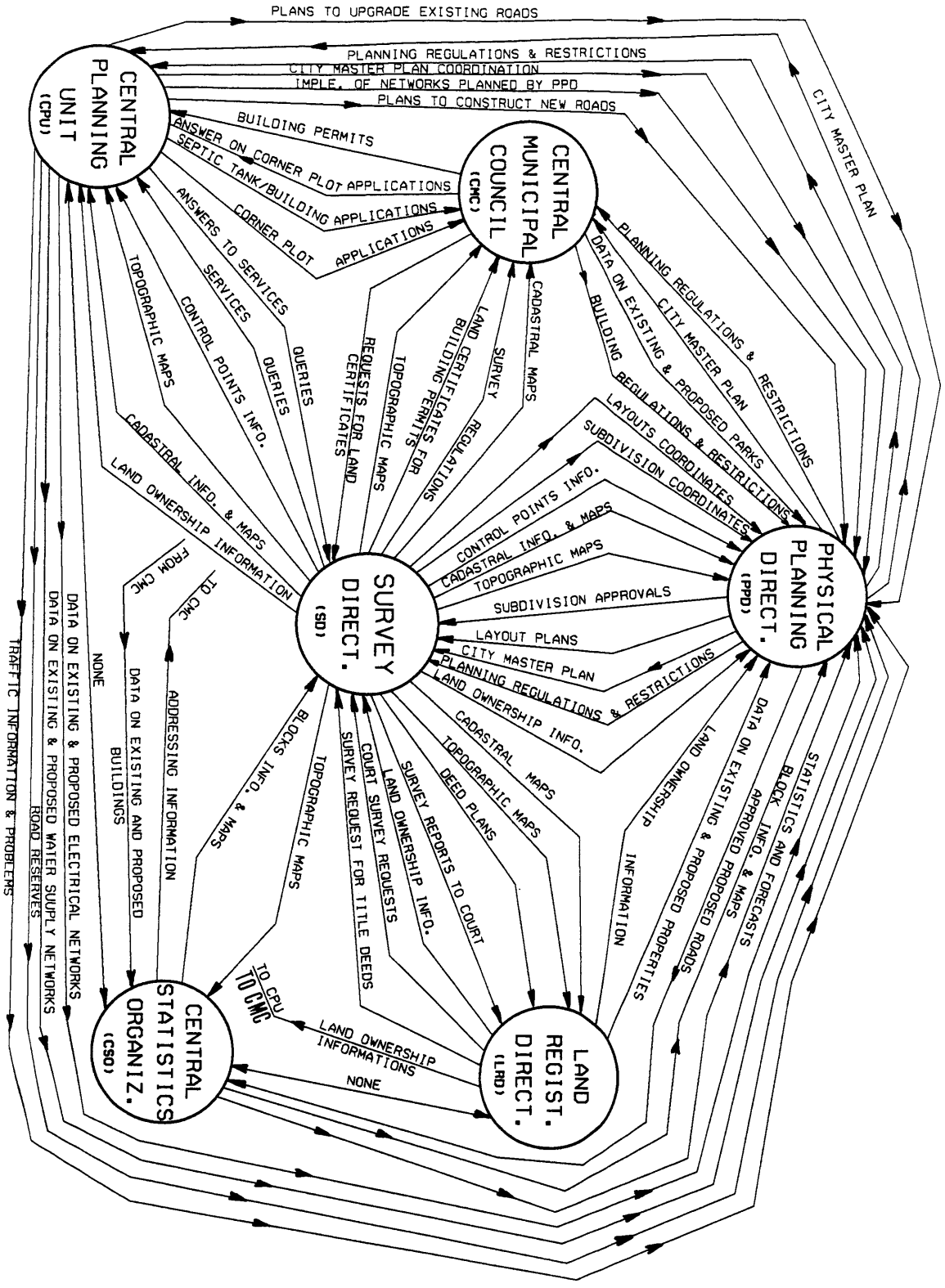
The sharing and exchange of data and information between government organization in Bahrain is not restricted by any form of legislation, but the constraints in institutional support; different level of automation and unawareness seems to be the major drawback which has resulted in the under utilization of information. The problem and deficiency areas in the existing situation are presented below :

3.4.1 Current Data Exchange

As shown in Figure 3.1 there is a heavy data exchange traffic between the selected organizations. But the current data exchange procedures adopted by those organizations suffer from some defects; those defects can be stated as follows :

a) *Media of Deliveries* : In most cases, the media by which the required data is transferred from one organization to another is hardcopy (maps, reports, figure lists, printouts, etc.); this media of delivery is inadequate for many organizations. For example, Central Planning Unit (CPU) prefers to have planning plans from Physical Planning Directorate (PPD) in digital form instead of hardcopy maps. Ministry of Works, Power and Water (MWPW) and Ministry of Housing (MOH) had overcome this problem by purchasing parallel computer systems and as a result, now a steady transfer of data by 'mag. tapes' between the two systems. In some organizations such as Land Registration Directorate and Central Municipal Council (CMC), plans to computerise their current manual systems have low priority (for financial or political reasons).

b) *Method of Deliveries*: Between all organizations the required data (maps, reports, lists, printouts, mag.tapes, etc.) is collected physically by messengers. The required data can be collected after at least 3 weeks from the time the data request is received. Local networks are used to transfer data between departments within one ministry such as Ministry of Housing (by the end of this year) and Ministry of Works, Power and Water.



Note : This is not the proper way to show the data flow, but it is done only to give an overall picture of the directions and amount of current data flow.

Figure 3.1 : Data Flow Diagram (DFD)

c) *Duration* : Currently there is no organization which can supply the required data within a time frame that meets the needs of the external users. This is because of the adopted tedious paper work routines and procedures, or because the receiver has failed to send his messenger to the sender to collect the data on the time specified. For example, Survey Directorate (SD) has to wait 6 weeks for services queries answers (is a particular parcel affected by an electrical cable or water pipe or telephone line or sewerage line) from the Central Planning Unit (CPU). This is because CPU has to pass the queries to the organizations concerned, wait for their answers and pass them to SD.

3.4.2 Constraints to Data Exchange

Constraints to data exchange have limited the cooperation between the organizations and reduced the value of information. The value of any information system lies in the extent of its use. In no order of priority, constraints to data exchange in Bahrain are discussed below

a) *Lack of National Data Transfer Standard* : Standards can remove any misunderstanding in term of data meaning between the sender and receiver because they speak the same language. Currently in Bahrain there is no standardisation of data format which enables electronic data transfer to be made. As a result, the information is exchanged in most cases as hardcopy and in a form which the producing organization can provide, not necessarily in a form which the receiving organization needs. The absence of national data exchange standard has lead to redundant data existing in many computer installations caused by the frequent re-keying of information into different organization computer systems. Most organizations are aware of the importance of the standards for exchanging data but none is ready to take the initiative to establish it.

b) *Information Confidentiality* : Some information held by governmental organizations are classified as confidential information although they are needed by many organizations. For example, addressing information held by the Central Population Register (CPR) are classified as confidential information to some organization such as CPU, SD and PPD, and linked through a network with Ministry of Labour and Social Affairs, Ministry of Interior, and Ministry of Health. Also information on free lands (vacant lands) held by the Survey Directorate and Land Registration Directorate are classified as confidential information. This is a political problem which must be solved before implementing any national information system for Bahrain.

c) *Lack of cooperation* : There is lack of cooperation in term of data exchange between some organizations. For example, Physical Planning Directorate (PPD) within Ministry of Housing collects data on building such as use, type, age , etc., by field surveys and investigations, where these information are already held by Technical Affair Directorate (TAD) within Central Municipal Council through building permit applications. Also TAD conducts some land surveying activities to collect road and parcel data, where these information and more are held by Survey Directorate. Central Planning Unit (CPU) receives from PPD an approved city master plan, showing all the proposed roads, sites for services, recreation locations,

schools, etc. for a particular city. CPU uses this plan as a base for their services and utilities planning. Currently PPD modify those plans without reporting the changes to CPU which already has spent thousands of Dinars in roads design, roads construction, and trenches digging. This lack of cooperation cause a duplication in data collection and recording, and cost the government millions of Dinars every year.

3.4.3 Who Owns What ?

The majority of the organizations interviewed do not know fully what type of data are held by other organizations. Organizations do not have data directories, which documents what information exists, its type and characteristics, where it can be found, how it can be retrieved, is it confidential and how much does it cost. Such directories can provide the users (external+internal) with sufficient information to judge the usefulness of the data sets without requesting it and wait for weeks for negative results. For example, Central Population Register (CPR) supply statistical information to different organizations as requested; CPR has to write a specific computer programmes to extract the different information required from its databases to satisfy different information requests and submit the results in a form of hard copies.
Presently, government organizations never thought about producing such directories because they have not realize yet their benefits in data exchange processes.

3.4.4 Existing Information Systems

The majority of government organizations have a computerised information systems for their own needs and applications (see Appendix B section 2.2). The existing systems are isolated, dedicated information systems established by different government and semi-government organizations with, it appears, little of consideration for the coordination of production, sharing and use of geographic information.

a) *Survey Directorate (SD)*, held all cadastral and topographic maps and their associated attributes in digital form, stored in Intergraph system. Physical Planning Directorate (PPD), held some of their plans also in digital form and uses the cadastral and topographic maps as background for their proposed plans. The two directorates are currently in the process of upgrading their information systems, and at a later stage of development, to link the two systems to give users the illusion of working with one system called *Bahrain Land Information System (BLIS)*. BLIS will be the key digital system to store, retrieve, analyze, update and report every piece of land in Bahrain and its related information held at SD and PPD. This proposed land information system will be based on the latest digital technology. The system will use Modular GIS Environment (MGE) GIS software on Unix Workstation/Server and Oracle RDBMS. This system will allow the Ministry of Housing to communicate with other organizations as one unified cell (node).

b) *The Ministry of Works, Power and Water (MWPW)*, with responsibility for the majority of the services authorities, and *Ministry of Housing (MOH)*, with responsibility for the capturing, updating and dissemination of cadastral, topographic and physical planning information, had realized the potential benefits of a common system based upon digital mapping.

As a result the two ministries started down a familiar road of purchasing parallel computer systems with a view to future networking. The physical join still lies in the future but there is now a steady transfer of data by 'mag.tapes' between the two systems.

c) *The Central Planning Unit (CPU)*, operates like a global server. Data requests from any directorate within the MWPW to external agencies as well as data requests from external agencies to any directorate within the MWPW must pass through the CPU. This is to avoid duplication of data requests, to manage and control data exchange between the MWPW and the external agencies, and to allow MWPW with its many directorates to communicate with the external agencies as one unified cell (node).

MWPW has one central database called Graphic Centre; it consists of two systems; all graphic design files are stored in Intergraph Graphic Design Software (IGDS), and alphanumeric files are stored in Database Management and Retrieval Software (DMRS). Currently there is no link between the graphic design files stored in IGDS and their associated attributes stored in DMRS.

As illustrated in Figure 3.2, each directorate within MWPW has a directory at the Graphic Centre; this directory hold all design files and their associated attributes belonging to a particular directorate (water, electricity, or roads etc.) with read and write facilities. A directorate can access its own files stored at the Graphic Centre via a remote terminal or workstation, and for consultation and planning purposes, it can access with read only facility files belonging to other directorates. A common directory containing cadastral and topographic design files loaded from Survey Directorate via mag. tapes, can be accessed by all directorates and use the cadastral and topographic design files as referenced files.

d) *The Central Population Register (CPR)*, within the Central Statistics Organization (CSO) is a directorate in the CSO. CPR consists of 3 registers; population register (name, CPR No., address, and occupation), companies and establishments register (name, number) and building register (address, type). All three registers are linked together so that knowing the finder in one register, the associated information from other two registers can easily be found. For example if you know the CPR No.(Civic No.) of a person you can know where he is working and where he is living.

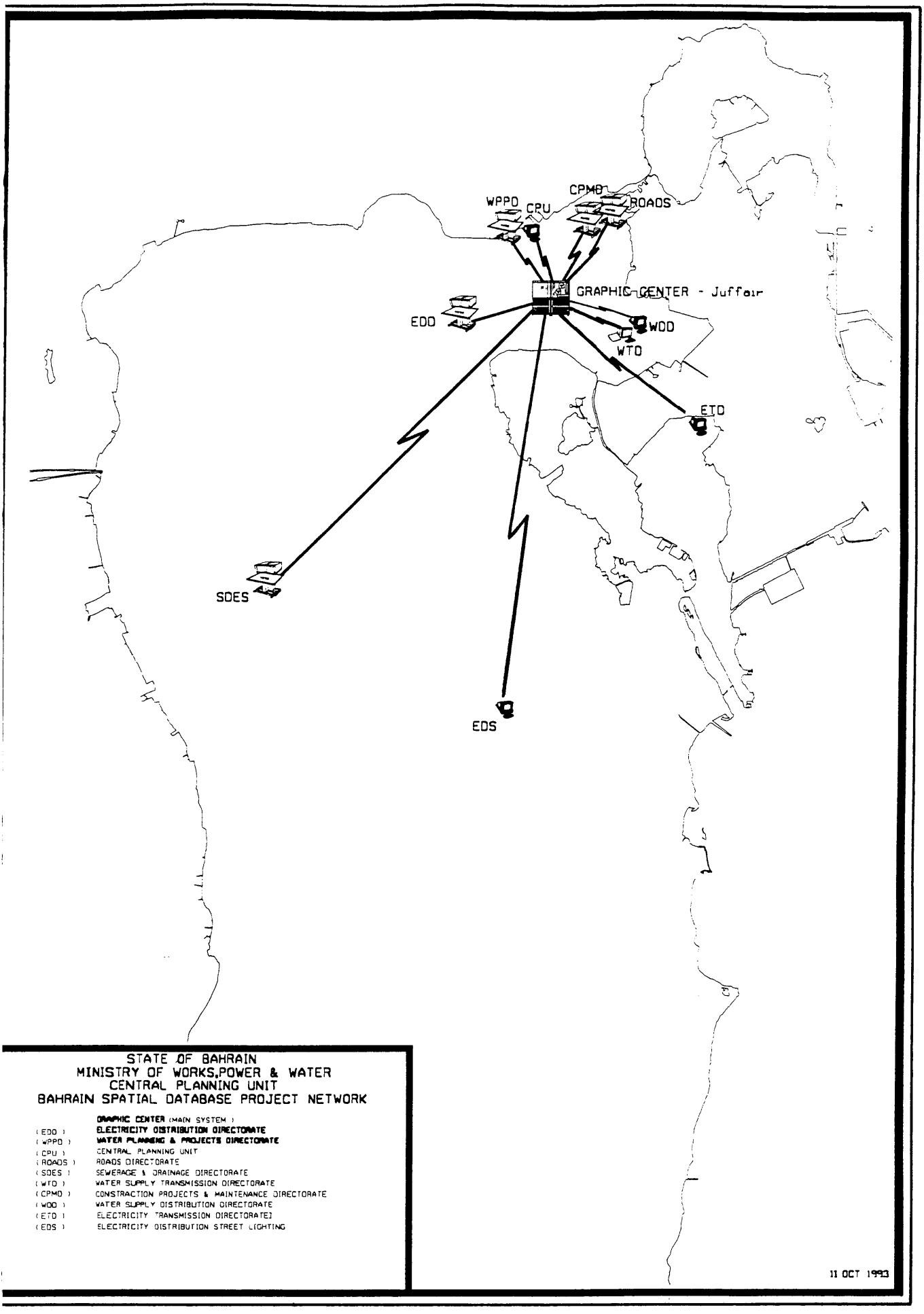


Figure 3.2 : MWPW computer system configuration

e) *Land Registration Directorate (LRD)* and *Central Municipal Council (CMC)* are still functioning using manual systems. Some processes in those systems need to be computerised; the computerisation of such systems requires the capture of hundreds of maps and records in digital form. With costs being high in terms of equipment and resources for data capture and conversion, LRD and CMC are very cautious in making that step. And as a result computerisation has a low priority status.

3.4.5 Data Quality

The quality of information or data directly signifies the quality of the system and its ability to fulfil its users' needs, and is therefore a very important factor for consideration in system development. Generally data quality may be expressed in terms of the following parameters:

- Accuracy (position, attribute)
- Completeness (without omission)
- Currency (timeliness, up-to-dateness)
- Appropriateness (fitting or relevant use)

Most data produced by government organizations are accurate, appropriate and complete enough for the internal and external use. But in terms of up-to-dateness, some information is still out of date. For example, information on land ownership held by Survey Directorate is always out of date due to the fact that ownership transfer cases which do not need a field survey are not reported to the Cadastral Division in Survey Directorate; but a number of organizations take land ownership information from Survey Directorate instead of Land Registration Directorate (LRD) because LRD with their manual system can not retrieve the required information within a time frame that meets the needs of the user.

Also digital maps showing electricity and water networks are 6 months out of date and in some areas even more than that. The two directorates are working hard in the updating process and in capturing uncharted underground electrical cables and water pipes.

3.4.6 Institutional Requirements

a) *Users Views* : Different users require different views of organizational information. Multiple views are essential to decision making process; a single decision maker requires different data sets from different databases (organizations) to formulate a correct decision. Ministers, managers, politicians, and researcher are a special user group who require a special type of data sets such as statistical figures based on certain criteria, small scale maps containing specific features or list of facts on specific date, etc. In Bahrain no organizational information system can support those user groups and even no organization has thought about them. The common practice now, when a minister needs different data sets from different organizations, is that one organization has to write a computer programme as fast as possible to extract the required data sets, and another organization makes its staff work overtime to meet the requested needs. Most organizations either fail to supply the data on time, or supply

much more data than needed, and it is up to the minister to extract the data set he needs.

b) *Education and Awareness* : The pressures of day to day work prevent the key personnels at governmental organizations from thinking about sharing their knowledge. Awareness of the value of information to other organizations is limited. A failure to communicate between organizations is a common occurrence.
Organizations tend not to focus on communication as a function of data exchange. The concept of information as something to share is often too abstract. This is further compounded by ignorance of what information other organization have or do not have. Such problems can to an extent be overcomed by education and awareness.

c) *Research Concept* : I explained the concept of my research to some government officials and I showed them the information infrastructure model for the proposed NLISB (Figure 5.2 in Chapter 5). And I received the following comments :

- *CPU officials* : Such a system will facilitate information sharing; currently information sharing is not satisfied yet. For example, we need addressing information from CSO to better perform our duties and responsibilities; we can not have such information because it is a confidential information. To achieve cross entities data sharing a common standard for data and hardware/software compliant to OSI/ISO standard is a must.

- *PPD officials* : As a concept it is a good concept, but implementing it would be a very difficult task which required a full cooperation of all participants and a powerful committee to impose policies such as financing, legislation, etc.

- *SD officials* : What we need is a national computer network through which the required data flows from an organization to another via remote terminals; with the technology of today it is possible like in airlines and banks. Decision makers can abstract the information they need from the information available on the screen of the terminal; there is no need to make them separate set of data, so no need for your complex model.

- *CSO officials* : In this architecture, updating the external views and hence updating the global database would be an institutional problem which must be solved to ensure the success of such a system.

3.5 Justification for the need for NLISB

As discussed in this Chapter the key information requirements are :

1. Overcome the constraints to data exchange.

2. Develop a national information infrastructure by :
   - establishing the ability to communicate and building links among organizations within the land data community.

- recognizing that data sharing can be facilitated through the use of common procedures and standards.
- establishing partnership for transferring data or for developing common database.

3. Create a national LIS Centre as a core computer system to :
   - control land related information transfer and exchange.
   - distribute up-to-date land related information.
   - provide access to integrated land related information.
   - enforce policies regrading legislations, data usage and access, standards, integrity, education, and finance.

Therefore it is apparent that, the organizations' greatest inadequacy has been exhibited in the field of information supply. The information and data that each organization possess is vast and part of it is needed by other organizations to serve as a tool for carrying out their duties and responsibilities and for legal, administrative, planning and economic decision making, which could ultimately save the government a lot of revenue; but the format of the data and the policies of the organizations constrain the easy flow of information and hence limit the full utilization of the information. Information flows must occur between organizations and cross disciplines for the creation of a better information base for a broad range of applications at the national level.
It is recognized that each organizational system is individual due to institutional, administrative and legal factors; however many of the problems and solutions are common to other systems.

Specific advantages of a NLISB include :

- Provide the key personnels and decision makers at many organizations with a comprehensive and up-to-date source of land-related information (spatial and non-spatial).
- Facilitate and speed up the information flow process.
- Save cost and time in data collection and recording.
- Reduce greatly paper handling.
- Provide the required data within a time frame that meets the needs of the users.

It can be concluded that the existing situation has much to be improved upon. It is evident that new objectives and policies will have to be formulated to provide better cooperation between organizations and thus enforce information integration and decentralization. Suitable changes in technology will have to be supported by appropriate changes in legal, administrative, organizational and operational aspects of the systems to overcome the existing problems. And above all the need for such changes should be realized at the highest level of management in each organization.

Chapter 4

Federated Database System (FDBS)

Issues related to Concept, Standards, Integrity and User interface

4.1 The Concept

A database management system allows an organization to centralise its data in a single system which is often found practical by users for reasons such as data maintenance, data currency and data security. But there are certain data types (e.g land-related data) which are common to a number of user groups. One group may need to use the data collected and stored by another group. Therefore user groups should have access to the data of other groups over a network.

The integration of existing databases into a composite database is in general quite difficult. This is because each database has its own conceptual model and data structure which are suitable for their specific applications and that means that we will have as many conceptual models and data structures as the existing databases. For example, one database may represent a parcel by links among nodes, arcs, and owner(s) while another database may represent the parcel as a distinct object with links to the owner(s). If a composite database approach is used, one or other of these conceptual representations must be selected, and the applications using the other representation may need modification. Thus, the composite structure may be difficult to construct, and if it can be constructed, it may be suboptimal for many user's needs.

In light of the difficulties posed by composite database, it is appropriate to pursue an alternative architecture that allows the existing database systems to maintain their autonomy, yet provides a substantial degree of information sharing.

The coordinated sharing and interchange of computerized information can be controlled among autonomous databases by a ***Federated Database System (FDBS)*** which is a collection of independent and possibly heterogeneous database systems united into a loosely coupled federation in order to share and exchange information.

The basic elements of the federated architecture are components, of which there may be any number; components represent individual information systems that wish to share and exchange information. A component may be viewed as an autonomous database. The components must maintain as much autonomy as possible; however, the components must be able to achieve a reasonable degree of information sharing. The federated architecture must balance the two conflicting requirements (as much autonomy as possible and reasonable degree of information sharing). Autonomy, specifically refers to four capabilities [Hiembigner and McLeod, 1985]:

1. A component must not be forced to perform an activity for another component. The role of centralized authority must be replaced by cooperative activity among components and supporting protocols.

2. Each component determines the data that it wishes to share with other components. Since partial, controlled sharing is a fundamental goal of the federated approach, each component must be able to specify the information to be made available as well as to specify which other components may access it and in what ways.

3. Each component determines how it will view and combine existing data. In a composite system, all access to the underlying data is mediated by a global schema. In a federation, each component must be able to, in effect, build its own global schema that is best suited to its needs.

4. A component must have 'freedom of association' with respect to the federation. Since the federation is a dynamic entity, a component must be able to dynamically enter or leave the federation. Further, a component must be able to modify its shared data interface, adding new data and withdrawing access to previously shared data.

The federated architecture must provide mechanisms to support information sharing. Specifically, components can communicate in the following three ways :

1. ***Data communication*** : Each component has a collection of data, and other components may be interested in accessing some portion of those data. Exchanging the data is the primary activity in a federation, and so a mechanism to support data sharing is essential to the operation of a federation.

2. ***Transaction sharing*** : A component may not wish to share its data directly, but rather to share operations upon its data. This may be the case if the data are sensitive or have consistency constraints attached to them. In any case, components must be able to define transaction that can be invoked by other components.

3. ***Cooperative activities*** : In a system of autonomous components, the only way that the federation can function correctly is by cooperation. Components must be able to initiate a potentially complex series of actions involving cooperation with other components. Cooperation in this context refers to negotiated data sharing [Heimbigner and McLeod, 1985].

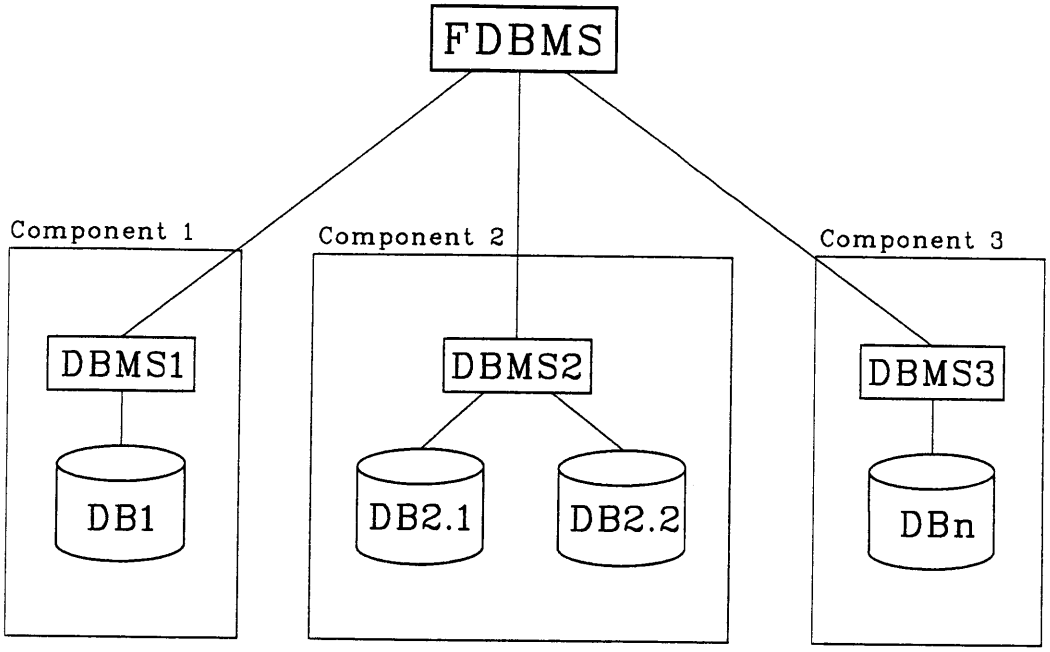


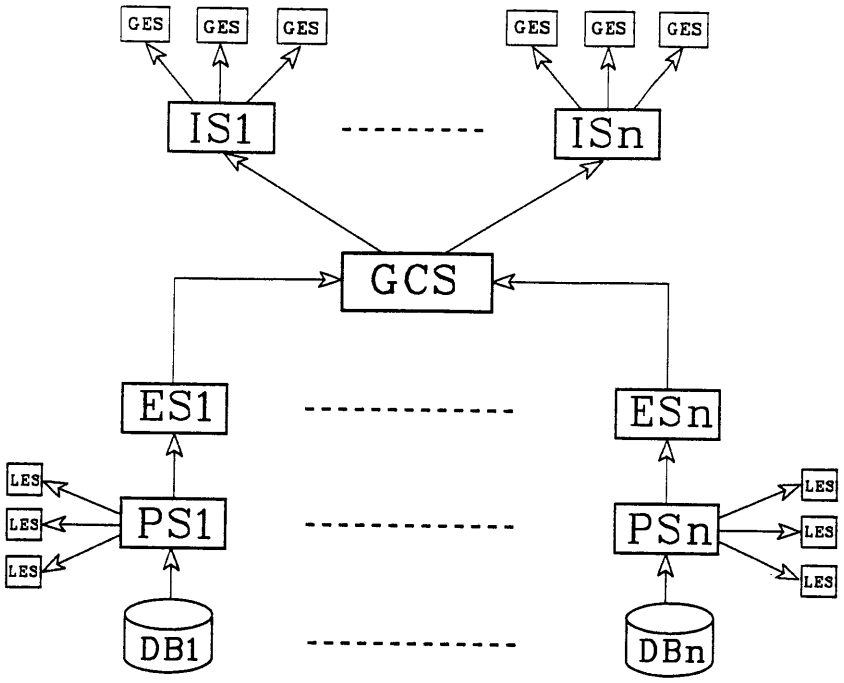
Figure 4.1 : The FDBS and its components

A component has associated with it three schemas, each of which describes some class of information important to the proper functioning of the component. The three component schemas are the *Private Schema, Export Schema,* and *Import Schema.*

1. ***Private Schema*** : The private schema describes that portion of a component's data that is local to (stored at) the component. The bulk of the private schema is devoted to describing the application data available in the database of a component. This portion of the schema, as well as the data it describes, corresponds to a normal database in a nonfederated environment.

2. ***Export Schema*** : The export schema portion of the component specifies the information that the component is willing to share with other components of the federation. The export schema consists of a collection of types of maps denoting the information to be exported to other components.

3. ***Import Schema*** : The import schema of a component specifies the information that the component desires to use from other components. As for the other two schemas, the import schema deals both with federation-specific and application-specific information.



GES - Global External Schema (external user groups)
IS - Import Schema
GCS - Global Conceptual Schema (general model)
ES - Export Schema
PS - Private Schema
LES - Local External Schema (local applications)
DB - Local Database (component)

Figure 4.2 : Different levels of FDBS schemas

4.2 Digital Geographic Information Exchange Standards

Geographic information can be defined as any information which is geographically referenced (e.g. maps). For example, map of land parcels, with each parcel annotated with a legal description as well as the owner's name and address. Digital geographic information is geographic information that has been encoded into a digital form. The encoding is done to enable computers to read, store, process and display data according to the user needs.

GISs often are implemented in organizations where geographically referenced data and special analysis programmes reside on departments; geographic data usually is maintained on systems including microcomputers, minicomputers, or mainframe. The potential need to integrate, share and exchange digital geographic information between organizations to support geographic data management and applications in a federated environment requires a host of

technical, financial and legal agreements and protocols between participating organizations (components). One of the most important agreement the participating organizations must agree upon to facilitate data sharing and exchange is an exchange standard. Geographic information exchange simply refers to the flow of digital geographic information from one information system to another. The exchange standard can be defined as a collection of agreements between sender and receiver that enables and assures the receiver's unambiguous understanding of the geographic information that the sender intended.

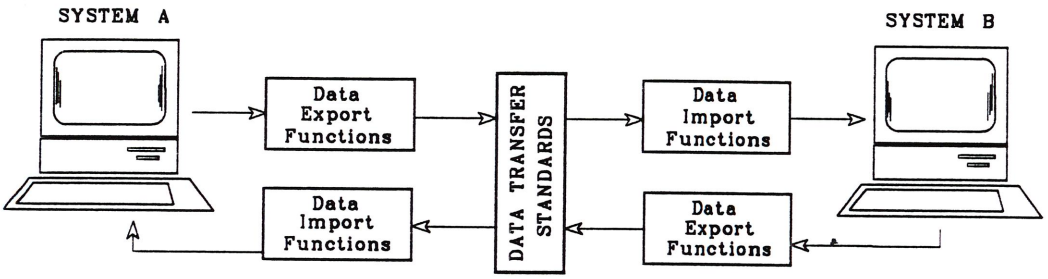


Figure 4.3 : Digital data exchange standard

Digital geographic information exchange standards are important because of the following reasons :

1. ***Data sharing*** : To encourage and facilitate the integrating, sharing and exchange of data sets between various organizations. This of course give more value to the organizational data. A generally accepted standard will simplify the problem of data exchange through a gradual elimination of unnecessary differences between formats.

2. ***Cost savings*** : Digital geographic information is expensive to capture. Therefore, whenever the required information is commercially available, it is usually more economical to purchase it than to generate it from scratch.

3. ***Efficient execution*** : Many government organizations need geographic information generated and stored by other organizations for the efficient execution of their missions.

4. ***Data integrity*** : General standards and definitions avoid loss of information during the exchange process which can occur due to different understanding or definitions of objects by users.

5. ***Knowledge transfer*** : Knowledge can be transfered from one organization to another via a generally accepted standards that every body can read/write data with. Generally accepted

standards contribute to the understanding of the different types of applications as utility, cadastre and different types of government applications.

6. ***Updating*** : Generally accepted standard contribute and support the process of updating a database using multiple sources.

7. ***Quality improvement*** : Often existing LIS data are very different in quality. Improvement of quality is possible by setting a well defined general applicable quality concept (the conceptual standard) and quality registration according to this concept in each of the LIS's concerned.

8. ***User protection*** : Increasing privatization and cooperation make users more dependant on each other and on the private sector. Well defined standards are a mean to protect the users' interest in the data.

9. ***Data meanings*** : Standards allow the transfer of digital information between non-compatible systems while preserving the meaning of the data being transferred.

UK National Transfer Format (NTF) is a medium independent, system independent, application independent transfer format capable of transferring digital map data or any other spatially related data, which conform to the data models on which the format has been based, together with associated attributes and topology. These data models have been used to define levels of vector data which can be transferred using NTF. In order to transfer data using NTF it is not necessary to have any knowledge of the recipients' database; all the sender is required to do is to encode the data from his application database into NTF, using an agreed data model and coding scheme; while the recipients must translate (decode) the data received from NTF into the internal format of their own databases.

NTF is a powerful tool for use within GIS. It is designed to make the movement of data between databases a standard process which will allow data to be transferred without any limitations on the data content, completeness or consistency. NTF imposes no structure or rules on the transfer but it does ensure that all data and relations are transferred completely. The burden this imposes on system suppliers and indirectly on users is the requirement to create software which can encode their system data into NTF and read NTF data into their systems.

One key to efficient development of federated database system is a standard language and protocol for remote data access. If all of the components in the system would support a common set of data operations, accessible via a standard language, it would greatly simplify managing data sharing and distributed queries. In a federated database system, it is the responsibility of the technical committee to set up a generally accepted standard for digital information exchange, to support the sharing of common data set between the system participants.

4.3 Constraints to Data Exchange

The value of any information system lies in the extent of its use. The acquisition of data has a cost but the data are of no value if they are not put to use, that is if they are not converted into information and used in the process of making decisions.

Integrating data sets from various sources create new products and services. If data are to be treated as a national corporate resource, a number of institutional problems such as *copyright, data ownership, control of access to and use of data, data confidentiality*, and *privacy* must be overcomed prior to any data integrating, sharing and exchanging processes.

To achieve a reasonable degree of information sharing/integration between government's organizations two requirements are essential; firstly the cooperation between them must be increase to a satisfactory level and secondly they must eliminate the traditional reservations that they have about releasing the information they hold.

Constraints to data exchange have limited the cooperation between organizations, reduced the value of information and decreased the revenue. Revenues can be increased by charging for the provision of existing or new information products or services. In no order of priority, constraints to data exchange are discussed below :

1. ***Data ownership and copyright*** : Data cost money and effort to collect. Time and money must be spent by some organization in order to acquire data. For example, a list containing fifty names and addresses of land parcels owners. What is the copyright in such a list ? The traditional answer is that if the list is written or photocopied by a third party there would be a breach of copyright. But what is the legal position if the list is accessed and processed by a computer ?

There has been considerable debate in the courts of many countries, on the extent to which computer software (data and programmes) can be protected by copyright law. If a programme can only be read and used by a computer is it subject to copyright ? I think yes.

The increased capabilities of computer-based information handling systems results in the transfer of data and information more easily, faster and in any volume. Technological change is also increasing the ability to obtain data and information, either with owner's approval or without. It is difficult to establish legal systems that make data more widely available without penalising the data providers. Existing laws are somewhat out of step with a rapidly developing technology and increasingly information-based society.

2. ***Control of access to data*** : Control of access to data poses technical constraint to data exchange which can be in general solved by either restricting the points at which access to the data may be achieved or else by the use of passwords that provide a hierarchy of access rights. Control of access to data increases data security, but if its level is higher than necessary it will be a constraint to data exchange.

3. ***Information confidentiality and privacy*** : Some organizations are spending time and money to collect a huge amount of data, using only some of it for their activities (applications) and storing the rest in stores in case of hard copy data or in mag.tapes in case of digital data. That data could be needed by other organizations and because that data is considered to be a confidential data nobody could use or ask for it. It is a waste of money and time keeping data which can not be used by anybody just because it has been characterized as confidential information.

At the same time, allowing information to be freely available is dangerous and leading to misusage (change, delete and copy) of the information. Governments must have a policy on confidentiality specifying the confidential information and how it can be accessed. If LIS holds confidential information, then permission to release will have to be obtained from the organization concerned.
Information confidentiality sometime has a cultural and social dimensions. For instance, in some societies it is impolite to pry into the affairs of others so that the data that are stored in one part of an organization are considered to be of no concern to another part. Elsewhere the pressures of day to day work prevent people even from thinking about sharing their knowledge. Awareness of the value of information to other people is limited. A failure to communicate between members of an organization is a common occurrence. People tend not to focus on communication as a function of data exchange.
Such problems can be to an extent overcomed by education and awareness.

4. ***High charges for data*** : Many of the problems currently existing within the GIS community, not from who owns data but economically, concerned with pricing information. This latter is of particulary important since the cost of data can account for such a high proportion of the running costs of GIS. High charges for data can make data integration/sharing processes economically difficult to implement; at the same time low or reasonable charges encourage data transfer and make data integration/sharing thinkable.

In the US only modest costs covering copying and media charges are levied on government information under the Freedom of Information Act. Maps produced by the US Geological Survey (USGS) are freely available for use within the USGS and for certain federal activities; and for others the charges only cover the costs of reproduction and distribution. The same is also true for digital data, a policy strongly supported by the private sector who is able to sell added-value products at commercial rates.

The problem of high levels of cost recovery imposed on the users is that it encourages infringement of copyright laws. Government's policy on charging must be very closely linked to the issue of data ownership and data usage.

5. ***Lack of National Data Transfer Standards*** : As mentioned earlier, standards can remove any misunderstanding in term of data meaning between the sender and receiver because they speak the same language. Without the common language (standard) communication between them, this will be impossible. Efficient data exchange is the primary reason of the standard existence and development.

If data are sent from A to B then it is assumed that B attaches to those data the same meaning as does A. Without an accepted general standard, this can not be achieved. For example, the concept of a land parcel differs between users; a lawyer may consider a parcel as a legal entity that may extend to the centre line of the adjoining road, while a local authority may only consider the parcel up to the edge of the roadway. Those differences in users understanding of data lead to wrong interpretation and as a result wrong decisions will be made.

With networking between different agencies working in different communities, there is a need for standards for the coding and classification of all forms of spatial data.

4.4 Database Integrity and Security

Protecting a database containing shared data means maintaining high data *Reliability, Security* and *Integrity.*

Reliability relates to the protection of the data against unexpected loss, damage or destruction; the objective is to ensure that the database is always available when it is required, or at least quickly recovered in the event of unexpected damage of some sort.
Security concerns the prevention of unauthorised access to data. While,
Integrity relates to the maintenance of high-quality, consistent, and up-to-date data.

The primary reason why maintaining the integrity of the data in a database environment is that there may be many users accessing the database at the same time. Without careful control their transactions may interfere with each other and render the database invalid and internally inconsistent. The most important integrity protection facility is *concurrency control*; this enables users to access and update the database at the same time without the updates interfering with each other. This database protection is managed by the DBMS, usually under the direction of a Database Administrator (DBA). The major objective of the DBA has been to insure that data integrity and security are maintained in the corporate database.

Data integrity has been defined as "both the accuracy and availability of the database [Weldon, 1981, p.133]".

As mentioned earlier, users may be jointly competing for the same database item. For example, user X may be updating a record while user Z is currently attempting to retrieve the same record. Which version of the record will user Z be working with; the update version or the version prior to update ? Both users should never have to question the integrity of the data item they are working with, thus the importance of *concurrency control.*

Concurrency control deals with the isolation and consistency properties of transactions. The distributed concurrency control mechanism of a distributed DBMS ensures that the consistency of the database is maintained in a multi-user distributed environment. If transactions are internally consistent, the simplest way of achieving this objective is to execute

each transaction alone, one after another. It is obvious that such an alternative is only of theoretical interest and cannot be implemented in any practical system, since it minimize the system throughout.

The level of concurrency (i.e., the number of concurrent transactions) is probably the most important parameter in distributed systems [Balter et al., 1982]. Therefore, the concurrency control mechanism attempts to find a suitable trade-off between maintaining the consistency of the database and maintaining a high level of concurrency.

There are three basic ***Concurrency Control Techniques*** which allow transaction to be executed safely in parallel, subject to certain constraints :

1. ***Locking methods***
2. ***Timestamp methods***
3. ***Optimistic methods***

These methods have been mainly developed for centralized DBMSs and then extended for the distributed case. Both locking and timestamping are essentially conservative approaches in that they cause transactions to be delayed in case they may conflict with other transactions at some time in the future. Optimistic methods, are based on the premise that conflict is rare and allow transactions to proceed unsynchronized, and only check for conflicts at the end when a transaction commits.

1. ***Locking methods*** : Concurrency control in most distributed systems is based on locking, just as it is in most nondistributed systems. In a distributed system, however, request to test, set, and release locks become messages (assuming that the object under consideration is at a remote site). For example, consider a transaction T that needs to update an object for which there exist replicas at 'n' remote sites. If each site is responsible for locks on objects stored at that site, then a straightforward implementation will require at least 5n messages :

n lock requests
n lock grants
n update messages
n acknowledgments
n unlock requests

The total time for the update could thus easily be several orders of magnitude greater than in a centralized system.

The usual solution to this problem is to adopt the primary copy strategy, which works as follows :

* One copy of each replicated object is designated as the primary copy. The remainder are all secondary copies.
* Primary copies of different objects are at different sites (so this is a distributed scheme once again).
* Update operations are deemed to be complete as soon as the primary copy has been

updated. The site holding that copy is then responsible for propagating the update to the secondary copies at some subsequent time.

For a given object R, the site holding the primary copy of R will handle all locking operations involving R (remember that the primary copies of different objects will be at different sites, in general). Under this strategy the set of all copies of an object can be considered as a single object for locking purposes, and the total number of messages will be reduced from 5n to 2n+3 (one lock request, one lock grant, n updates, n acknowledgments, and one unlock request). But notice once again that this solution entails a loss of autonomy; a transaction can fail if a primary copy is unavailable, even if the transaction is read-only and a local copy is available. Another problem with locking in a distributed system is that it can lead to global deadlock. A global deadlock is a deadlock involving two or more sites.

2. ***Timestamp methods*** : Timestamp methods of concurrency control are quite different from locking methods. No locks are involved and there can therefore be no deadlock. Locking methods generally involve transactions which make conflicting requests wait. With timestamp methods, on the other hand, there is no waiting time; transactions involved in conflict are simply rolled back and restarted.

The fundamental goal of timestamping methods is to order transactions globally in such a way that older transactions and transactions with smaller timestamps, get priority in the event of conflict. If a transaction attempts to read or write a data item, then the read or write will only be allowed to proceed if the last update on that data item was carried out by an older transactions; otherwise the requesting transaction is restarted and given a new timestamp.

3. ***Optimistic methods*** : Optimistic methods of concurrency control are based on the premise that conflict is rare and that the best approach is to allow transactions to proceed unimpeded by complex synchronization methods and without any waiting. When a transaction wishes to commit, the system then checks for conflicts and in the event of a conflict being detected restarts the transaction. So we optimistically allow transactions to proceed as far as possible. To ensure atomicity of transactions all updates are made to transaction-local copies of the data and are only propagated to the database when no conflicts have been detected. In the event of conflict, the transaction is rolled back and restarted. The overhead involved in restarting a transaction is clearly considerable, since it effectively means redoing the entire transaction.

In a Federated Database Systems (FDBS), the Global Transaction Manager (GTM) is responsible for maintaining database consistency while allowing concurrent updates across multiple databases. There are two types of transactions to be managed : global transaction submitted to the FDBMS by federation users and local transactions directly submitted to a component DBMS by local users. The basic problem in supporting global concurrency control is that the FDBMS does not know about local transaction since a component DBMS is autonomous. Without knowledge about local as well as global transactions, it is highly unlikely that efficient global concurrency control can be provided. Additional complications occur when different component DBMSs and the FDBMS support different concurrency control mechanisms [Gligor and Popesluzeletion 1986]. Several researchers are currently studying these problems [Alonso et al. 1987; Breibart and Silberschatz 1988; Elmagarmid and

Helal 1988; Pu 1987].

4.5 User Interface for the Exchange of Geographic Data

The exchange of geographic data sets between organizations has always been important specially in federated environment, because data capture is usually laborious, expensive and time consuming. Exchange of data requires conversion of data from one format to another; such conversion requires a sequence of interfaces and software packages.

Geographic data sets are large in volume and application; they can be used in an enormous range of disciplines. Spatial and non-spatial data can be, and are, represented in very different formats in different geographic information systems (GISs). Spatial data in particular can have very complex structural inter-relationship (Peuquet 1984).

Transfer of data between two different GISs requires an interfacing system including a sequence of one or more interfaces, each interface being a mechanism (usually a software package) by which one data structure can be converted into another data structure (Van Roessel et al. 1986).

A widely-adopted interfacing strategy is very important in a federated information system where a group of organizations, within a country, collaborate in defining an interchange format, a '*standard*' format in which each organization will both supply and accept data.

The user interface is the part of a software system that a user interacts with. Normally, we can distinguish between two level of the user interface : The physical level and the cognitive level. The physical level of the interface is typically more obvious, consisting of input and output devices such as the mouse, keyboard and video monitor. In contrast, the cognitive level of the interface is consisting of the underlying model used to present the information, the interpretation that the user then makes, and the intentions that the user then formulates [Intelligent Databases, 1989].

Armstrong et al. (1991) recognised the need for the user interface to be flexible enough to present multiple views to the user. For example some information is readily viewed as a distribution on a map, while other data are better presented in a tabular or graph form. A requirement for a decision support system is the ability for the decision maker to access a variety of information, to view this information, to make changes to elements of the information and to view the effects of those changes in real time. This requires a powerful user interface(s) to retrieve the required information and represent it on an organized screen; it also requires a processing power to perform such tasks.

The interface must be flexible enough to allow users to recover from unintended actions, even after a number of subsequent processes have been carried out. In the dBASE IV environment all files tagged for deletion are kept in the wastebasket until such times as the user chooses to empty this by confirming their deletion. In this way files may be recovered long after their

to empty this by confirming their deletion. In this way files may be recovered long after their apparent disposal.

Also the interface should indicate exactly what is the current status of files, applications or tools. The use of colour changes to show active tools or animation in icons to indicate that some processing is occurring are examples. It is important that these indicators are consistent across applications if the user is not to be confused.

4.6 The Canadian Experience

In 1988, the GIS Division, Natural Resources Canada has consulted the various users within its Sector, and other departments at the federal, provincial levels of governments, suggesting the project of GIS inter-operability and the need for communications between multiple GISs in a heterogeneous environment. The project is called ***Delta-X***.

Delta-X is a federated multi-database system that provides inter-operability between different database management systems (DBMS). It is based on the assumption that each underlying DBMS is based on the client-server architecture and each client workstation is connected to a network that is configured with access to at least one DBMS server.

4.6.1 Delta-X Functionalities

As it can be seen in Figure 4.4, Delta-X is a loosely coupled network of Delta-X servers and Delta-X clients. Clients and servers attached to the same LAN form a Cluster. Clusters are connected to each other via a WAN, which forms the backbone of the Delta-X system.

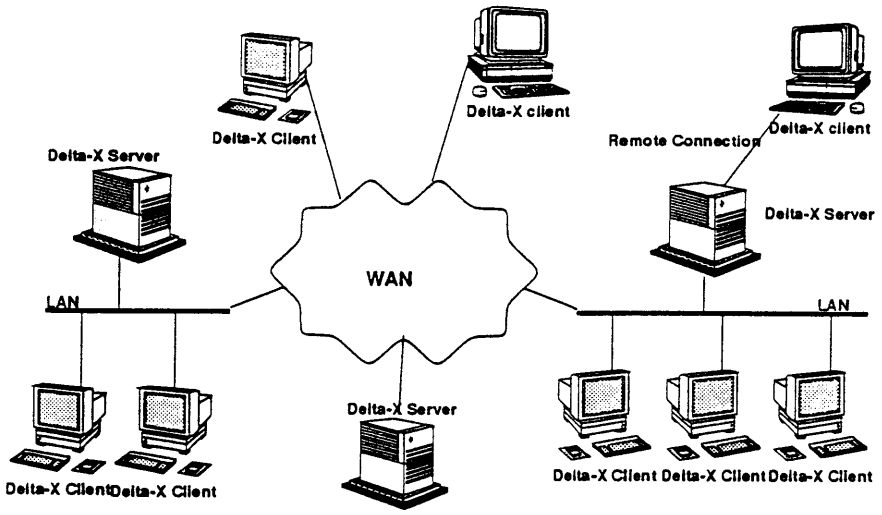


Figure 4.4 : The Architecture of the Delta-X System
[from Jan Medved and Juraj Petras]

4.6.2 Delta-X Clients and Servers

Delta-X has a ***Client*** component and a ***Server*** component. On a Client, Delta-X provides a Graphic User Interface (GUI) that enables GIS users to start and control transfer/conversion transactions and communicates with the server. On a Server, Delta-X provides the client-server and server-server communication software, a module that transfers data, a network management agent, an interface to a database, and a set of data conversion routines.

A client connects to a server, requests a transaction, and then disconnects from the server. When the server finishes the requested transaction, or when it has to report the transaction's status, the server connects to the client and delivers requested data or reports the status.

The Delta-X server is a node in a network of Delta-X hosts which has a data repository containing a part of shared data stored in the Delta-X federation. The Delta-X server performs the following functions :

1. Transaction management and surveillance
2. Data storage, access, and management
3. Data conversion
4. Client-server and server-server communication over a LAN or WAN
5. Naming and authentication for Delta-X clients

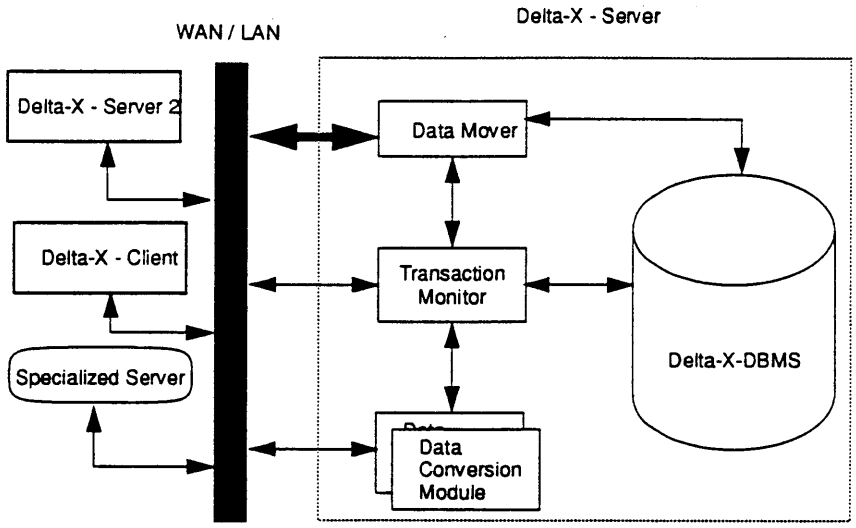


Figure 4.5 : The Delta-X Server
[from Jan Medved and Juraj Petras]

4.6.3 Delta-X System Limitations

1. Delta-X transactions are long-lived, they can take about an hour to complete on a powerful workstation. Therefore, mechanisms must be put in place for the user to inquire about the status of the transaction and to control the flow of the transaction.

2. If possible, Delta-X must allow concurrent accesses to data for as many transactions as possible so that reasonable throughput and response time of the system is guaranteed. This requirement can be easily met, as most accesses to Delta-X data are read-only.

3. Delta-X supports versioning of data - each update creates a new version of the data.

4. Delta-X at present is not able to support collection of data about who accessed which data and when, to support billing for access to data.

4.7 View principle

The conceptual schema (conceptual model) of the individual database provides the global or overall view of the database, but individual users may be interested in particular subsets of the database. Such subsets may be referred to as user views or external views, and may be described by external schema (external model).

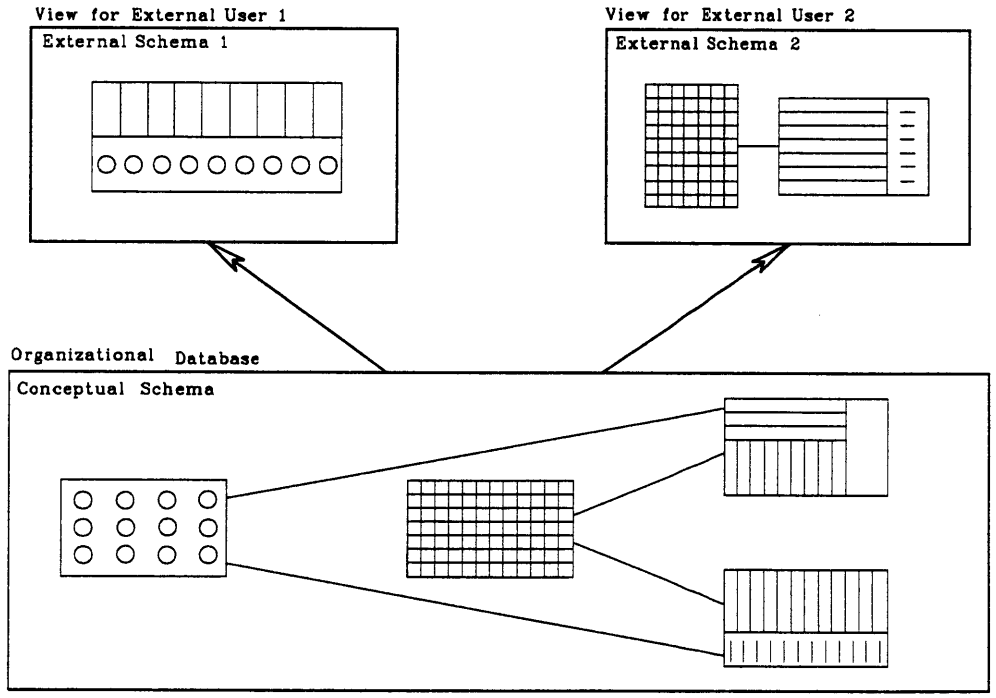


Figure 4.6 : External views (for different users) as a subsets of the database

Different users require different views of organizational information, because they have different information needs and backgrounds (Figure 4.7 illustrates the generation of two views of a single database).

Employee Database

Employee	Location	Department	Salary	Birth
Ali	Henglo	Survey	15,000	1960
Ahmed	Enschede	Public-relation	15,000	1971
Fatima	Amsterdam	Survey	17,000	1958
Adel	Enschede	Computers	23,000	1962
Khalid	Henglo	Computers	20,000	1957
Omer	Amsterdam	Survey	22,000	1963
Nadia	Enschede	Public-relation	18,000	1967
Sharif	Amsterdam	Public-relation	15,000	1955
Radwan	Henglo	Public-relation	26,000	1961

External view for external user 1

Define as - Get department (name, department, salary, birth) where Employee (employee, Henglo, department, salary, birth) and name = employee

Name	Department	Salary	Birth
Ali	Survey	15,000	1960
Khalid	Computers	20,000	1957
Radwan	Public-relation	26,000	1961

External view for external user 2

Defined as - Get payroll - department (employee, salary) where Employee (employee, city department, salary, public-relation)

Employee	Salary
Ahmed	15,000
Nadia	18,000
Sharif	15,000
Radwan	26,000

Figure 4.7 : Different user views of an Employee database

The external schema would generally be derived from the DBMS data model as they must be consistent with the conceptual schema, which is also derived from this model. Each external schema relates to a specific user requirement. Information concerning such requirements would have been obtained during data investigation.

External schemas enable user groups to have their particular view of the database. In a relational system, a view is defined as the result of a query on real relations. A view is a dynamic window in the sense that it reflects all updates to the database. An external schema can be defined as a set of views. Beside their use in external schema, views are useful for ensuring data security in a simple way. By selecting a subset of the database, views **hide** some data. As users may only access the database through views, they cannot see or manipulate the hidden data, which are therefore secure.

For example, suppose that user A is the owner of the entity **PARCEL** with four attributes PID, AREA, C_easting and C_northing. Suppose that he wants to allow user B to access this data only for parcels with an area equal or less than 800 sq.m. A can define a view :

Range of C Is **PARCEL**
Define **800-PARCEL** (PID,AREA,C_easting,C_northing)
Where C.AREA <= 800

A can grant 800-PARCEL to user B. B can now use **800-PARCEL** to access **PARCEL** Id, area and centroid coordinates, but only for parcels with an area equal or less than 800 sq.m.

In a federated database system (or multi-database system), it would be very difficult and impractical for the individual database to provide a specific view for each database (user) in the federation. Instead one standard user view can be created to serve all users needs. Each local DBMS in the federated system defines one standard external schema, which describes the data it is willing to share with others. The standard user view can be created by integrating a set of different user views into a single integrated view.

User views contain requirements for the portion of a database of interest to different users. The result of their integration is the *standard external schema.*

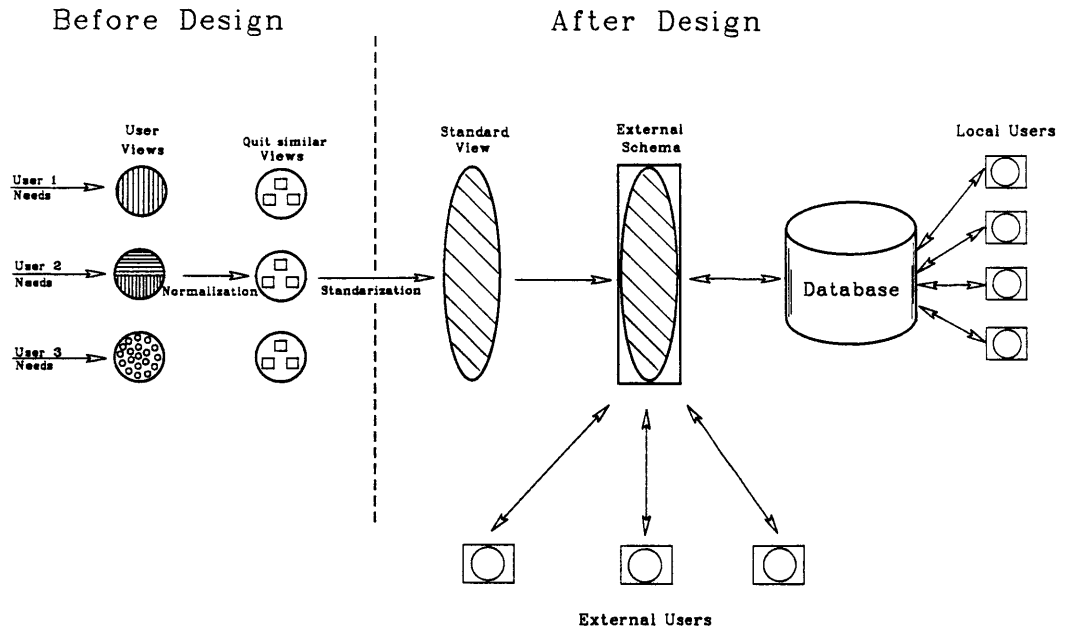


Figure 4.8 : User views standardization

The Architectural model for NLISB which will be discussed in Chapter 5, will based upon the above described '***View***' principle.

Chapter 5

Guidelines for the development of NLISB

5.1 The Proposed Information Infrastructure for the NLISB

NLISB is proposed to be a federated multi-database system that provides inter-operability between different database management systems (DBMS). The inter-operability term describes a distributed system that includes a global component to access globally shared information and multiple local component that manage only information at an individual site.

NLISB will be based on multiple local servers distributed across a wide area network and connected to a single global server. With this architecture NLISB will be a solution for national land information sharing in a distributed system.

Establishing an overall information infrastructure model as a solution to the problems discussed in Chapter 3, constitute the starting point in the development of the proposed NLISB.

The information infrastructure model for interconnected government organizations, with most likely heterogeneous DBMSs, is derived from five goals that must be achieved :

1. Uniform access to remote databases and hence facilitate data exchange, sharing, and flow.

2. Upgrade coordination between existing systems by :
   - reducing data redundancy
   - enforcing data quality control
   - enforcing standards for data collection
   - developing a national standard for data exchange

3. Maintain the autonomy of all databases in the federation : each database is free to join or leave the federation; the system must not be affected by the addition of new database or quitting of an old database.

4. Create a database on national level to support data exchange and national applications.

5. Create a land information centre (LIS Centre) as a federated multi-database management system that provides interconnection between different organizational DBMSs, and facilitates the access to metadata of various databases, e.g. information on specific data sets, ownership, geographic coverage, format, availability, access mode, cost, etc. The LIS Centre can control and manage the data flow between the databases in the federation.

5.1.1 NLISB Architecture

Retrieving information from a collection of independently designed databases is a formidable

task. In a federated system the participating (component) databases typically have different schemas, expressed in different data models, and are implemented on different database management systems, each with its own retrieval language. Formulating and implementing queries that require data from more than one database poses many problems for the user. These problems include resolving discrepancies between the databases, such as differences in representation and naming conflicts, resolving inconsistencies between copies of the same information stored in different databases, and transforming a query from the user's language into a set of queries expressed in the different retrieval languages supported at the different sites.

To resolve discrepancies between the local databases, external schemas (export schemas) must integrated into a single schema (global schema). If the external schemas are expressed in different data models (usually they do) they may be translated into a common model before the integration is done. This process is referred as to a Global Conceptual Schema (GCS) design. Once the GCS has been designed, views over the global schema can be defined for users who require global access. In the case of a federated database system, the GCS represents only the collection of some of the local databases that each local DBMS wants to share with others. In another words, each local DBMS defines an external schema (export schema), which describes the data it is willing to share with others.

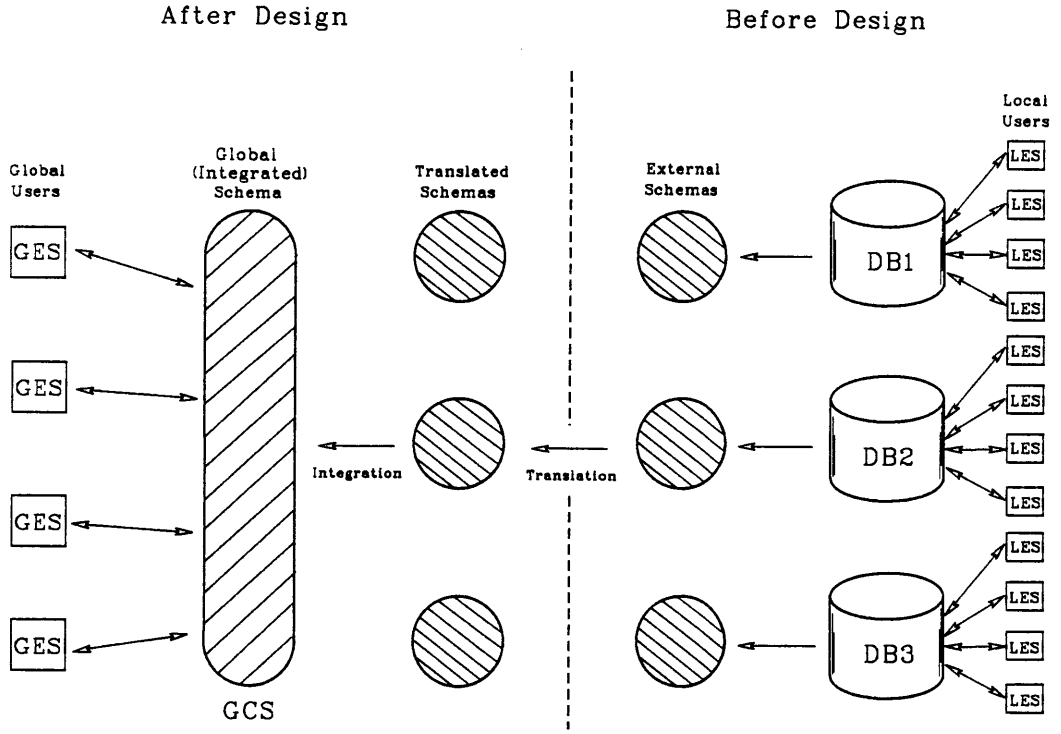
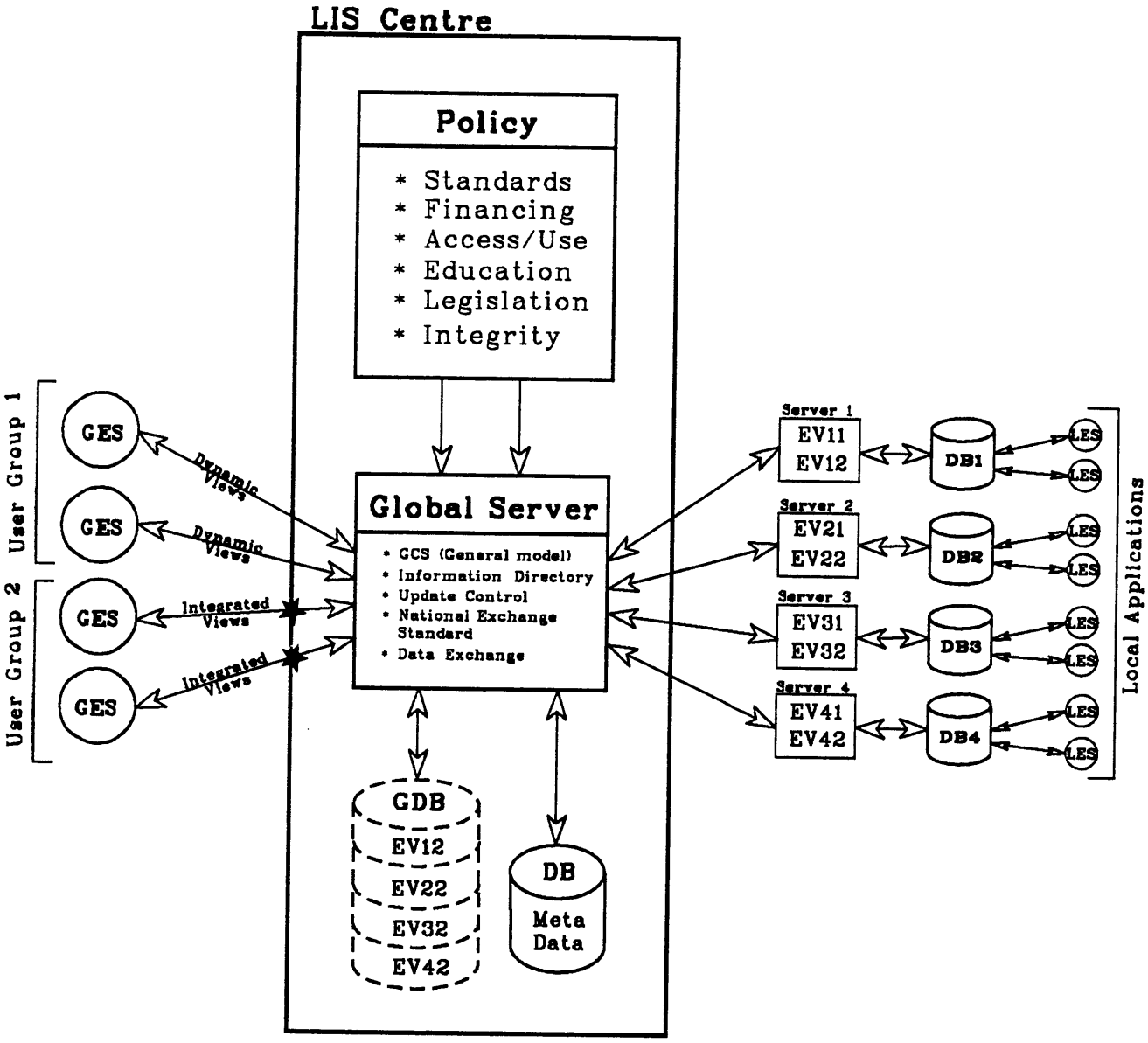


Figure 5.1 : External Schemas Integration

The users (global users) of the global database (GBD) are effectively different users than those (local users) who access only a local database, utilizing a different data model and a different data language.
Therefore local applications have a Local External Schema (LES) defined on the local conceptual schema. While global applications which require the integration of information from different databases (i.e urban planning, environmental studies, etc.) must have a Global External Schema (GES) defined on the global conceptual schema (GCS).

Global users express their queries against the GCS in a common data language. However, since the global database is not physically materialized, these queries must be modified into equivalent queries against the local schemas. Since these queries are still in the common data language, they finally must be translated into programmes that will be executed on the local databases.

The model illustrated in Figure 5.2 is in principle technology-independent. Each participant's database (DB1, DB2, DB3, ... , DBn) contains a specific land-related information plus other types of information, useful for their specific applications; also each database contains a land-related information which is of interest for other participants and in some cases this information is vital for their decision making process. Also some applications on national level (global applications) require integrated information from the participating (different) databases.



★ - User Interface
EV - External View
DB - Organisation's Database
LES - Local External Schema
GDB - Global Database with general standard format (virtual database)
GES - Global External Schema with general standard
GCS - Global Conceptual Schema

Figure 5.2 : The information infrastructure model for NLISB

To accommodate every participant's needs in terms of supply and exchange of undetailed land-related information (e.g. roads network, high tension electricity cables, water supply network, basic topographic maps at scale 1: 1000 and 1:2000, etc.), to support national level applications, and to prevent direct access to the actual departmental databases, which will put more burden on the hosting (local) system reflecting badly on the system response time and the accessibility by the hosting departments to its own files, subsets of the local databases (External Views (EVs)) defined by external schemas can be created describing the data each departmental databases willing to share with others. Those views are nothing but undetailed land-related information needed by the external user groups for their planning and decision making processes.

Each organization needs an access to a facility to find out what information is availabe, determine if this information is of a quality that it can use, and then extract the information for its purpose; and to find out if it will be charged for this service. This facility can be called a "***Global Server***".

The proposed system will serve two global user groups; user group 1, can be the actual organization (system's participants), shown as DB1, DB2, .., DBn in Figure 5.2 who need to exchange/share data and may need an integrated data from more than one database. And user group 2, who required a specific integrated information to support their national level applications (decision making, urban planning, environmental studies, etc.).

The scenario on which this research will be based on is to create a land information centre (LIS Centre) with a global database (GDB), containing data sets required by the user group 2. The GDB will be able to serve a limited number of users from group 2; this because after a certain period of time a new user group with a new information requirements wants to join the club, and due to the deficiency of the GDB to serve this new group a second global server with a second GDB is needed to support the new user group requirements.

NLISB is a loosely coupled network of local servers and NLISB clients (users). Clients who are attached to one local server via Local Area Network (LAN) form a cluster (i.e. a number of departments within a ministry). Clusters or local databases are connected to each other and to a single global server via a Wide Area Network (WAN), which forms the backbone of the NLISB.

Local servers within the federation can communicate with each other via WAN to exchange data with fast data flow. Global users (i.e. decision makers) outside the federation can only access the system through the global server, and extract the required data from its global database or communicate with any local server in the system.

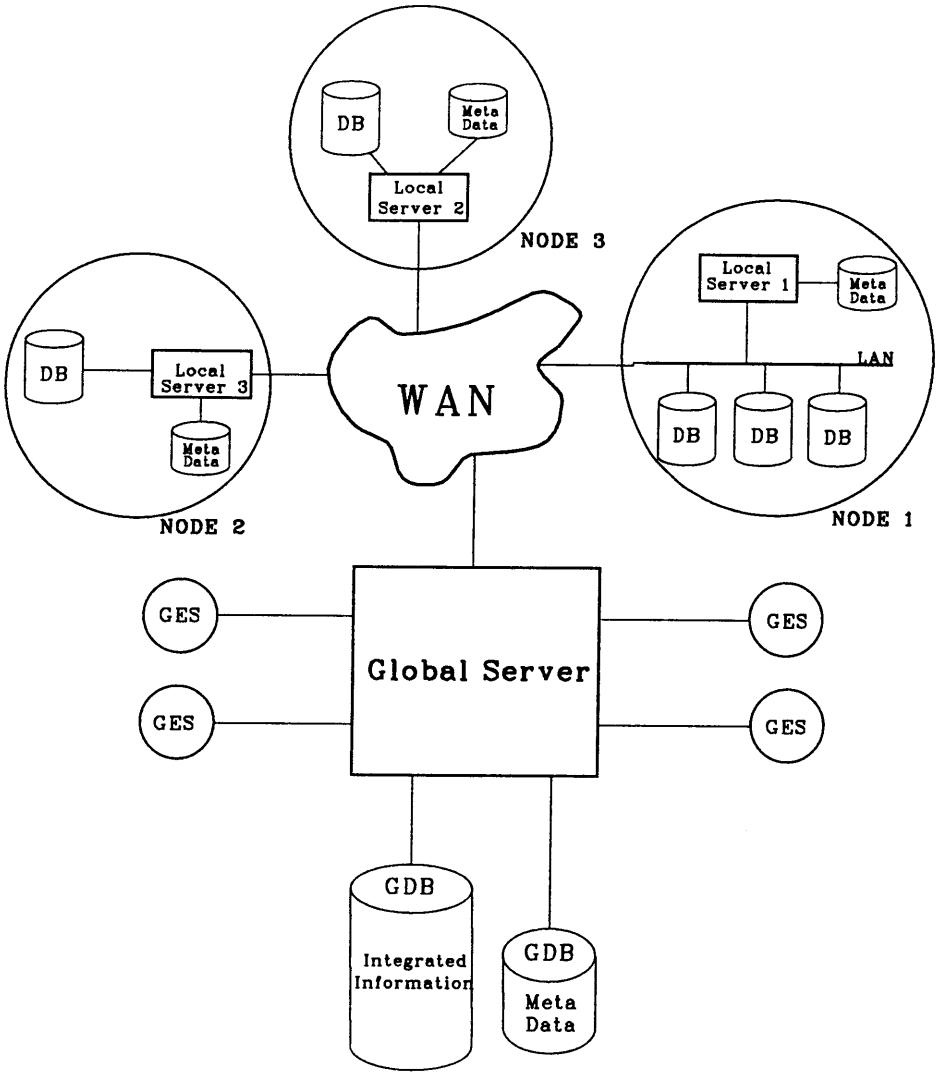


Figure 5.3 : The communication model of NLISB

5.1.2 NLISB Components

To achieve the five goals mentioned in section 5.1, NLISB can be constituted of the following components :

Local Server : The Local Server is a node in a network of NLISB which has two external schemas, according which two external views can be extracted from the local database; the first view (EV11) to serves user group 1 (participant databases) and the second view (EV12) to serves user group 2 (decision makers).

The local server performs the following functions :

1. Transaction management (received and sent).
2. Data access, and management via external views (schemas).
3. Data conversion from and to a global format via a set of data conversion routines.
4. To communicate with other local servers and with the global server over WAN via communication software.
5. Local information directory (metadata database).
6. To communicate with the local database it is attached to via an interface.
7. To validate the requester's permission for accessing the requested data.

Each local sever can authorize access to particular portions of the database its belong to, by specifying an external schema, which specifies the part of the database that may be accessed by a certain user group of external users. A single local server can be accessed by many users at the same time. Even a single user can start many transaction on the same server.

Global Server : A global server is essentially an interface to all local servers that allows a multi-database (or global) user to access data stored in remote autonomous databases in the federation.

The *Global Server* performs the following functions :

1. Transaction management between global client and local servers and between itself and global users.
2. Monitors and coordinates the activities of local servers in the federation. When a local server wants to join or leave the federation, it contacts the global server, which updates its configuration and broadcasts the configuration tables to the rest of the servers in the federation.

The *Global server* must contain the following components :

1. *Global Conceptual Schema (GCS)* : It is the conceptual model of the global database; GCS represents only the collection of some of the local databases that each local DBMS wants to share. It is defined by integrating the external schemas (export schemas) of local autonomous databases or parts of their local conceptual schemas (models). The GCS can be mapped onto either a relational database, as a collection of relational tables, or into object-base as objects and properties. Global users access the system by submitting queries over the global schema.

2. *Global information directory (metadata database)* : Facility for browsing which helps users to save their valuable time identifying and locating data they need. It provides access to metadata database which contain metadata of various databases, namely, information on specific data sets, location, ownership, format, cost of access, etc. By this facility a user can have full information about the data he needs before importing it into his system.

3. *Update controller* : There are essentially two databases which need to be updated; first the

global database which contain external views (EVs) to serve the external user groups and second the metadata database. The update controller allow the database owners, that provide the external views and metadata of their databases/data sets to the global database and to the metadata database, to insert and update the existing information in both databases. Updating can be done by a flexible approach and friendly entry forms. To insert a new data or modify an existing information, privileged users must pass a password validation check. All databases owners must have password that allows them to gain access to the global server update functions.

5.2 Key issues related to System Design

The system design aspect must follow a favourable feasibility study. The global concept of NLISB has been presented in the previous sections of this Chapter.

In this section, the design aspect and alternative scenarios of the proposed system will be discussed within the framework of the global concept of NLISB.

The discussion will be based upon fieldwork findings regarding data needed and data exchange between the six selected governmental organizations, namely :

* Survey Directorate (SD)
* Land Registration Directorate (LRD),
* Physical Planning Directorate (PPD),
* Central Municipal Council (CMC),
* Central Population Register (CPR),
* Central Planning Unit (CPU).

5.2.1 Databases

Suppose that the NLISB is formed only by the above organizations (system's participants). Each of the above organizations has data that it is willing to share/provide for others within the federated system and for external users (global users) outside the federated system.

The sharable data will be presented as an external views defined by the external schemas according to which the required items of the sharable data will be selected from the organization's database. The following table illustrates those views and their owners (organizations).

Table 5.1 : The External Views (EVs)

Organization	External View	View Name
Survey Directorate	Cadastral maps Topo maps Parcel numbers Beacon numbers Control points Coordinates Owner names	EV11
Land Registration Directorate	Ownership data : * owner name * owner address * type of ownership	EV21
Physical Planning Directorate	Maps of : * proposed roads * proposed recreation sites * proposed E.substations sites * proposed gardens sites * proposed services sites	EV31
Central Municipal Council	Data on Building : * location * area * usage * no. of stories * date of construction	EV41
Central Population Register	Person (CPR) No. Person address Land address Building address Company address	EV51

Organization	External View	View Name
Central Planning Unit	Road data : * existing & proposed road networks	EV61
	Water data : * location of water towers * location of underground water pipes * location of desalination plants * location of pumping stations	EV71
	Electricity data : * existing & proposed electricity networks * location of pylons * location of underground cables * location of generators * location of major & minor substations * location of generation plants	EV81
	Sewerage data : * existing & proposed sewerage networks * location of manholes * location of pumping stations * location of sewage treatment plants	EV91

In the absence of an integrated database system, the user needs to determine :

1. Physical database locations, database names, data item names, data item formats, units of measure for each data item, and query language.

2. How to translate the original query into queries and/or transactions and submit them for execution to each physical database system.

3. How to access the different databases and merge data retrieved from them.

There are two alternative scenarios of solving most of the problems listed above :

a) ***Scenario No. 1***

Ask each database in the federation to develop where possible a cross-reference mechanism between its entities and similar/related entities in other databases. For example, parcel numbers in SD database could be related/associated to owner names and title deeds registers held at LRD. And similarly owner's CPR No.(civic No.) at LRD could be related to owner's address held at CPR database.

Relationships can be established by using utilities (electricity, water and sewage) and road networks since those networks are always associated with building, parcel and address. Perusing the cross-reference mechanism makes it possible to combine and integrate information from different databases. As shown in Table 5.2 the key identifier in each database can be associated with other related entities in other databases.

Table 5.2 : The Cross-References

Identifier / Organization	Parcel Number	Title Deed Number	Building Permit Number	C P R Number	Sheet Number	Plan Number	Road Number
Survey Directorate	Ⓧ	X		X	Ⓧ		X
Land Registration Directorate	X	Ⓧ		X			
Central Municipal Council	X	X	Ⓧ				
Central Population Council				Ⓧ			
Physical Planning Directorate	X				X	Ⓧ	X
Central Planning Unit	X						Ⓧ

Ⓧ Responsible for determination of identification

X The identification can be used/associated

To establish links between similar/related entities in different databases, the databases (nodes) must adopt some changes such as inclusion of key identifiers in their data sets, restructuring the data sets and relating their data sets to other data sets in other databases. For example, currently the utilities and road directorates use cadastral and topographic maps as a display only to tell their engineers where to go. If they could link those maps to their information by a topological relationship. For example, topological relation between cadastral parcels in the cadastral maps and utility features (electrical cables, water pipes, and sewage line) in the utility maps. Based on such relation, it would be possible to perform query such as 'which parcels are affected by utility feature X. Survey Directorate (SD) can use the same topology to relate its cadastral maps to the Central Planning Unit (CPU) utility maps. This kind of links would be a benefit for both organizations.

Those changes are essential for any node to join the federated database system. Unlike the multi-database system which does not enforce any changes on the nodes.

The degree of autonomy of each node, is what differs a federated database system from multi-database system.

The required ***changes*** at each node to accommodate this scenario are as follows :

1. ***Survey Directorate (SD)*** : The present cadastral database is composed of four different files :

a) *Graphic Files (Design files)* : The graphic files are organised sequentially according to Intergraph structure; one file for each 1:1000 scale map sheet, each file contains elements describing the parcels and the point numbers defining it.

b) *Attribute Files (DMRS files)* : The attribute files are composed of records containing; parcel no., case no., job no., owner's name and parcel centroid coordinates.

c) *Coordinate Files (ASCII files)* : The coordinate files (point files) contain the coordinates of the instrumentally surveyed points with code precising the nature and the point number (beacon no.) as a primary key.

d) *Parcel Files (ASCII files)* : This file is composed of records for each surveyed parcel and its associated beacon numbers, and use the parcel number as a primary key.

Currently there is no link between the graphic elements representing a parcel in a design file and the parcel's attributes file, which mean that the user can not access graphically the attributes of a parcel by pointing it with the cursor or vice versa.

Clearly, the present cadastral database is not a well structured database. Restructuring the cadastral database is a must in order to be able to exchange and share its data with other organizations. Having a relational database composed of entities such as parcel, owner, ownership, mapsheet, point, etc., and link graphic files (map sheets) to the associated

attributes makes it possible to submit cadastral queries to the database.

Spatial analysis such as 'which parcel is adjacent or surrounded by which parcels' or 'which parcels are touching a specific road' can be done by introducing Topology (a mathematical method used to define spatial relationships) between points, lines and polygons in the cadastral maps.

2. ***Land Registration Directorate (LRD)*** : LRD is still operating on a manual information system, based on large number of registration records and hard copy maps. LRD has three identification sources for parcels; the case number (title deed no.), registration number and owner's name.

If LRD would adopt the parcel number as a parcel identifier and use the current three identifier as attributes, the information of a particular parcel can be easily cross-referenced and exchanged with information held at SD for the same parcel.

LRD needs to reorganize and structure its information in a well designed database as a solution to its current information problems (storage, process, search and retrieve) and to meet external organizations (users) requirements.

3. ***Physical Planning Directorate (PPD)*** : PPD is currently in the process of creating a relational database, to serve their requirements. PPD uses cadastral and topographic maps from SD as a background layers in its database, where planners superimpose the proposed roads and services sites on top of cadastral and/or topographic maps.

It would be beneficial for SD and PPD if PPD would adopt the same sheet numbering system used by SD for their maps series of proposed features (roads and services sites) and relate those features to the parcels numbers; so it would make it possible to know by single map sheet number the cadastral parcels, topographic features and proposed features of the same area, and to know which parcels will be affected by which proposed feature(s).

4. ***Central Municipal Council (CMC)*** : Technical Affairs Directorate (TAD) within CMC, collects information on buildings through building permits and store it in their manual system as technical maps and records for their use only. This information are of some value to PPD; and other organizations can be related to parcel number via building permit number.

To achieve this, TAD must computerised its information system and create a suitable database to meet their requirements, but with consideration of integrating with other related organizations.

5. ***Central Population Register (CPR)*** : CPR holds addressing information (person address, parcel address, building address and company address). CPR number (civic no.) is associated with person's name and address. A vacant (empty) parcel has a temporary address which will be given to the owner only if he obtained a building permit. CPR does not use/relate parcel number to parcel address although it is possible to do so. LRD registers passport number with owner's name instead of CPR number which is the key identifier for owner's address in the

CPR registers. CPR needs to receive from SD the new parcels subdivision and new parcels layouts in order to address them and to update their parcels addresses register; currently it is not the case.

6. ***Central Planning Unit (CPU)*** : CPU uses an Intergraph system for its graphic data and VAX system for its alphanumeric data. This makes it compatible with SD and PPD systems. Currently there is no link between graphic elements in the design files and their associated attributes in the alphanumeric database. Although they have separated electricity, water and sewage networks in separate layers in the system there still no links (topology) between the layers.

b) ***Scenario No. 2***

In this scenario, linkage between external views (cross-reference) can be done by creating a global database using the external views as its input. The global database will be created in the global server according to the global conceptual schema (GCS) which will take the burden of integrating the different external schemas. In this scenario the global database must be turned from virtual to physical for specific global applications.

A Global database (federated database) is needed to properly integrate the data from several local databases, and to present this information to potential customers in a manner that is both meaningful and useful to the customer.

The Global database in this scenario will consist of a four-level schema architecture similar to that discussed by Sheth and Larson [1990] and M. Tamer and P. Valduriez [1991]. Each level is represented by a schema and builds on the previous level. Figure 5.3A shows the different levels which can be used on the proposed NLISB.

The ***Local Schema***, represents each original data source as it exists on the local database. This schema is created by the local database owner and can not be modified by the NLISB.

The ***Intermediate Schema***, translate each local schema into a common data model. Each data source is now represented in exactly the same data model (i.e. Relational data model). There are two main reasons for having a common data model, 1) to facilitate integration, and 2) to allow access through a common query mechanism.

The ***Integrated Schema***, integrates data from all the Intermediate Schemas into a single schema (GCS). The Integrated Schema provides the relationships between the various local databases. For more details see section 5.1.1 in this chapter.

The integration of local schemas can not be properly performed until conflicts between the different local schemas are resolved. For example, different entities may have the same name, similar entities may have different names, and identical entities may have different data type (i.e. one is a number and the other one is a character) or different scale. These conflicts and how they can be resolved are discussed in detail by M. Tamber and P. Valduriez [1991].

The ***View Schema***, creates views on the GCS for presentation to the end users. The View Schema is the outside worlds view of the data available at the global database.

Each of these schemas, with exception of the local schemas, can be represented in a relational data model. This model is chosen for a number of reasons : First, the relational data model is very popular, and local databases using the relational model can be added to the system with a minimal amount of effort. Secondly, the relational model has great support for processing distributed databases. Finally, the relational model has a widely used query language that is supported by many database management systems.

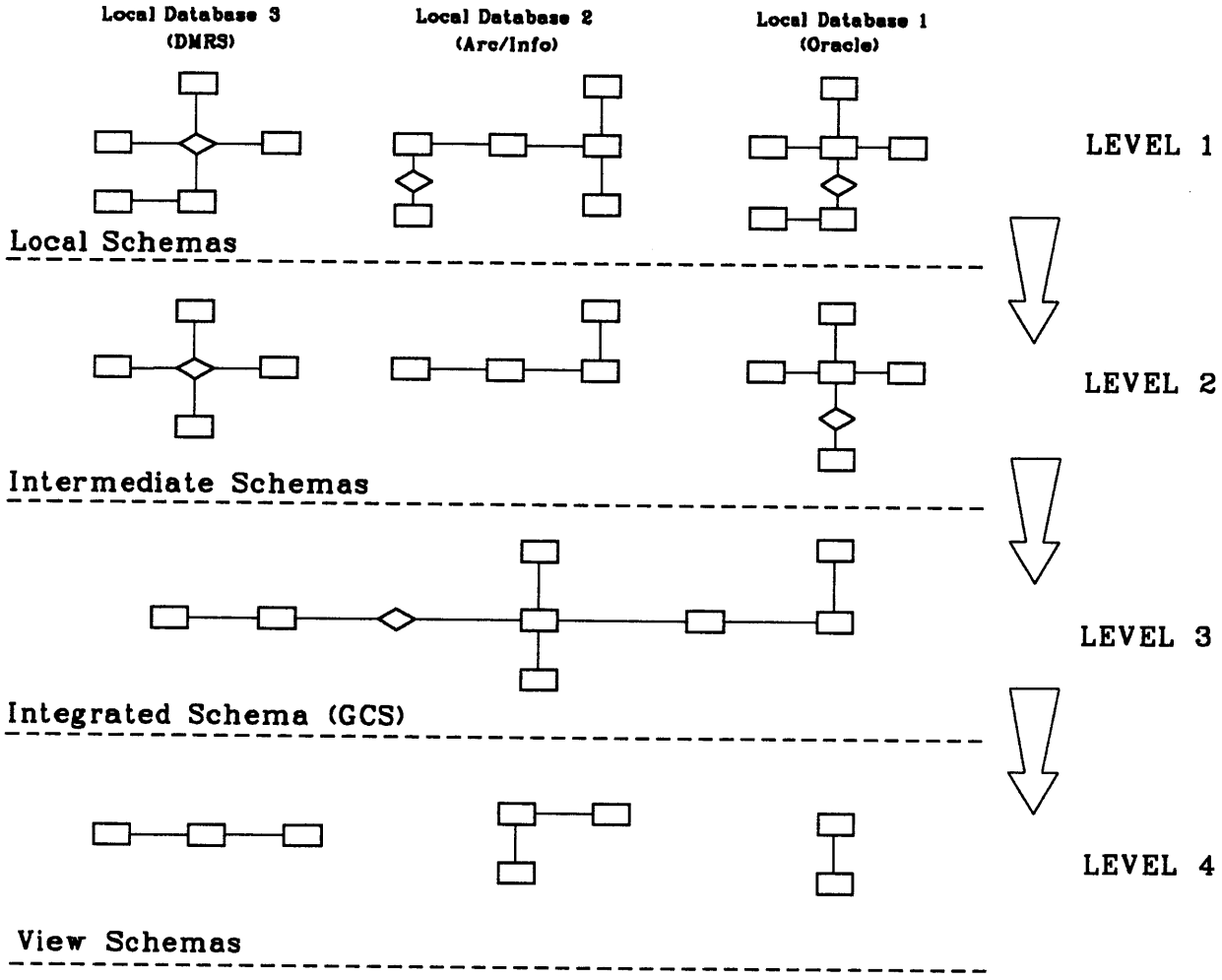


Figure 5.3A : Four levels schema architecture

With LIS Centre as the core computer system a one-to-many relationship can be adopted between organizations instead of many-to-many relationship. Clearly, the integrated data in the LIS Centre will be a very useful commodity because it obviated the need to contact a number of agencies to obtain composite data about a single (or many) parcels of land.

As changes in the views items occur in the organization's database, it is possible to have these changes electronically and automatically transmitted to the LIS Centre database the night following the change.

c) ***Recommendation***

Scenario No.2 is recommended to be used for the proposed NLISB. This scenario is chosen for a number of reasons : First, the integrated data in the global database can be a very useful commodity because it obviated the need to contact a number of agencies to obtain composite data about a single (or many) parcels of land. Secondly, the system response time for data retrieval by this scenario will be much higher than the one in scenario No.1 because the integrated data are already held in the system global database. Thirdly, communication difficulties or failures between any local database and NLISB does not affect the data retrieval process because the required data is stored at the global database; however it will affect the updating process if the failure takes longer time than expected. Fourthly, by this scenario NLISB would be able to administer the state's key land data, redistribute updates to users, and provide access to integrated data. Finally, users with very special data requirements can be supported by this scenario where the global database can provide them with the data they need.

This does not mean that scenario No.1 is not suitable for the proposed NLISB; besides its drawbacks it has a number of benefits : First, in this scenario, data integration takes place at the time of data retrieval via the cross referencing mechanism where the query is decomposed to sub-queries. Secondly, scenario No.1 does not require the integration of the local database conceptual models into a single conceptual model to form the global database. Thirdly, scenario No.1 unlike scenario No.2, does not entail modifying existing systems to supply data to and receive data from the global database.

5.2.2 Standardization

Standardization means the establishment of standards, and it is normally associated with efforts to achieve uniformity.

In the case of topo data standards, however, uniformity is impossible, in view of the fact that different users : - View topo features differently
- Have different interests in different features, in the level of classification of features and in the attributes assigned to the features.

It can furthermore be argued that what is necessary is not uniformity but clarity, as what is

implied in a standard used, i.e that if digital data is to be exchanged amongst the various agencies involved in its collection and storage, is that these agencies correctly interpret each others standards.

In order to be optimally effective in facilitating the exchange of data between different agencies using the concept of this research for data exchange, standardization at two levels must be discussed and clarified :

Level 1 : *Standardization of data in the local Database*

a) ***Classification*** *(class tree)* : Features can be classified into four levels as shown below

For example, in level I of the classification, we can find classes as :
- Building
- Parcel

Under Building class we can find level II sub-classes as :
- Education
- Residential
- Medical

Under Education sub-class we can find level III objects as :
- Museum
- School
- College

Under Museum we can find level IV properties as :
- Science
- Military
- Natural

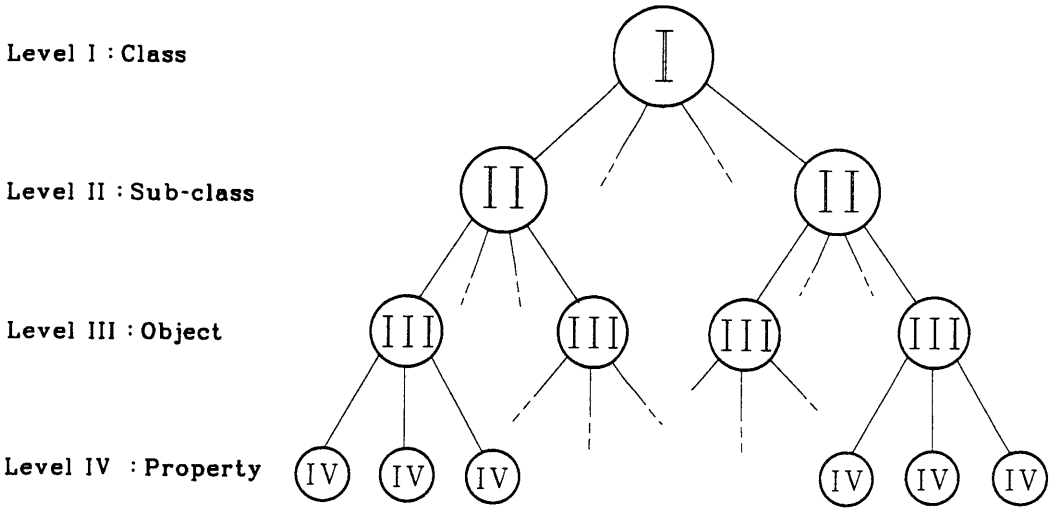


Figure 5.4 : The features classification levels

Each level can be assigned with a unique code, for efficient selection, retrieval, display and search of features. So, to code the science museum the following coding system can be used

B - is code for level I class " **B**uilding "
E - is code for level II sub-class " **E**ducation "
18450 - is code for level III object " Museum "
999 - is code for level IV property " Science "

The full code of a science museum would be **BE 18450 999**

b) ***Data Dictionary*** : The data dictionary may be regarded as 'data about data' it defines the entities, their attributes, and associated domain values. The DBMS must provide a data dictionary function in the database to allow system users to know the exact definition of the entities and their associated attributes.

c) ***Topology*** : Topology is the mathematical method used to define spatial relationships between primitive objects (points, lines and areas). In a topological approach, the end points and intersections of lines, such as street or water-line segments are recorded as nodes (points). The lines themselves between intersecting lines (or from node to node) are Arcs (lines). The closed areas bounded by chain of arcs are polygons (areas).

The topology can be recorded in three data tables; one for each type of spatial element (Node, Arc and Polygon), and the coordinate data, based on the national coordinate system (UTM in case of Bahrain), are stored in a fourth table.

Topological information is used for several purposes in a GIS. Initially it may be used in editing and quality control. By applying logical tests to topological data, the system can identify errors such as missing or extraneous lines. Other uses include retrieval and spatial operations as contiguity and connectivity. Contiguity is the spatial relationship of adjacency. Connectivity refers to Arc and Node connectivity relationship which can be used to model utilities and other networks. Additionally, topological information supports efficient polygon over-laying procedures. In a GIS, polygons and nodes are often stored in one type of data layer and arcs are stored in a separate data layer.

For some applications, Nodes, Arcs and Polygons can be stored together in one data layer. For example, the water layer can contain all nodes, arcs and polygons forming the water network, and similarly for other layers for electricity, and road networks; then the separate layers can be related to each other topologically.

Level 2 : *Standardization of data to be transferred from a local database to other databases (users)*

As it has been already explained in Chapter 4 (section 4.7), individual external users may be interested in particular subsets of the database. Such subsets can be described by the External Schema (ESs) sometimes referred to as Export Schemas, which can support external user's applications and access to the local database.

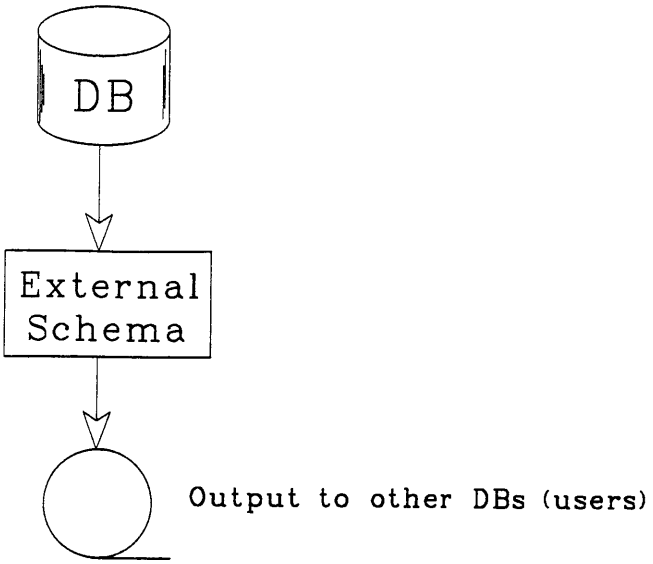


Figure 5.5 : The External Schema (ES)

Different users require different views of organizational information, because different users have different information needs and requests. This means to have different ESs to support different users requirements.

Different data sub-sets defined by different ESs can be standardized using one of the following three alternative scenarios :

a) ***Scenario No. 1***

Is to design different external schemas for different data subsets to support different external users requirements. This means a standard data subsets per each external user (specific model, entities, relation, attributes and geometry).

The advantage of this approach is that each external user will have his particular view of the database; in other words his needs will be fully satisfied.

The disadvantage, is that owner of the local database will have the burden of designing large number of ESs, he may reorganize his data sets or write some application programmes to satisfy the requirements of some users.

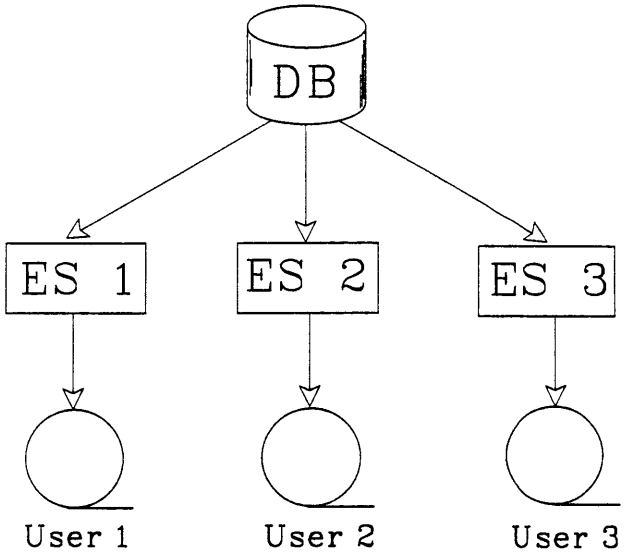


Figure 5.6 : Different ESs for different external users

b) ***Scenario No.2***

Is to design one general External Schema, which specify and describe the data sets the local database (data model) is willing to share with other databases (users).

The sharable data sets can be viewed by the external users as a standard product from a particular database. This standard product (data sets) can be defined by an agreement between external users and data owner. The agreement must be on data model, entities, relations, attributes, scale, form and format. For example, all external users have agreed with a cadastral database to receive a cadastral map in a Microstation format containing only parcel Id, road Id and owner's names and a specific associated attributes in dBASE-IV or Oracle format.

The advantage of this approach is that, the local database (data owner) will have to design a single ES (data model), which describes the data sets it wants to share with others. This will relieve the data owner from the burden of designing a new ES every time a new user joins the club.

The disadvantage, is that the individual users can not get exactly what he wants. The standard product will either be a little less or a little more than the user needs; and as a result the individual user may need to make a special agreement outside the system to get more detail data than those specified by the standard ES.

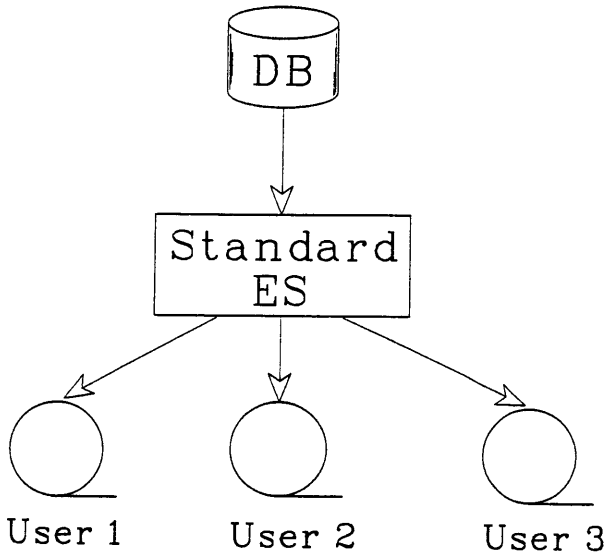


Figure 5.7 : A standard ES to serve different users

c) ***Scenario No. 3***

Is to design a standard ES as a standard data (standard product) for data exchange between system's participants (local databases), and several ESs for very special applications such as a pilot project in the country which require a very specific information from each local database or a decision making process which require a high level data abstraction.

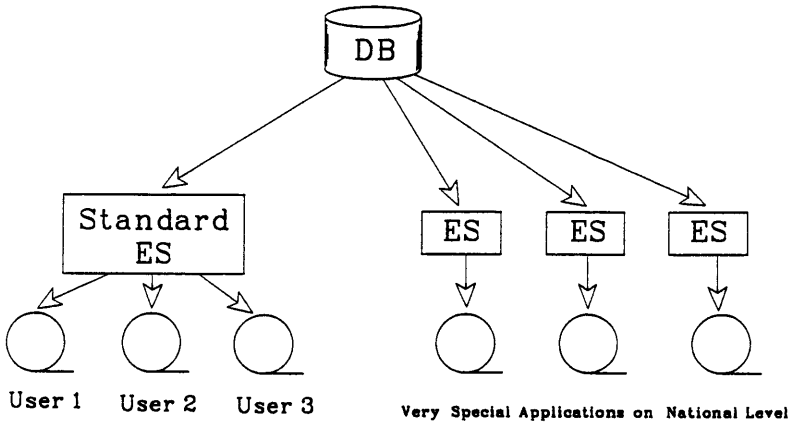


Figure 5.8 : A standard ES with different ESs

The advantage of this approach is that the local database would be able to serve a variety of users including user group with very special requirements. In most cases, the special requirements of special users or applications are not met or looked at by data owners.

The disadvantage of this approach will be the same disadvantage as for scenario 1 where several ESs have to be designed.

d) ***Recommendation***

Scenario No.3 is the most suitable scenario for the proposed NLISB among the foregoing scenarios for a number of reasons : First, by this scenario the NLISB would be able to serve a large variety of user groups among which users with very special requirements. Secondly, this scenario is compatible with the prefered scenario (scenario No.2) on databases (see section 5.2.1 item c).

5.2.3 Global and Local Information Directories

1. The Concept

Facility for browsing metadata helps users to save their valuable time identifying and locating data they need. An Information Directory is a spatial browser that provides this facility to users. It provides access to metadata of various databases, namely, information on specific data sets, location, ownership, format, cost of access, etc.

Knowing all that facts about the data before exchange is important to most users in order to decide whether the data are suitable or not.

A land-related information directory, which documents what land information exists, its characteristics and where it can be found, is a critical tool in land information management.

2. The Design

The basic design concept for the Information Directory is that the user is provided with sufficient information to judge the usefulness of the data set without accessing it directly.

The Information Directory contents can be exactly determined after extensive discussions with key personals in the participating organizations. The following list can be a guideline to what kind of information (minimum information) the directory must provide to users :

1. the geographic coverage.
2. the type of data (spatial or non-spatial).
3. the format and scale of available map data.
4. the form of the data (digital or analog).

5. the accuracy of the data.
6. the date of last updating.
7. the completeness status.
8. the usage limit (applications suitability)
9. the purpose for which the data was collected.
10. the agency/organization and contact persons of the data set.

The proposed NLISB can have two types of information directories; first, the Global Information Directory at the global servers; second, the Local Information Directory at each local server. In the following sections the content of the two types and the relation between them will be discussed in two alternative scenarios :

a) ***Scenario No. 1***

As mentioned in the previous sections of this chapter, each local database can provide a standard view to others. Information about those standard views can be held at the metadata database at the global server which can be accessed by the global (external) users. In other words the global users will be able to know from the global server via the global information directory (metadata database) what information he can gets through the global server.

In this scenario the metadata on all standard views from different databases can be grouped according to use or type. For example, all data on building from different databases can be grouped in one group, and all data on land use can be grouped in another group, etc.

If the user needs more detailed information than available via the standard view he can access the local server through the global server or through his local server.

The local metadata database (local information directory) at each local server contains a full description of the data available at the local database it belongs to. The user can browse the local metadata and if the information he needs is available at the local database, the user can contact the person responsible of the information and a special agreement can be made to transfer the required information.

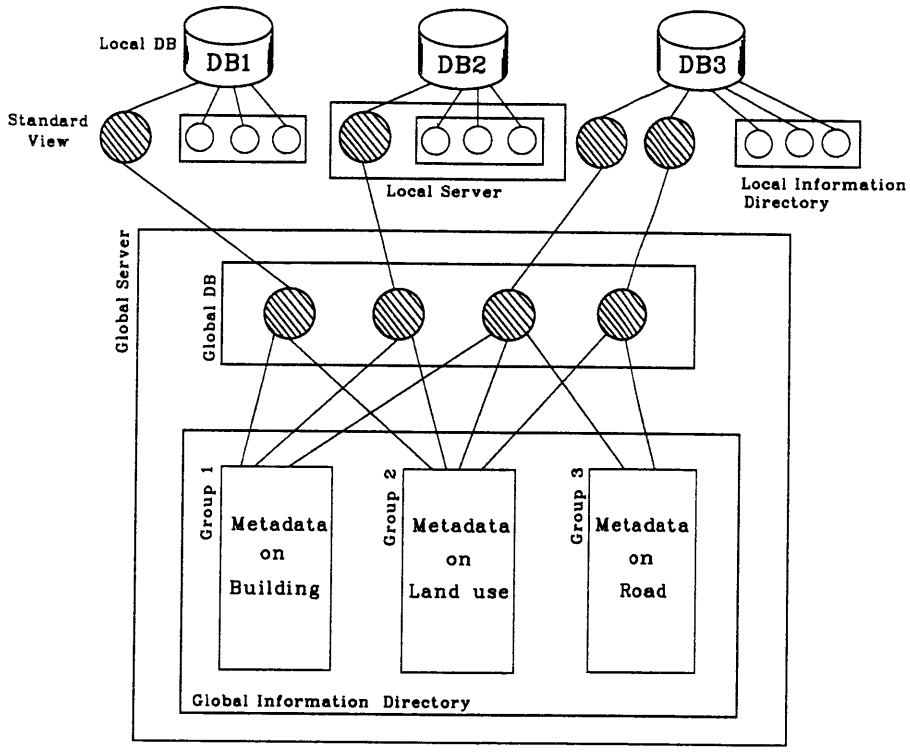


Figure 5.9 : The basic model of information directories for scenario no.1

b) ***Scenario No. 2***

In this scenario, the global metadata database can maintain two types of databases; one contains map data, the other contains metadata.

The map database may contains data for displaying maps of high level abstraction from the local databases such as the main under-ground water pipes network at scale 1:2000, the high tension under-ground electrical cables network, main roads network at scale 1:50,000, or block boundaries map at scale 1:5000. The other database maintains the directory, catalogue, etc. of the data sets available in each local database including information on standard views.

The descriptive part of the global metadata database can be composed of two sections : one contains description of the standard views, that is the information the user can get via the global server (the standard views), the other contains full description of data sets available at the local databases (non-standard data sets).

Local information directories at local servers will maintain a full description of the data sets available at each participating local database.

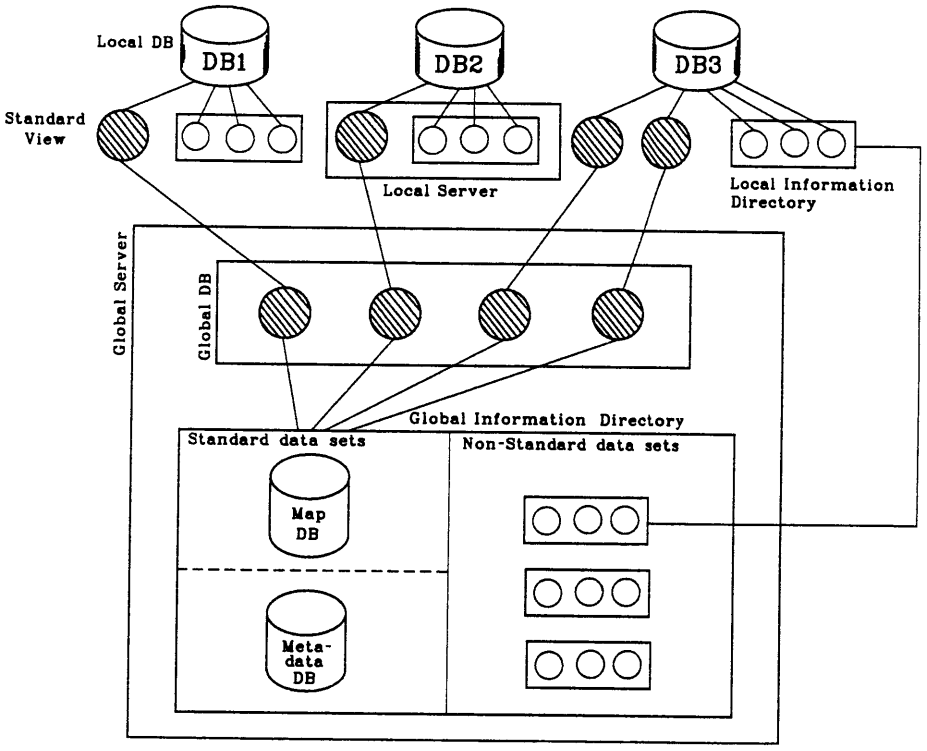


Figure 5.10 : The basic model of information directories for scenario no.2

c) ***Recommendation***

Scenario No.1 is the most suitable scenario to design the global and local information directories; in this scenario the metadata is clustered in groups according to use or type; this can give the user a better and easier searching facility where he can browse a specific metadata set of the global database as well as of the local metadata database. Besides this scenario is very compatible with the prefered scenario No.2 on the databases and scenario No.3 on data standardization (see section 5.2.2 item d).

5.3 NLISB Operations

5.3.1 Operational Framework

The environment in which the proposed NLISB will work will be composed of the following:

* large organizations which often use different (and incompatible) information systems to store their spatial and non-spatial land-related data in different databases.

* a wide area network (WAN) connecting multiple local servers with each other and with the global server.

* the global (external) users, who are authorized to connect via a communication interface (user interface) at their workstations to the global server.

This research is based on the assumption that the databases residing in various organizations are autonomous. The availability of autonomous databases over a WAN to users has two implications. First, the data owners must be part of a federated environment and the data users must have authorization to access data in the federation. Second, the data owners manage and control their spatial, non-spatial, and metadata so that those data will be up-to-date, consistent, error free and secure from unauthorized changes.

In this environment, the user can browse the metadata database (global information directory) for data sources. Data transfer from owners to users' systems can be executed by the LIS Centre (see further details on the LIS Centre in paragraph 5.6).

5.3.2 Local Server Operation

Each local database has a spatial and non-spatial data set. Spatial data - typically maps - can come in different source formats, such as Microstation, AutoCad, or Arc/Info, and from different source systems, such as UNIX Worksations, VAX, or PCs. Non-spatial data - typically text files or tables-come in different database formats, such as RDBMS, VAX (Ascii), or DMRS.

A local database can store (its standard view(s)) data which it wants to share with other local databases on its local server, where it can be accessed by other users. Local servers will be capable of converting the sharable data from owner's format into the national exchange format and vice versa. In this approach the owner has the obligation to up-date the sharable data which reside in the local server database every time he updates the same data items at his local database.

As an alternative approach, no data will be stored in the local server's database. Instead an External Schema (Export Schema) will reside at the local server database, and according to

that external schema the sharable data sets (standard view(s)) can be extracted from the local database, converted and sent to the users. This approach relieves the owner from up-dating the copy of the sharable data sets at the local server database and ensure the user that he will get the latest versions of the data sets he requested.

The local server can handles requests both from the global server and from other local servers in the federation. Local servers can have two types of standard views; one for data exchange between the local databases and for any interested global user. These views are shown in Figure 5.2 as EV11, EV21 and EV31. The other view is a very special one containing information (high level abstraction) for very special applications on the national level such as :

* large planning projects i.e building a new town, schools, hospitals, or a new highways.
* environmental studies.
* researches in a particular topic i.e. noise level and effect on people and buildings adjacent to a particular high-way, road or airport.

This type of views will contain information such as :

* statistical figures on population according to age, and on buildings according to use, in a specific area.
* data on road such as construction date, construction material, thickness and its capacity; plus tempolar data in order to study the expansion rate of a particular road for future design of that road.
* city master plan which shows all the proposed roads, gardens, schools, hospitals and recreation sites in a particular city for the coming five years or more.
* cadastral data such as a block boundaries map at scale 1:5000 for a particular city or the number and area of empty lands in a particular area.

This type of views are shown in Figure 5.2 as EV12, EV22, and EV32; they can be stored in the virtual database of the global server for fast access by any interested external user group. In this case the virtual global database needs to be converted to a physical database.

Data in the local servers can be stored in any commercial database model - relational or object-oriented. Each local server has its own metadata database which fully describes the data which reside in the local database it belongs to.

5.3.3 Global Server Operation

The Global Server is a master server which can monitor and coordinate the activities of the local servers in the federation. When a local server wants to join or leave the federation, it contacts the global server which updates its configuration and broadcasts the configuration tables to the rest of the servers in the federation.

A user connects to the global server, requests a transaction, and then the global server first

validates the requester's permissions for accessing the requested data and, if successful, it connects (invoke) the concerned local server for executing the transaction and starts the transaction. The global server through its transaction monitor will be able to notify users about the status of transactions in progress, finished transaction, or aborted transactions. The transaction monitor also logs accounting data in order to support billing of users who access data stored in the federation.

The global server can be accessed by any local server in the federation and by user interface at the external user workstations.

A national data interchange format makes NLISB easily extensible. Each new local database (node) only requires two new conversion routines - to and from the national interchange format.

The global server has two global database; one is virtual, used to store integrated views according to the global conceptual schema (GCS) and is materialized only when a very special integrated information is needed by a certain user group for national level applications for easy access. The first global database is therefore referred to as virtual.

The second, will be a metadata database containing an information directory about data sets stored in the global server and/or data sets at each local database (see section 5.2.2).

5.3.4 Updating Operation

As already mentioned, a Federated Database System (FDBS) consists of many databases, which are controlled by different Database Management Systems (DBMSs). A FDBS creates the environment for logical database integration without requiring physical integration of the databases.

In FDBS a copy or a subset of the sharable data sets immigrates from one local database (data owner) to another (data user) and vice versa. In this environment a concurrency control mechanisms is required to enable the local DBMSs to report changes or updates on the data sets in different databases (nodes) as soon as they update their original data sets.

Another problem may occurs when the update is applied by an unauthorized database (node). For example, if Physical Planning Directorate (PPD) has a copy of a topographic map from Survey Directorate (SD). PPD has updated its copy of the topographic map by using their own mapping procedures and techniques. What happens if the updating techniques used by PPD are not up to the standards of SD in terms of data collection and presentation ? and what happens if the unauthorized updates immigrates to other nodes in the federation ?

To overcome this inconsistency problem, the system must have a mechanism to enable the authorized node (data owner) to approve or disapprove the update. If the updates are approved, they can be propagated to all copies in the federation as well as to the original one. If not, that update will stay at the unauthorized node, and the data set can be stamped of

flagged with "below the owner's standards".

Recently, a large amount of research has been conducted in the area of federated database systems. However, the problem of updating copies of data sets in local databases (nodes) in the federation has not been sufficiently addressed; an MSc research in this area is now in progress by Ibrahim El-Sharaki (GIC.2 course participant 1993/94 at the ITC). His proposed model is based on the placing of a server on the communication flow for a specific data set (the main database at a primary node) to handle the questions raised above. The research will be limited to the communication flow between the primary nodes, as well as between a primary node and its associated secondary nodes.

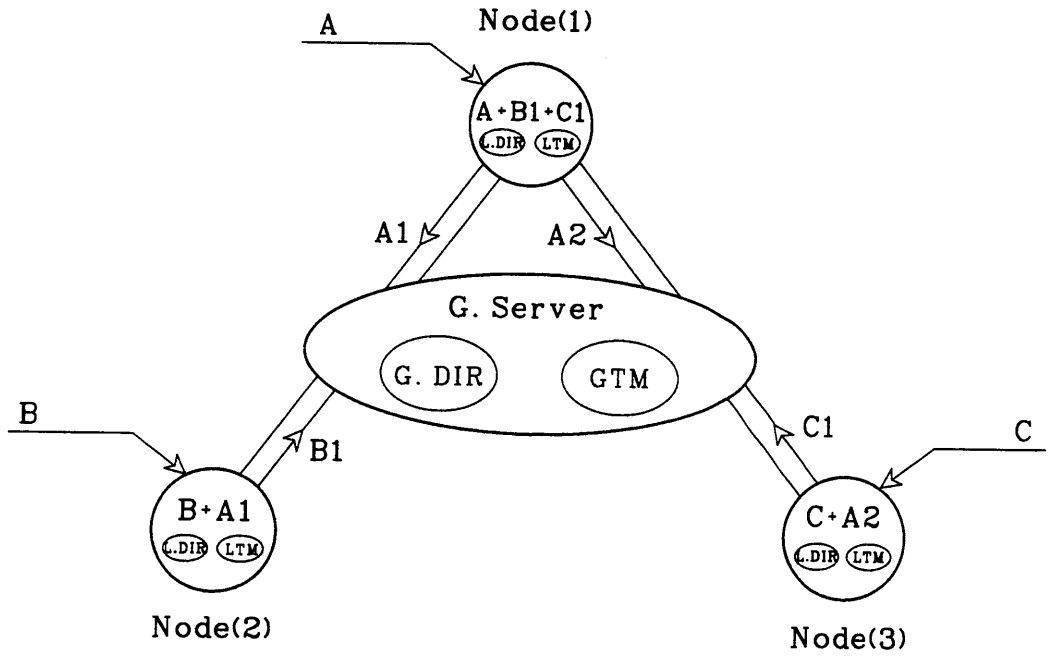


Figure 5.11 : The basic data sets updating model
[from Ibrahim El-Sharaki]

The proposed global server model illustrated in Figure 5.11 has two main functions :

* To support different views for different users i.e. A1 is a subset of A from node(1) to node(2), and A2 is another subset of A to node(3), etc.

* To control the updates in the Network :

- Propagate any update which might take place at any local database (node) (i.e. when A is updated at node(1)) to the abstracted copies in the Net, i.e. update data sets A1 and A2 at node(2) and node(3) respectively.

- Include criteria (standards) to allow the specialized nodes to evaluate and approve the updates that might take place at other (non-specialised) nodes. For example, The updates of B1 in node(1) need to be evaluated and approved by the specialized node(2).

- Incorporate the updates at other nodes (after being approved) into the master data set A and the other subsets of A (A1 & A2) in the Network.

The global information directory (G.DIR) can supply the global server with the required information in order to locate other copies in the Network as shown in Figure 5.11. The G.DIR contains information about data location in the Network while the local information directory (L.DIR) contains information about the data residing at the local node and the data abstracted from other nodes. These directories also contain indicators for the authority body that is responsible for a particular data type in the Network.

The Global Transaction Manger (GTM) in the global server will coordinate between the different Local Transaction Managers (LTMs). The LTM at each node ensures that the local transactions as well as the local update does not conflict with each other or corrupt the local database.

When any node starts to update any of its data items, the LTM will consult the L.DIR and the update will take place only at that node if the data sets are unique (i.e. only one copy is available in the Net). While if there is more than one copy, the LTM sends first a message to the GTM at the global server to keep the update in the global server's buffer. Then the global server will consult the G.DIR in order to locate the other copies in the Net and check whether they are under any transaction operations. The GTM will wait until all the copies are released and then start to propagate the update to these copies as well as to the original copy. These operations, however will only take place after the update is approved by the authorized node (data owner).

5.4 Phases of Development of NLISB

Information as well as systems and financial means are costly resources for an organization. Efficient and effective use of information is decisive for the good management of production processes. Further more, there exists a high correlation between the quality of the information and the quality of the decision making process, will it be strategic, tactical or operational; the correct use of information is highly dependant of the developed Information Systems; the methodology used to develop the Information System is therefore an important success factor for the organization [C. Paresi and O. Essien].

Systems Development is a non-trivial task; it costs time and money because of the complex nature of modern Information Systems and therefore needs a clear step by step approach in the process of development. This is the concept behind Methodologies. It defines the pieces or components, phases and activities that one finds in a typical System Development Project; and also the interface between those components [C. Paresi and O. Essien].

Four approaches to development methodologies have emerged from research and experience; these are the Formal Methods, the Structured Methods, the Soft Methods, and the Socio-Technical Methods. In practice, any development is a combination of these different approaches; however, this section will focus on the Structured Methods; indeed considering the development of the proposed NLISB, the problem has been enough structured to support the use of Structured Methods.

C. Paresi and O. Essien have identified four Major Phases of Structure Methodologies :

a) System Strategy and Planning
b) System Analysis
c) System Design
d) System Realisation

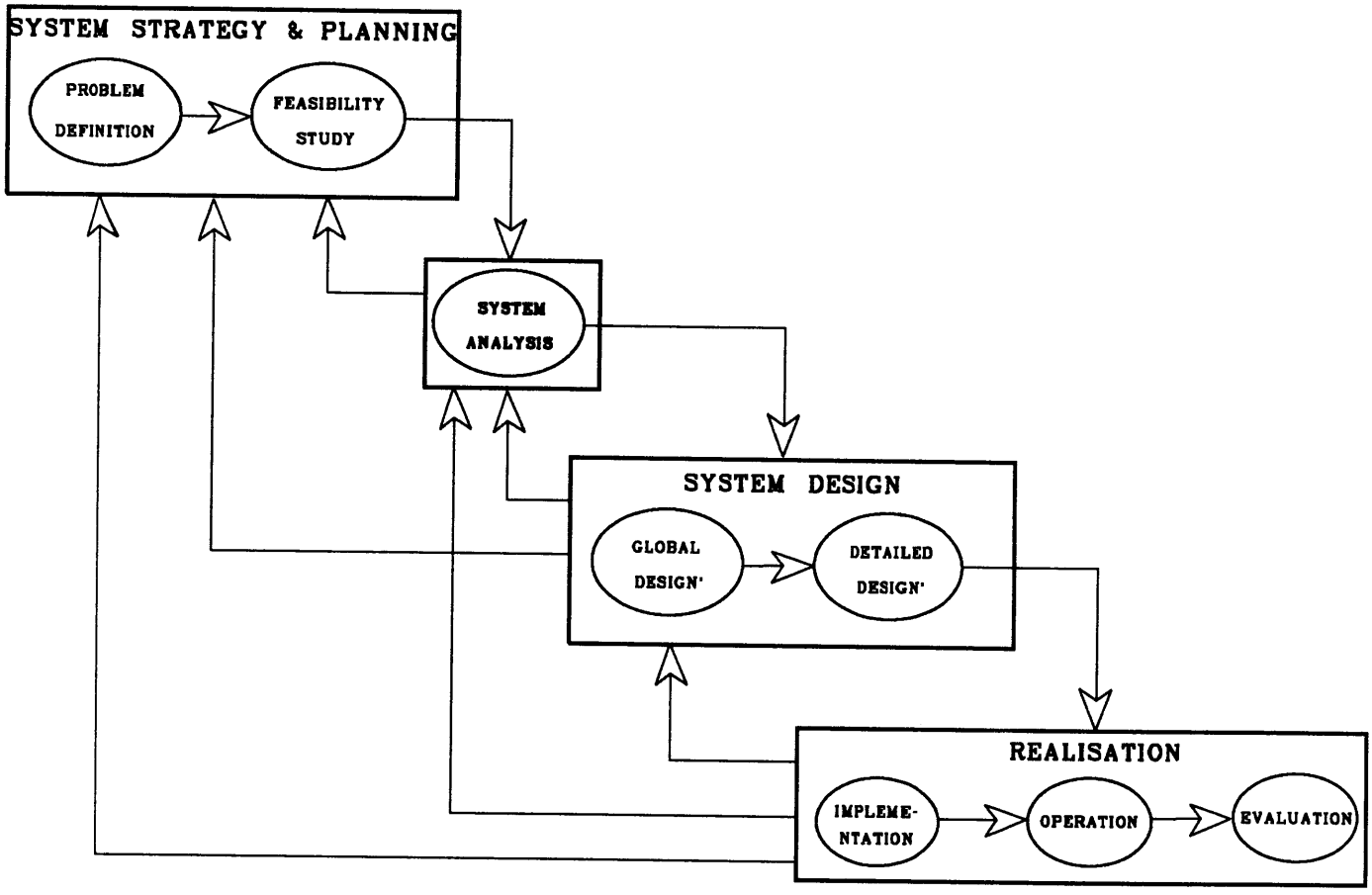


Figure 5.12 : System Development Major Phases and Life Cycle
[from C. Paresi and O. Essien]

a) System Strategy and Planning Phase

Considered as the most important phase it has as objectives to define the problems to be solved. The purpose of this phase and of the information systems plan is to create a framework for developing and maintaining an organization's technological infrastructure and the information systems and applications supported by this infrastructure.

It consists mainly of *Problem Definition Study* and *Feasibility Study.*

Main activities during *Problem Definition Study* include :

- Definition of System objectives and problems.
- Definition of global Development Plan and Direction for the System.
- Definition of Non-functional requirements.
- Analysis of characteristics of the Organisations (strategy, structure, decision centres, processes, trends, developments).
- Definition of Subsystems and the priority order of their development.
- Definition of solution(s) and their consequences on the organization and existing. system. The conceptual solution gives an idea of what the new system would look like.

A *Feasibility Study* follows to indicate :

- What processes would be automated or manual.
- What inputs would be needed by the system/subsystems and the expected output(s).
- The organizational, technical, operational and economic feasibility of the project.

The activities proposed in this phase have been covered in Chapters 2 and 3. Feasibility study has not been covered due to shortage of study time.

b) System Analysis Phase

As an objective, this phase seeks to make a detailed appraisal of the existing systems in the organizations. Main activities include :

- Detail analysis of existing systems organization and functions.
- Detail analysis of user's needs and problems.
- Detail analysis of existing information structure.
- Detail analysis of relation between systems functions and information.
- Detail analysis of non-functional requirements.
- Detail analysis of systems behaviour.

These analysis are done using questionnaires, derivation from an existing system, synthesis

from the characteristics of the system in use, or experimentation with an evolving information system; and with particular reference to user studies, prototypes may necessary.

The activities proposed in this phase have been covered during the three weeks field work and well presented in Chapter 3 as a current situation analysis of the information infrastructure.

c) System Design Phase

Objectives here include selecting engineering design needed to implement the system, specifying new changes to existing programmes and databases, and specifying detailed user procedures that describe how they would use the system. The phase consists of Global and Detail design. Main activities include :

Global Design :

- Broad design of conceptual solutions proposed by the feasibility study.
- Important input and outputs are defined and performance requirements are specified.
- Outline of the part of the system to be automated or otherwise.
- Consideration of design alternatives.
- Specification of system hardware/software requirements, including a decision on off-the-shelf purchase of software or otherwise; and on whether hardware should be purchased or leased; and on if software is not purchased, whether development would be done by internal programmers or external contractors. Interface between sub-systems are also specified.

Detailed Design :

- Detailed specification of system hardware/software components.
- Detailed database (and programmes if necessary) design module.
- Detailed user procedures are documented.
- Detailed interfaces between users and computers are defined showing exactly how the user will be expected to utilise the system; this presupposes a specification of relationship between hardware and software components, database design, and technical infrastructure of the system environment.
- Detail specification of which component will realise what requirement in the analysis phase (i.e. mapping components and requirements).
- Detail specification of transition from the old to the new situation (organizational and technical, including user training).
- Detail specification of the realisation plan.

Activities related to this phase are well covered and presented in chapter 5 as a key issues related to system design.

d) System Realisation Phase

This can be seen in three perspectives : - Implementation and Installation
- Operation/Maintenance
- Evaluation/Justification

As objectives, it aims to turn to fruition all that had been put down on paper in previous phases and to ascertain how worthy the whole project is. Main activities include :

System Implementation and Installation :

Purchase of hardware components; Procurement (by purchase or otherwise) of software components; Creation of the test Database; Training of system users; Testing of each system component and then of the total system; system conversion and implementation of organizational changes; and the creation of maintenance procedures for technical staff.

System Operation and Maintenance :

System follow-up; back-up; recovery and audit trail procedures; and Creation of an evaluation plan.

System Evaluation and Justification :

This is the major turning point in the system life cycle and takes place approximately one year after installation. Activities include evaluation on employee impact, cost/benefit and effective analysis to check whether the set goals have been realised, or if improvements are needed.

This phase is only given here as an indication of activities to be considered in the later development of NLISB.

5.5 The Critical Success Factors of Developing NLISB

The *Critical Success Factors (CSF)* method [Ref. M. Wasmund, 1993] can be applied as a means of supporting both NLISB planning and requirements analysis.

Critical success factors are those few things that must go well to ensure success for the proposed NLISB. The factors describe critical things or entities that must be obtained in order to reach the goal (establish a national land information system).

The goal to be achieved is decomposed into a set of critical factors. Activities supporting

those factors are then entered into a matrix and their relationship to the factors is validated.

The basic steps of the CSF method are outlined below :

1. ***Define the goal*** : This step defines the goal to be achieved which is in our particular case, to establish a national land information system for Bahrain.

2. ***Decompose the goal into a set of critical factors*** : This step defines the critical factors that are required to accomplish the stated goal.

3. ***Define activities*** : This step defines the activities to be performed to support each factor.

4. ***Build and validate the CSF matrix*** : Factors and supporting activities are entered into a correspondence matrix, showing which activities support which factors (see Table 5.3).

The obtained matrix can be used for several purposes. First, it allows recognition of unsupported factors, i.e., factors for which no activity has so far been defined. Secondly, it shows the most important factors which are supported by greater number of activities and at the same time it shows the most important activities which influence a greater number of factors. Thirdly, it allows elimination of redundant activities, i.e., activity X supports exactly the same factors as activity Y. Activity X (or Y) is therefore redundant and can be eliminated, thus allowing focus of available resource on crucial topics. Fourthly, the CSF matrix may serve as a project management ingredient to track and readjust activities, making their relationships to the success of the overall goal visible.

The CSF method should normally be used by key managers of the organizations (they know their business) in a Delphi environment. The above proposed CSF matrix has been developed by the author and should therefore be considered as subject to validation and improvements."

Table 5.3 : Interrelation of Critical Success Factors and Supporting activities

Critical Success Factors									Activities
Legislations	Cooperation	Institutional Support	Financial Support	Management Awareness	Infrastructure Maintenance	Quality of Information	Data Exchange Standard	Price of Information	
X	X	X	X	X		X	X		Form a high level Steering Committee
X	X				X	X	X	X	Establish an effective communication Network
X	X	X				X	X	X	Carry out institutional changes
	X	X	X	X	X	X			Conduct presentation and seminars and upgrade staff
		X	X	X		X	X	X	Identify national and local benefits
	X				X	X	X	X	Implement quality systems
X	X					X	X	X	Review legislations
X			X		X			X	Develop markting system
	X					X	X		Upgrade data collection, storing and presentation techniques

5.5.1 Critical Success Factors (CSFs)

The following factors have been identified as CSFs for the development of the NLISB :

1. *Legislations*
2. *Cooperation*
3. *Institutional Support*
4. *Financial Support*
5. *Top Management Awareness*
6. *Maintenance of the Information Infrastructure*
7. *Quality of Information*
8. *Data Exchange Standards*
9. *Price of Information*

1. ***Legislations*** : A major limitation on the development of land information systems (LISs) has been the availability of data; without suitable data, particularly digital maps, the effective use of LIS is not possible.

The problem for most LIS users is knowing what the availability of data is, who owns the data and what rights they have to use those data. There is also the issue of integrating data sets for the purpose of analysis and what rights exist for passing such derived data on to third parties. For example, in a federated environment it is possible for one agency to purchase data from some source, restructure the data into a cleaned data set with some added value and enhancements and make it accessible to other nodes in the system and to external users as a better alternative to the original data. Such an action could be harmful to the prestige of the original data owner. Processes for restricting access to sensitive (confidential) information must be reviewed, and legally authorized. Legal responsibility for erroneous or incorrect data must be clearly established.

These legal issues, must be controlled and addressed as legislations and policies by senior management of the participating organizations in the federation, to decide on.

2. ***Cooperation*** : Many different government organizations handle land-related data. The control and exchange of these data require inter-organizational cooperation and some degree of surrender of organizational autonomy.

The efficient utilization of land-related data in any NLIS requires the cooperation of various organizations. This cooperative effort result in widespread utilization of the geographic land-related data thereby increasing the cost effectiveness of the data collection.

Cooperation between organizations, is vital for the planning phase of a NLIS development, for the identification of potential external users, for cost sharing of the system, and for legislations review and issuing. In order to guarantee the best possible cooperation between participating organizations an independent high level steering committee must be formed. Its tasks will involve coordination between different ministries and departments, and enforce policies and legislations.

3. ***Institutional Support*** : Technology is often seen by some governmental organizations as a necessary evil which creates unemployment and disrupts the status quo. Computers are accepted into government departments because they can do the tedious clerical tasks quicker and hence more cost effectively. Government departments have to change this look towards the technology in order to see it as the opportunity to share and exchange land-related data, to create effective land information systems, and to manage and distribute up-to-date land related data; as a result they will have to give their political and institutional support to the proposed NLISB in the form of their willingness to cooperate and be a part in the proposed system.

Without on-going political support at the senior management and/or cabinet level, NLISB has little change of success. Administrative reorganization, legal reforms, financing, and enforcement of other policies affecting the NLISB depend on this support.

4. ***Financial Support*** : Financial support for all investments needed for the proposed NLISB, by the participating organizations is a fundamental factor for the introduction of an integrated NLISB.

Investment in NLISB will not occur unless the concerned government organizations believe that the benefits will exceed the costs of implementation. The basic aim of any benefit-cost analysis is to determine if benefits exceed costs.

One of the obvious potential benefits is greater efficiency through prevention of time-wasting duplication of work. If it is possible to establish the level of duplication that takes place between organizations, then it may be possible to calculate the savings that arise from preventing it. Benefits can be gained from savings in hours spent on searching for, handling, and processing documents, reduction in equipment, stationary and storage requirements, and increase in overall efficiency. Pricing NLISB products and services can be an essential mechanism for cost recovery of its development and implementation. Non-tangible benefits should be as much as possible qualified, if not quantified e.g. effects on decision making.

5. ***Top Management Awareness*** : Top management in the participating organizations should play a major role in formulating policies and legislations, and give the necessary political and financial supports to the proposed NLISB.

Top managers would not be able to play their major role without a full awareness of the land management crisis in the country and a full believe in the potential benefits from having a national land information system. Top managers need to understand the practicalities as well as the theory of land information management by understanding land, information, and management.

Top management awareness of the problems of land information management, and lack of cooperation, lead the managers to create the conditions in which information infrastructure can be designed and implemented. Better knowledge and information tend to bring about a better understanding of the problems and hence create the possibility for better solutions.

6. ***Maintenance of the Information Infrastructure*** : To maintain the established information infrastructure we need to create a national LIS Centre responsible to a high level steering committee. LIS Centre main tasks would be first, to maintain and control the cooperation between the participating organizations. Secondly, to support the organizations to adapt/implement the necessary technical and organizational changes. Thirdly, to implement the accepted general standards for land-related data exchnage.

In Bahrain; the present conventional approach to acquiring land data from other organizations is a time-consuming activity requiring a lot of administrative overheads just to get the data in the hand of the requesters. Although almost each organization possess a computerized information system, they can not communicate with each other.
It's like every body has a nice car but there are no roads to drive on and hence no communication can be made between them; There are no roads. There is no information infrastructure.

7. ***Quality of Information*** : Within any land information system, the data held must have a number of characteristics other than their relevance to the land. These include : [P. F. Dale and J. D. McLaughlin].

a) *Currency* : The data must be accessible in an up-to-date form within a time frame that meets the needs of the user.

b) *Precision* : The data must provide measurement information to the standard that is required. For example, measuring heights in inches is more precise than doing so in feet; similarly, underground facilities, must be recorded to a precision which they can be dug up expeditiously.

c) *Accuracy* : There must be little or no error in the information extracted from the data. Where possible error exists, the degree of probability of its correctness should be available. There must be a legal responsibility for erroneous or incorrect data. For example, in the registration of title, in which anyone who loses because of errors in the registration process can receive compensation.

d) *Verifiability* : Different users should be able to get the same answer to the same question.

e) *Clarity* : The information must be free from ambiguity.

f) *Accessibility* : It should be possible to extract information quickly and easily.

g) *Freedom from bias* : There should be no alteration or modification to the raw data in order to influence those who receive them.

h) *Appropriateness* : The information derivable from the data should relate to the potential users' requirements.

i) *Completeness* : Completeness is the degree to which a data collection has values for all attributes of all entities that supposed to have values. The data also should be complete in spatial cover and content.

8. ***Data Exchange Standards*** : Although administrative mechanisms may exist for the exchange of land-related data between government departments, they may not operate effectively. At a technical level, national standards for the exchange of data will almost certainly need to be established. These should cover data transfer formats, data classification, and accuracy standards [P. F. Dale and J. D. McLaughlin, 1989].

A national land-related information system can be viewed as an attempt to improve the effective flow of information between organizations. Effective flow of information requires an effective communication network which requires sophisticated communication technology, data exchange standards and coordination.

9. ***Price of Information*** : Land-related information creates marketable products and service. Appropriate scales of fees to charge for the NLIS products and services are difficult to assess. A too high charge will discourage its use; a too low revenue will discourage governments from investing in the system and it will take longer period than expected to recover development and implementation costs.

P. F. Dale and J. D. McLaughlin have identified three general strategies for determining the price to charge for LIS products :

a) *Cost-based pricing*, where prices are set largely on the basis of the fixed and variable costs of production and handling.

b) *Demand-based pricing*, where the price is based on what people are actually prepared to pay or what is perceived as the value of the product.

c) *Competition-based pricing*, which depends on what other producers of the same product or service are charging. This of course, does not apply when one organization has a monopoly.

In NLIS (federated) environment, organizations can purchase data and combine it with other data and change it from its original form. Therefore, it is possible to legally allow the organizations (data owners) to charge the purchasers for these products and services they have generated from the original data.

We should have two scales of fees (prices) for NLIS products and services; one is for the system participants (government organizations); the fees in this scale can be equal to the true cost of production, because those organizations need the data to fulfil their mandated responsibilities; besides they are system participants. Therefore, they are entitled to get the information they need for the cost of production.

The other scale of fees is for the external agencies (private sector agencies); the fees in this scale can be higher than production cost, because this group of users will use the information in their big projects which are generally very cost-effective.

5.5.2 Activities supporting the CSFs

The following of activities have been identified as the most important activities to support the CSFs :

1. *Form a high level steering committee*
2. *Establish an effective communication network*
3. *Carry out institutional changes*
4. *Conduct presentation and seminars and upgrade staff*
5. *Identify national and local benefits*

6. *Implement quality systems*
7. *Review legislations*
8. *Develop marketing system*
9. *Upgrade data collection, storing and presentation techniques*

1. ***Form a high level steering committee*** : To develop a NLIS, we need a body that is responsible for policies formulation, for legislations enforcement and for the coordination between government organizations. These responsibilities are best undertaken by an independent committee (steering committee) under which there will be a number of sub-committee (technical task forces) which take care of technical issues such as data exchange standard, communication networks, hardware/software purchasing, interface design,legal and economic matters, etc.

To give the steering committee the require political, legal and economical powers, its member must be from the key personals in different ministries and their chairman must be a Minister or at least an under secretary. This committee must be formed at the very early stages of the system development to ensure a successful, organized, and authorized development operations.

2. ***Establish an effective communication network*** : An effective communication network is an essential activity to support the effective flow of information, information infrastructure, cooperation, quality of information, and data exchange standards.

A land-related information network is the backbone of the land-related information infrastructure. A network requires sophisticated communications technology, data exchange standards and special coordinating mechanisms.

3. ***Carry out institutional changes*** : Individual organizations have to carry out some changes on their databases, and on their land-related information (data structure, data classification, and content).

Organizations need to change their look towards technology and see it as an opportunity to manage, share and distribute information. Organizations also need to give more consideration to each other and to external users requirements and modify their procedure and their database to accommodate those requirements and needs.

Organizations have to upgrade/increase cooperation between them to reduce duplications in data collection and recording.

Therefore, carrying out institutional changes is a must to every organization in order to be able to join the federation system of the NLISB and share its potential benefits with other participants.

4. ***Conduct presentation and seminars and upgrade staff*** : System developers have to conduct presentations and seminars directed to senior managers at government organization to support their awareness in the proposed system potential benefits, phases of development

and to give an overall view of the proposed system and what it can and can not do for them. This activity is very essential to have the senior managers' political and financial supports.

The use of a new system creates a need for job-specific education and training. New levels of education and training and new management skills are needed to exploit modern technology and to maintain the equipments in working order. Therefore, training programmes or courses are needed to upgrade the staff knowledge and to allow them to play their crucial role in the development of the NLISB.

5. ***Identify national and local benefits*** : The identification of the potential benefits of the proposed NLISB for the individual government organizations as well as for the central government is a fundamental factor in getting the necessary political and financial supports and to encourage the government to invest in the system.

6. ***Implement quality systems*** : The meaning of the term quality can be inferred from the statement: a product or service has quality when its meets requirements and/or expectations. Quality can be seen as a top management concern, since producing quality products or services is of strategic importance in creating a market for that products or services.

Quality assurance involves all steps and measures taken during data collection and system development and maintenance in order to guarantee that final results satisfy prescribed quality standards.

The degree to which a product is quality assured is determined by the quality system used to scrutinize the product. Therefore, quality system is a system which is used to perform quality assurance on a product or service. The level to which the product is quality assured is determined by the quality system. The more involved the quality system, the higher the level of quality assurance.

The ISO offers three levels of Quality System (ISO 9001, ISO 9002, and ISO 9003). Each level offers a different level of quality assurance. The choice of the level is determined by the organization's quality objectives.

7. ***Review Legislations*** : Legislations on data access, data copyright, data ownership, and data confidentiality need to be reviewed/reformed or issued if they do not exist, to support data sharing, data exchange, and data flow through the proposed system.

A legislative reform is often required before a modern LIS can be effectively implemented. Reforms can include changes in the standards and procedures in some organizations. For example, a Parcel-based LIS, can entail extensive changes in land tenure, conveyancing, and land registration.

8. ***Develop marketing system*** : In order to guarantee a continuance selling of any product or service we need a marketing system that creates the correct environment to market that product by advertising, fair pricing, distribution, guarantee of the quality of the product, and satisfying the customer by providing him with the products he needs.

The Government must not act as a monopolist whose fundamental goal is to maximize profit, but as a guardian of society's best interests. One of government's responsibility must be the provision of land-related information services and products to all government agencies at a price that just covers the total costs of production.

9. ***Upgrade data collection, storing and presentation techniques*** : An organization willing to join the federated proposed NLISB needs to upgrade data collection, storing and presentation techniques to meet the requirements and needs of other organizations in the federation. This change is part of the changes that each individual organization must undergo to be able to join the federation. For more detailed information on this topic see section 5.2.1 of this chapter.

5.6 The Land Information Centre (LIS Centre)

5.6.1 The Needs

Considering all CFSs and supporting activities to establish the proposed NLISB, there is a need within the government to define a body to perform the foregoing activities to establish the proposed system, and take the responsibilities of policies formulation, of legislations reform, of day-to-day operation, and of control and management coordination between government organizations (system's participants). This body as an information centre, can be called ***LIS Centre***.

5.6.2 The Responsibilities of the LIS Centre

1. Reduce duplication in data collection and recording of land-related information.

2. Provide access to integrated/linked land-related information.

3. Facilitate land information sharing among government organizations by overcoming the current procedural problems.
4. Provide government organizations with the necessary information on data availability (who has what).

5. Develop and maintain Policies and legislations formulation.

6. Coordinate between participating government organizations.

7. Assess land information needs from other organizations (potential participants in the federation).

5.6.3 The Benefits from the LIS Centre

1. Data can be gathered directly from its source (Data owner).

2. Data quality will be largely improved.

3. Flow of information will be cost effective.

4. Land-related information will be better managed.

5. Data can be available on-line in electronic format.

6. With LIS Centre, one-to-many relationship can be adopted instead of the current many-to-many relationship between government organizations.

7. LIS Centre could become a significant information broker in the future.

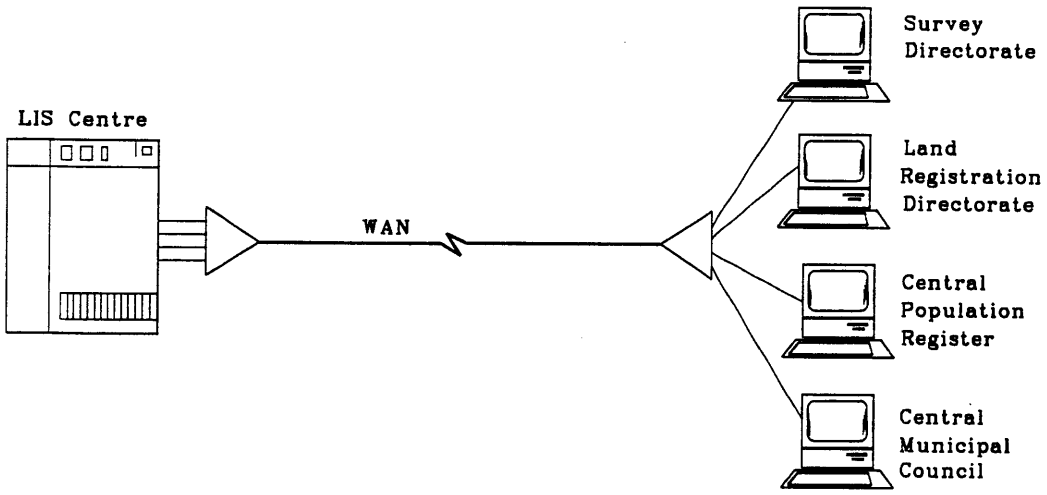


Figure 5.13 : LIS Centre as a Hub for the proposed NLISB

Chapter 6

Conclusions and Recommendations

The research has achieved all of its objectives, and based on the work carried out, the following conclusions and recommendations are made :

6.1 Conclusions

It is apparent that the concept of the NLISB proposed in Chapter 5 can be a solution to Bahrain land information data sharing and data exchange problems, if we go a step further in this concept, land data integration can be achieved in the proposed LIS Centre which will be a very useful commodity because it obviated the need to contact a number of agencies to obtain composite data about a single (or many) parcels of land.

This research is the first of its kind conducted for the establishment of a land information infrastructure in Bahrain. The research concentrates on the early stage on the necessity and constraints to develop a NLIS. Then at a later stage it analysises the current situation of the information infrastructure in the country and finally gives guidelines to develop, design, and maintain a NLIS for Bahrain with the emphasis on institutional, technical, legal, and economical issues towards the framework for establishing a NLIS in Bahrain. Without a prevailing awareness for the need for a NLIS, among the government officials, any attempt or proposal to establish a NLIS will be a total failure.

Sharing land-related information between several government organizations via Global and Local Servers Architectures leads to efficient utilization of land data. But it requires the cooperation of various organizations and a host of technical, legal, and economical agreements between the participating organizations.

There are many situations found in government organizations which indicates a lack of cooperation, lack of efficient data flow and data sharing, and institutional problems.

Information Technology (IT) needs to be introduced to some government organizations, as their information systems are still manual, although they are considered to be the main maintainer of land information in the country.

The introduction of IT entails some changes on the people's work in those organizations as well as on the organizations themselves. But it is an essential step to raise those organizations to the required level of automation in order to be able to join other organizations in a federated land-related information system, and share the potential benefits of such a system with others.

The current situation analysis has ascertain the necessity to have a NLIS, to overcome the land information management problems. This research proposes a NLISB as a conceptual solution of the current land-related data sharing, exchange, and flow between government

organizations.

The proposed NLISB, is a federated land information system which provides access to land-related information stored in different organizational databases. The organizations' databases can be located any where within the country, and can be connected by a Wide Area Network (WAN). Each organization is responsible for the maintenance of its own database.

Institutional, legal, technical, and economical constraints need to be overcomed and policies need to be formulated by a high level steering committee before any attempt to establish a NLIS. Failing to do so, the proposed system will have a very little chance of success.

Implementing a NLIS such as the proposed NLISB entail to encounter many technical and administrative difficulties such as :

* Difficulties in modifying existing organizational information systems to supply data to, and receive data from, other organizations and the LIS Centre via WAN.
* The perception of existing organizations that their land information role, which they have been practicing for many years, will be under threat.
* Difficulties and delays in data conversion and data quality, held by some government organizations
* Difficulties in legislative reformes.

The system's participants can be defined as those organizations who are responsible for the maintenance of land-related information in the country, these participants will include :

* Survey Directorate (SD) - Ministry of Housing
* Land Registration Directorate (LRD) - Ministry of Justice
* Central Planning Unit (CPU) - Ministry of Works, Power and Water
* Technical Affairs Directorate (TAD) - Central Municipal Council
* Central Population Register (CPR) - Central Statistics Organization
* Physical Planning Directorate (PPD) - Ministry of Housing
* Technical Affairs Directorate (TAD) - Ministry of Housing
* Ownership and loans Directorate (OLD) - Ministry of Housing
* Bahrain Telecommunication Company (BTELCO)

While the potential customers (external users) of the proposed system can be defined as those organizations or agencies who need land-related information for their projects, decision making, and planning processes, these customers will include :

* Banks
* Real Estates Agents
* Construction Consultants and Contractors
* Private Surveyors
* Bahrain Petroleum Company (BAPCO)
* Other Government Organizations and ministries
* Bahrain's Centre for Studies and Researches

Finally, the introduction of NLIS to effectively use and share land-related data offers the participants accurate, accessible, good quality, and up-to-date common information. As a result of having better, more accessible information, the private sector and general public within the country would benefit greatly.

6.2 Recommendations

1. ***Top level Steering Committee*** : Forming a top level steering committee from all concerned (participating) organizations and agencies is a must not only to control the cooperation of various organizations but also to take responsibility for laying down the legal framework, formulating new policies and specifications for guiding and monitoring the development of the system towards the specified goals. The Steering Committee should be supported by Tasks Forces with specific responsibilities.

2. ***Awareness*** : Awareness for the need for a NLIS has to be disseminated among government's top level officials to gain the continued political and economical support, necessary for the development and maintenance of the system.

3. ***Potential external users*** : System's participants must identify the potential external users and invite them to participate early in the planning phase. Once the users are brought together, their needs can be identified and the data needed for the widespread can be categorised.

4. ***User Requirements*** : After developing the list of potential users, interviews and questionnaires should be utilized to identify exactly each user's data needs, output product requirements, how they use it, positional accuracies and who the data comes from and goes to, specified user's requirements should be validated.

5. ***Legislations*** : Legislations for the protection of copyright, confidentiality, and misuse of government land information should be introduced as soon as possible.

6. ***Charges*** : Charges for NLISB products and services should be at marginal cost, for the system's participants and at a higher rate for the external users.

7. ***Automation*** : A few government departments such as Land Registration Directorate (LRD) and Central Municipal Council (CMC) are still operating on a manual information systems. These departments need to consider the automation of their system as a first priority in order to be a part of any NLIS in the future, the participation of such departments is essential for the success of the system, because they maintain large amount of land-related data needed by many organizations.

8. ***Standards and procedures for data flow*** : NLIS requires standards and procedures for the systematic collection of information from a number of sources, and mechanisms for the exchange of information among various databases.

9. ***Communication and Cooperation*** : Communication and cooperation between system participants is essential from the initial stages of system development to help to determine the success of the system. Only through communication, cooperation can be achieved, and only cooperation, legislations and policies can be formulated.

10. ***Parcel Identifiers (PIDs)*** : Survey Directorate's PIDs must be referenced in as many other land records as possible in other organizations, to facilitate data input and exchange. Procedures must be put in place to propagate changes in PIDs done by Survey Directorate to other organizational databases.

11. ***Data Sharing Agreement*** : A Data Sharing Agreement need to be made between participants to provide the means by which system participants equitably share the costs and benefits of developing and maintaining a NLIS. One of the key items in the Data Sharing Agreement is the definition of, and agreement on, mapping standards for the multi-participant global database. This Agreement must include public access, and the pricing of the system products and services. A legal review of the Agreement need to be conducted by each organization to ensure compliance with the government's laws.

12. ***Final Recommendation*** : The creation of a LIS Centre as an independent body to implement the foregoing recommendations is a critical factor for the success of the overall enterprise.

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Appendix A

Questionnaire for Determining user requirements for development of National Land Information System for Bahrain (NLISB)

The Aim

This questionnaire is designed to support my MSc. Research study on ***Guidelines to Establish a National Land Information System for Bahrain (NLISB)*** which will be submitted to the International Institute for Aerospace Survey and Earth Sciences (ITC) at The Netherlands in partial fulfilment of the requirements for the award of the Master of science Degree in GISs for cadastral Applications (GIC.2).

The questionnaire is directed to a selected governmental departments which share, use and generate land-related information. Its main purposes are to identify the land-related information at each selected department, what type of information the departments exchange or share between them and how information flow from one organisation (producer) to another (user), in order to study the possibility of establishing the proposed NLISB to maintain the land_related information in one system and to facilitate the sharing, integration and disseminating of up-to-date land-related information.

The objectives of the proposed system are :

1. To reduce the redundant data existing in many computer systems caused by the frequent re-keying of information into different organisation computer systems.
2. To prevent the duplication of data collection between the participating departments.
3. To provide the planners and decision makers with a good tool to support their (legal, administrative and economic) decisions.
4. To facilitate the processes of data exchange and data supply within a time frame that meets the needs of the user.

Your answers will purely be used to support the purpose of the mentioned research, and I kindly request your full cooperation, such that the results contribute optimally to the success of my research.

Your cooperation is highly appreciated,

Thank you.

Ali Al-Ansari

1. ON ORGANISATION

Organisation's name : .....
Person's name : .....
Position : .....
Address : .....
Telephone No. : .....

2. ON EXISTING SYSTEM(S)

2.1 Do you have currently a digital mapping facility ? Yes / No

2.2 Do you use standards for your mapping activities ? Yes / No

2.3 Do you have currently a computerized alpha/numeric land related information system(s)?
Yes / No

2.4 What is the degree of automation of your system ?
Manual Automated Partly automated

3. ON DATA

3.1 What types of land related data (spatial and non-spatial) do you generate ?

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.....
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.....
.....

3.2 What types of land related data (spatial and non_spatial) do you regularly use ? and from whom ? (names of agencies/departments)

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3.3 Do you receive the information in an adequate format ? Yes / No

3.4 What products do you generate from that information ?

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3.5 Who are the users of such products ?

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.....

3.6 Are you charged for that information ? Yes / No
if yes, how much ?

.....

3.7 Do you need any other type of (spatial and non-spatial) data ? Yes / No
if yes,
a) What kind ? and from whom ?

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.....
.....
.....
.....

b) What products do you generate from that data ?

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c) Who are the users of such products ?

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3.8 Do you charge the users for your information/product(s) ? Yes / No
if yes, how much ?

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3.9 How is your data stored ?

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3.10 How often do you update your data ?

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.....

3.11 Do you use topographic maps from Survey Directorate ? Yes / No
if yes, - in what form ? digital / hardcopy
- at what scale(s) ?

.....

- are they relevant in meeting your requirements ? Yes / No
if no, why ?

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3.12 Do you use cadastral maps from Survey Directorate ? Yes / No
if yes, - in what form ? digital / hardcopy
- at what scale(s) ?

.....

- are they relevant in meeting your requirements ? Yes / No
if no, why ?

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3.13 Do you use any other maps from other organisations ? Yes / No
if yes, - what kind of maps ? .....
- in what form ? digital / hardcopy
- at what scale(s) ?

.....

- from whom ?

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.....
.....
.....

3.14 In what form you prefer to have the maps ? and why ?
Digital Hardcopy Both

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3.15 What problems do you expect in sharing/exchanging your data with other organisations? And why these problems ?

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3.16 Do you have confidential information ? Yes / No
if yes, of what kind and why they are confidential ?

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3.17 Who has decided the confidentiality of that information ?

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.....

3.18 Are there any constraints to get the information you need from other organisations ? Yes / No if yes, of what kind ? and what are that information ?

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.....

3.19 Are there any information you would like very much to have now or in the future ? Yes / No if yes, of what kind and from whom ?

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.....

4. ON SOFTWARE

4.1 What kind of software are you using ? and for what ?

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.....

4.2 What kind of databases are you using ? and for what ?

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4.3 What types of operating system are you using ?

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4.4 Are there any constraints due to existing software ? Yes / No
if yes, what kind ?

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5. ON HARDWARE

5.1 What kind of hardware (computer and peripherals) system are you using? and for what?

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5.2 Are you networked (Internal (LAN) / External (WAN)) ? Yes / No
if yes with whom and why ?

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5.3 Are there any constraints due to existing hardware ? Yes / No
if yes, what kind ?

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Ministries	Departments	User of your data			Method of Deliveries					Media of Deliveries					How long does it takes to summit the data to the user ?						How frequent the user ask for your data ?					With whom you exchange dat	Data Format											
																											Map			Table		Report		Air photo			Text	
		Main	Secondary	Minor	Collect	Postal	Network	Telephone	Others	Hardcopy	Mag. tape	Flobby disc	Cassette	Network	Minutes	Hours	One day	More than one day	One week	More than one week	Every day	Once a week	Twice a week	Once a month	Twice a month		Scale	Paper	Digital	Paper	Digital	Paper	Digital	Scale	Paper	Digital	Paper	Digital
Housing	Survey																																			
	Physical planning																																			
	Technical affairs																																			
Central Municipal council	Parks																																			
	Technical affairs																																			
	Environment																																			
Justice	Land Registration																																			
Works Power and Water	Electricity																																			
	Sewerage																																			
	Water																																			
	Roads																																			
	C.P.U.																																			
Government	C.S.O.																																			

Put (X) where appropriate regarding your use of information from other organisations

Ministries	Departments	From whom you take data ?			Method of Deliveries					Media of Deliveries					How long you wait to receive the data ?						How frequent you ask for data ?					Use similar computer system	Data Format											
																											Map			Table		Report		Air photo			Text	
		Main	Secondary	Minor	Collect	Postal	Network	Telephone	Others	Hardcopy	Mag. tape	Flobby disc	Cassette	Network	Minutes	Hours	One day	More than one day	One week	More than one week	Every day	Once a week	Twice a week	Once a month	Twice a month		Scale	Paper	Digital	Paper	Digital	Paper	Digital	Scale	Paper	Digital	Paper	Digital
Housing	Survey																																			
	Physical planning																																			
	Technical affairs																																			
Central Municipal council	Parks																																			
	Technical affairs																																			
	Environment																																			
Justice	Land Registration																																			
Works Power and Water	Electricity																																			
	Sewerage																																			
	Water																																			
	Roads																																			
	C.P.U.																																			
Government	C.S.O.																																			

Checklist of Map Features

From the following list select the map features that are used by your organisation or unit. Please note the ones you NOW use with "N" and the ones that are desired in the FUTURE with "F". Also indicate the positional accuracy that is required. Use letter alone when accuracy is not important.

Example : N-2 = NOW ± 2cm accuracy OR F-3 = FUTURE need ± 3 cm accuracy.

GEODETIC CONTROL

..... Horizontal
..... Vertical

ROADS AND STREETS

..... Centerlines
..... Foot paths
..... Curbs and gutter
..... Names
..... Numbers
..... Pavement types
..... Width
..... Length
..... Parking lots
..... Safety features
..... Traffic directions

UTILITIES

..... Manholes
..... Water mains
..... Water lines
..... Valves
..... Hydrants
..... Desalination plants
..... Pumping units (water)
..... Storage units (water)
..... Sewer mains
..... Pumping stations (sewer)
..... Treatment stations (sewer)
..... Sewerage lines
..... Telephone poles
..... Telephone lines

ELECTRICAL

..... Poles
..... Under-ground lines
..... Overhanging lines
..... Street lights
..... Substations
..... Power stations
..... High tension overhanging lines
..... Pylons

LAND-RELATED FEATURES

..... Parcel boundaries
..... Parcel dimensions
..... Parcel number
..... Parcel address
..... Buildings
..... Owner's name
..... Owner's address
..... Land use
..... Easements
..... Region boundaries
..... Region names
..... Region number
..... City boundaries
..... City names
..... Block boundaries
..... Block numbers
..... Grid base (UTM)
..... Public use properties
..... Gardens
..... Cemeteries
..... Airports
..... Coast lines
..... Tracks

OTHER FEATURES NOT LISTED ABOVE

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Appendix B

1 Functional Statement

1.1 Survey Directorate (SD)

Ministry of Housing (MOH)

Main *duties* and *responsibilities* :

1. Update and develop the State's geodesic network.
2. Update and produce various survey maps identifying topographic signposts of the State's geographical areas.
3. Organize, sort, and index estate records. Conduct on-site field surveys to validate facts.
4. Conduct hydrographic surveys in Bahrain's territorial waters and issue navigation maps.
5. Establish, develop, update, and audit a topographical information bank.
6. Establish and develop an automated cadastral information bank.
7. Develop and update new survey methods and systems.
8. Prepare survey documentations.
9. Prepare reports and provide technical advice on lands and estates to the officials, and propose survey laws and regulations.
10. Audit and validate survey plans.
11. Provide survey services to various official agencies as requested.
12. Survey and audit private estates which impact on the expansion of roads, streets, and public services construction.

1.2 Land Registration Directorate (LRD)

Ministry of Justice and Islamic Affairs (MOJIA)

Main *duties* and *responsibilities* :

1. Register all actions that establish real rights and estates including transfers modifications or terminations, such as sale, gift, exchange, compensation and division and other contracts and legal actions.
2. Prepare estate deeds and records related supplement rights and any other modifications that occur.
3. Issue permanent and temporary ownership documents to owners.
4. Place advertisement in the official gazette on every estate action that require registration and those for which there is no estate document. Publish statistics about estate transaction.
5. Implement and record all court decisions issued on various estate rights.
6. Prepare index system for all estate ownership and provide the concerned official with the required information on estate ownership.
7. Collect registration fees according to various categories and percentages specified by the law and according to estimated value of the estate.
8. Appeal to the courts, at all levels on the cases brought against the directorate, and follow up cases until decision is made.
9. Set up system to maintain land maps, mortgages, and all documents to support legal registration of deeds and public record documents.

10. Provide data to the officials regarding unoccupied land and make sure government ownership of such land is recorded and provides information to concerned parties.

1.3 Physical Planning Directorate (PPD)

Ministry of Housing (MOH)

Main *duties* and *responsibilities* :

1. Prepare the general strategic plans including construction growth at the state level and road networks.
2. Conduct research and prepare town planning including roads and public services.
3. Prepare detailed planning for developing the residential and commercial areas of towns and villages.
4. Prepare plans for upgrading older urban and rural settlements.
5. Prepare plans for entertainment centres, including architectural designs, for towns and villages.
6. Prepare cost estimates and budgets in support of plans.
7. Coordinate all plans with concerned agencies.
8. Conduct on-site evaluation of projects to ensure that builders and agencies are complying with building and construction laws.
9. Propose and participate in the formulation of physical planning and building laws and regulations.
10. Conduct studies on public land utilization in an effort to realize maximum compensation and benefits.
11. Conduct research and studies in support of growth and development of future citizen settlements.
12. Review and update planning standards.
13. Operate and maintain computer systems in support of physical planning.

1.4 Central Planning Unit (CPU)

Ministry of Works Power and Water (MWPW)

Main *duties* and *responsibilities* :

1. Facilitate the planning and coordination of programmes, are plans and projects within the Ministry.
2. Coordinates through various committees established within the Ministry on matters related to operations carried out within the Ministry.
3. Liaise with external agencies on behalf of the Ministry on matters of mutual concern and when the Ministry views or input are best presented in a unified manner. In particular liaison with Ministry of Housing which includes the management of data exchange, coordination of participation in physical exercises and representation on joint working committees.

a) Ministry of Housing (MOH) :

- Permanent MWPW representatives on Technical Coordination Committee (TCC) with MOH.
- Coordinate MWPW response to land subdivision applications.
- Coordinate MWPW response to MOH survey consultations.
- Coordinate requests to locate plant.
- Administer all land ownership request to Survey Directorate, MOH.

b) Central Municipal Council (CMC) :
- Coordination of MWPW and Parks Directorate in matters of mutual concern.
- Administer and monitor building permit, septic tank and fencing permit circulation.

c) Traffic and Licensing Directorate (TLD) :
- Consultation on matters of mutual concern including wayleave procedures

4. Coordination of planning of programmes and projects :

a) Advise on the necessity for coordination between utilities in formulating respective development programmes or major projects.
b) Coordinate MWPW participation in the formulation of MOH land use master plans.
c) Ensure that the data employed for planning purposes within the Ministry is consistent between all directorates and is up-to-date.

5. Products of organization :

a) Coordination exercises relating to : - Programmes
- Area plans
- Projects

b) Policy review recommendations. Advise/recommendations on operations within the Ministry.
c) Procedures to coordinate functions internal to the Ministry and between specific external agencies.
d) Procedures to exchange data (internal/external).
e) Data collection, analyzing and dissemination.
f) Research documentation and dissemination.
g) Inter-directorate committee administration.

1.5 Central Population Registration (CPR)

State for Cabinet Affairs (Central Statistics Organization (CSO))

Main *duties* and *responsibilities* :

1. Establish and maintain the Central Population Registration for the State of Bahrain.
2. Responsible for addressing all areas, building and roads of the State of Bahrain and up-dating it.
3. Establish a central demographic information bank.
4. Communicate with government agencies to obtain population and addressing data and to coordinate the sharing and use of the registration data bases.
5. Issue a population card for nationals and residence in Bahrain.
6. Centralize all government information systems in hand with the central population registration system being the main core of information.

2 Information flow

2.1 Liaison

a) Survey Directorate (SD) liaison with other organisations

FROM/TO ORGANIZATION	DATA RECEIVED BY SD	DATA SUPPLIED BY SD
Central Planning Unit	* Answer on service queries * Electrical cables location * Water pipes location * Sewerage lines location * E.substation location * Reserved location for services	* Control points information * Horizontal * Vertical * Topographic maps * Paper * Digital * Cadastral maps * Paper * Digital * Service queries

Physical Planning Directorate	* Subdivision approvals * Layout plans * City mater plan * Planning information * Proposed roads * Proposed schools sites * Proposed services sites * Proposed recreation sites . . etc * Planning restrictions and regulations	* Topographic maps * Paper * Digital * Cadastral maps * Paper * Digital * Beacon coordinates * Subdivision coordinates * Layouts coordinates * Land ownership information
Land Registration Directorate	* Land ownership information * Government Vs private lands * Names and addresses of owners * Type of ownership * Court survey request * Survey req. for title deed	* Topographic maps * Paper * Cadastral maps * Paper * Survey reports & plans to court * Deed plans
Central Municipal Council	* Request for land certificates	* Land certificates for building permits * Survey regulations * Topographic maps * Paper * Property boundaries
Central Statistics Organization	* Blocks information & maps * Block boundaries * Block number * Roads names & numbers	* Topographic maps * Paper

b) Physical Planning Directorate (PPD) liaison with other organizations

FROM/TO ORGANIZATION	DATA RECEIVED BY PPD	DATA SUPPLIED BY PPD
Central Planning Unit	* City master plan coordination * Implementation of networks planned by PPD * Plans to construct new roads * Plans to upgrade existing roads * Traffic information and problems * Road reserves * Data regarding existing and proposed water supply networks * Data regarding existing and proposed electrical networks	* City master plan * Planning regulations & restrictions
Land Registration Directorate	* Data related to existing and proposed properties * Government Vs private land * Names and addresses of owners * Type of ownership	None
Central Statistics Organization	* Statistics and forecasts for * Population * Employment * Education levels * Economic sectors * Specialised sectoral studies * Block info. & maps	* Approved proposed roads

Central Municipal Council	* Data related to existing and proposed parks facilities * Number and location * Type of ownership * Type of grade of facility * Capacity * Area * Building regulations and restrictions	* Planning regulation & restrictions * City master plan

c) Central Planning Unit (CPU) liaison with other organizations

FROM/TO ORGANIZATION	DATA RECEIVED BY CPU	DATA SUPPLIED BY CPU
Central Statistics Organization	None	None
Land Registration Directorate	* Land ownership information * Government Vs private land * Names and addresses of owners * Type of ownership	None
Central Municipal Council	* Building permits * Answer on corner plot applications	* Septic tank/building applications * Corner plot application

d) Central Municipal Council (CMC) liaison with other organizations

FROM/TO ORGANIZATION	DATA RECEIVED BY CMC	DATA SUPPLIED BY CMC
Land Registration Directorate	* Land ownership information * Government Vs private land * Names and addresses of owners * Type of ownership	* Building permits * Approval on corner applications
Central Statistics Organization	* Addresses * Persons * Buildings	* Data on existing and proposed building

e) Central Statistics Organisation (CSO) liaison with other organizations

FROM/TO ORGANIZATION	DATA RECEIVED BY CSO	DATA SUPPLIED BY CSO
Land Registration Directorate	None	None

2.2 Existing Information Systems

DATA ON	ORGANIZATION	STORAGE	DATA TYPES
Cadastral maps	Survey Directorate	Micro VAX, Workstation	G , AX
Topographic maps	Survey Directorate	Micro VAX, Workstation	G
Landscaping plans	Parks Directorate	Workstation	G
Telecommunications facilities	Batelco Engineering Dept.	Micro VAX	G , A , C
National Addresses	CPR	Workstation	G , AX
Ownership information	LRD	Manual	G , AX
Data on building	Technical Affair Directorate in CMC	Manual	G , AX
Electricity distribution facilities	MWPW	Micro VAX	G
Street lighting facilities	MWPW	Micro VAX	G , A
Electricity transmission facilities	MWPW	Workstation	G
Road designs	Road Directorate in MWPW	File server	G
Road duct register	MWPW	Micro VAX	G , A
Road register	MWPW	Micro VAX	G , A
Drainage facilities	MWPW	Micro VAX	G , A
Foul sewer facilities	MWPW	Micro VAX	G , A
Water distribution and transmission	MWPW	Micro VAX	G , A
Planning	MWPW	Workstation	G

G = Geographic
A = Attribute
C = Connective topology
AX = Attribute data held separately from geographic data