DEVELOPMENT OF CADASTRAL CONTROL INFORMATION SYSTEM (CCIS) ONLINE

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Abstract

The cadastral reform is inevitable in this new millennium to handle and manage the constant proliferation to technological enhancement in computerization, information acquisition and communication. These will lead to the concept and realization of the Coordinated Cadastral System (CCS) for Malaysia. The most significant change that IT has brought about is the shift from conventional analogue data to digital data and consequently the introduction of the concept of online digital database. The usage of cadastral data control in CCS implementation is very important because all the measurement and cadastral control will be established according to cadastral control. The objectives of the study are to develop online-based cadastral control information system (CCIS) and to analyze the effectiveness of the system. The dataset include GPS station information, topography map, and digital cadastral database. The development of CCIS involves several phases such as data gathering, system design, interface development and physical development. ArcIMS was used in the CCIS development. The Development of CCIS Online is one of the initiatives to shift to E -Government. This is viewed as a long-term effort that will continue to evolve and improve. CCIS has been developed. A series of analysis indicates that CCIS was operating effectively.

1.0 INTRODUCTION

Almost all aspects of our lives have been touched by digital technology. Electronic information flows lie at the core of most businesses. However while digital technologies have dramatically affected the field and office components of cadastral surveying, the final result is still a paper plan that requires manual interpretation and processing before being added to the authoritative survey system. Malaysia has embarked on a programme that aims to make the cadastre electronic and deliver the benefits that arise from so doing. As Malaysia braces herself to leap-frog into the Information Age, it was strongly believed that a modern cadastre with a digital land information system and infrastructure have a strategic role in helping to propel the nation into the cyber millennium (Electronic Government) like E-Cadastre. E-Cadastre changes the rules and relationships among the Cadastre Organization, employees and documents/information. E-Cadastre uses information technologies to connect employees through software and databases. This creates a new interaction among the employees. The on-line system presents the whole cadastre workflow at the fingertips of the employees with minimal physical transfer of objects such as technically, information, maps, and certified plan.

Cadastral reform has had resurgence worldwide and interest in it has apparently been mounting as it was increasingly recognized to be of significance to economic development, social stability and the environment. This was very evident in the last decade or so, in all continents and in many United Nations member states. Malaysia was not to be left behind in this progressive development. Spurred on by domestic demands and taking cue from developments overseas, it had unceasingly taken initiatives to continually and strategically implement cadastral reforms whenever and wherever appropriate. The most recent initiative is the endeavourer to introduce the Coordinated Cadastral System (CCS) for the purpose of further improving and increasing the efficiency of the cadastral surveying system.

The cadastral survey authority (DSMM) has taken a step in introducing the concept of coordinated cadastre that will be applied to the existing cadastral system in the country. Majid Kadir (2002) first introduced perception of the coordinated cadastre in local context -"This version refers to the coordinated cadastre as a coordinated-based cadastral system with the coordinates being given legal significance. The prominence of measured bearings and distances are reduced whereby they are considered as only a means by which the final adjusted coordinates are derived. The emphasis of this concept is the earth-centred geodetic datum, a single projection system for the whole country and the application of least square adjustment technique in the distribution of survey errors."

The integrity of a multi-layer cadastre is dependent on the establishment of correct spatial relationship between the components layers. The ability to do this is truly dependent on all being available in a common coordinates system to a level of spatial accuracy that satisfies the intended purpose. As opposed to the existing cadastral coordinates system (Cassini) in the eleven states, with each state having its own Reference Meridian and origin of coordinates and one coordinates system for mapping (RSO), CCS adopts geocentric datum as a geodetic reference framework for all states. The use of geocentric datum for cadastral and mapping purposes makes spatial database integration become compatible as a result of nationwide homogenous coordinates. Least square adjustment technique employs an authentic whole-to part concept, as error are contained (distributed homogeneously throughout the survey network) and not propagated. The resulting coordinates are thus more accurate as compared with the present coordinates (Refer Figure 1).

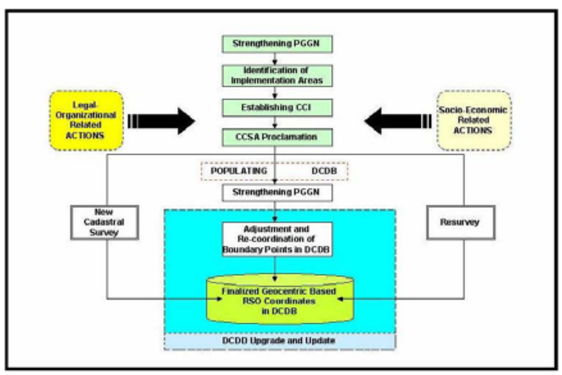

Figure 1: Basic CCS Implementation Model For Peninsular Malaysia (Majid Kadir. et.al, 2002)

2.0 THE USES OF GPS ON CADASTRAL SURVEY

2.1 Introduction

The feasibility of implementing CCS in Malaysia has been completed in 1999. It has been shown that GPS technology is found to be useful in providing control for the existing large cadastral network. By constraining the existing network with appropriate spacing of GPS stations, better adjustment results are obtained. Results from test adjustments carried out in the cadastral network of 10km x 10km area indicated that GPS control stations established at 2.5km spacing are sufficient in providing control for cadastral adjustment. Reference GPS is an ideal tool for the establishment, renovation, densification and maintenance of the control network as outlined below: i) provides an ideal means in determining a geocentric datum for the country by using IGS derived products such as precise orbits and International Terrestrial Reference Frame (ITRF). ii) Provides an ideal means of improving the internal relative accuracy of the national geodetic network to a new level of accuracy. iii) Provides tool for performing rapid densification of the existing geodetic network with reasonable stations spacing, iv) a tool for rapid and cost-effective maintenance of the geodetic network. A framework for the Coordinated Cadastral System should be based on the fundamental geodetic control network and is ideally established using the well known "from the whole to the part" principle. All cadastral surveys should in some way be connected to the existing geodetic control network. Network with dense control points and uniform accuracy is needed for this purpose. In the context of cadastral surveying, GPS could play the following role in providing the control; i) Establishment, improvement, densification and maintenance of the control network. ii) Connection to the control network. iii) Carry out cadastral survey of boundary marks.

Before GPS observations can be carried out, location of the control stations are selected with the following criteria (Majid Kadir et.al, 2002); i) cut off angle (elevation angle) > 15^{o}. ii) located away from transmission line, radio station, ground radar station and telecommunication station. iii) minimal multipath effects by avoiding glass surface, building, water surface and fence. iv) ground stability with less obstruction. v) good accessibility to location. The development of Cadastral Control Infrastructure (CCI) consists of four phases including reconnaissance, monumentation, GPS field observation, and GPS processing and adjustment. In developing Cadastral Control Infrastructure, the GPS observations were carried-out at two-grid spacing; i) cadastral Control Primary Grid at 10 spacing. ii) cadastral Control Secondary Grid at 2.5 km spacing. The cadastral control at primary grid is connected to First Order Geodetic Network or Primary GPS Geodetic Network (PGGN) 2000, while the secondary grid is tied to the primary grid for densification purposes. The important fact is that the new PGGN 2000 provides a single, uniform and consistent coordinate system within Peninsular Malaysia that will encourage an efficient exchange of spatial data and products related to information systems. It is inconvenient to keep all mapping activities in the existing local coordinates while positioning, navigation and information systems are referred to a global system. PGGN 2000 will play an important role in providing the basic geodetic infrastructure for the densification of GPS points in the Peninsular Malaysia.

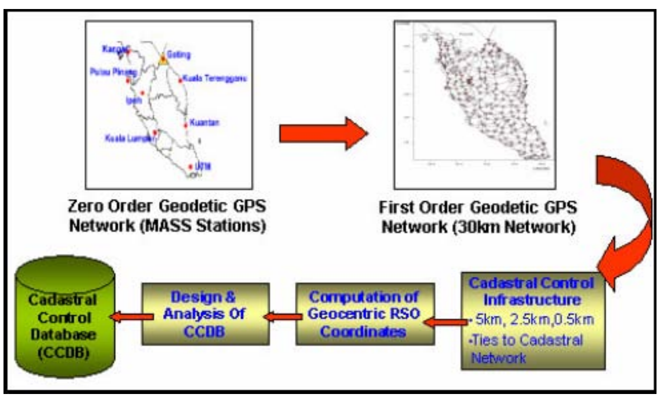

Figure 2: Conceptual Model Of Cadastral Control Infrastructure (Abdullah Hisam Omar, 2004)

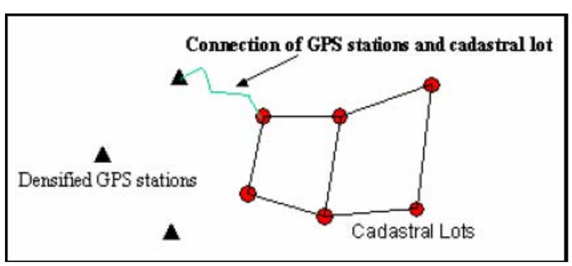

Figure 3: Connection of GPS Station to a Cadastral Boundary Mark

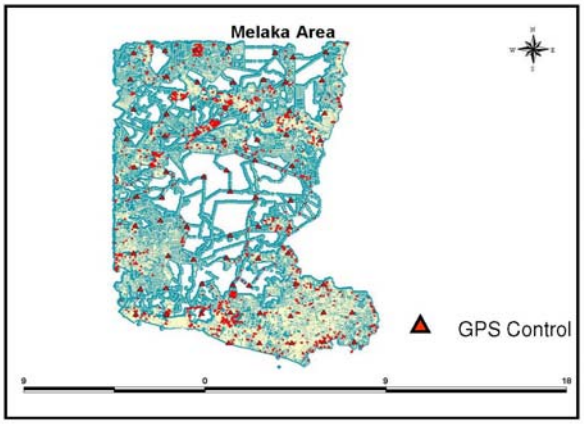

Figure 4: Cadastral Control Infrastructure for Melaka Study Area

Since the GPS network was purposely being set-up to provide control for the large cadastral network, a number of selected existing cadastral boundary marks in the study area need to be occupied by GPS.

2.2 Cadastral Control Infrastructure (CCI)

The existing cadastral survey practices used a standard traverse as a control system. The standard traverse has been connected to the second order and third order triangulation networks. These triangulation networks, namely; Perak and ASA systems have been established during 19 and 20 centuries for cadastral survey. There are some weaknesses in the present cadastral control system:-i) Sparse distribution of the control station, ii) Established along main road and not fully complete, iii) Have not been used practically. The implementation of CCS requires a homogenous datum. This factor plays an important role in providing accuracy and consistency of coordinate of the boundary marks. A high accuracy homogenous control wills constraint the error propagation especially when a cadastral network is spreading across the border. The selection of high accuracy geodetic datum established using GPS technology (1-2 part per million/ppm) for cadastral control system is appropriate. Cadastral Control Infrastructure (CCI) is one of the most important and critical issues to be considered in implementation of CCS. Appreciation of the value of CCI information also established in; i) cadastral control for cadastral adjustment, ii) control for engineering works, iii) georeferencing purposes.

3.0 CCI DEVELOPMENT

CCI started as a pilot project in the state of Melaka (30 km x 30 km). Cadastral Control Infrastructure developed in the study areas must have a systematic and efficient management. Cadastral Control Database (CCDB) plays a main role in CCS because it provides the references for GPS control during the adjustment module. The data collected (GPS station and coordinates) during the Cadastral control establishment process is easy to manage using database approach. CCDB facilitates the process of retrieving the value of the coordinates whether in 2D or 3D during the data selection and adjustment modules. The goals of database design are; i) to satisfy the information content requirements of the specified users and applications; ii) to provide a natural and easy-to-understand structuring of the information; and iii) to support processing requirement and any performance objectives such as response time, processing time, and storage space. The basic of the database design process include, i) conceptual design, ii) logical data model and iii) physical database design. CCDB comprise of two tables, namely; GPS and cadastral control station. DCDB, GPS stations and station location for each cadastral control stations respectively (location sketches and certified plans). Information about Cadastral Control station, such as station identity (boundary mark) and station coordinates have been kept in tabular format.

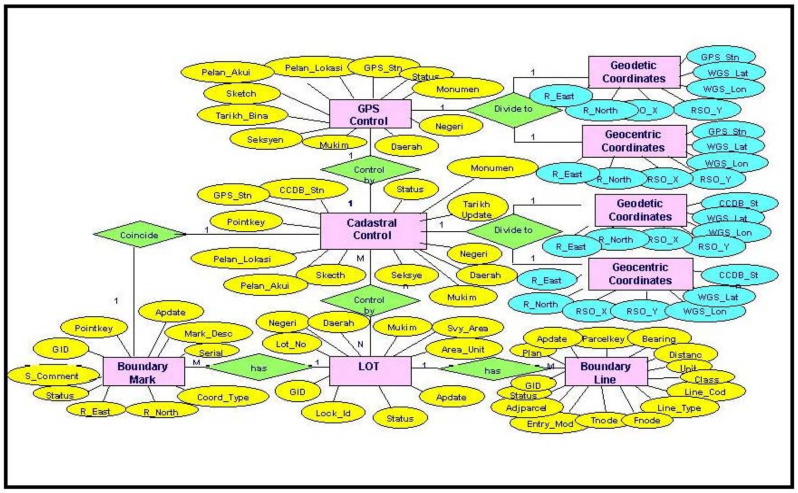

Figure 5: Cadastral Control Database Conceptual Model (Abdullah Hisam Omar, 2004)

Table 1: Logical Data Model For CCDB

Feature Dataset	Object Class Name	Object Class Alias	Type	Geometry
DCDB	Sto	Boundary Mark	Simple	Point
	Bdy	Boundary Line	Simple	Polyline
	Lot	Parcel	Simple	Polygon
Geodetic Control	GPS	GPS Station	Simple	Point
	CCDB	Cadastral Control	Simple	Point
None	GPSgeod	GPS Geodetic Coord.	Table	None
	GPSgeos	GPS Geocentric Coord.	Table	None
	CCDBgeod	GPS Geodetic Coord.	Table	None
	CCDBgeos	GPS Geocentric Coord.	Table	None

Table 2: Feature Classes in CCDB

Boundary Mark (-STO)	Boundary Line (-BDY)	Cadastral Lot (-LOT)	GPS Station (-GPS)	Cadastral Control (CCDB)
POINTKEY (Primary -Key)	APDATE	NEGERI	GPS_STN (Primary Key)	CCDB_STN (Primary Key)
APDATE	PARCELKEY	DAERAH	MONUMEN	MONUMEN
MARK_DESC	BEARING	MUKIM	STATUS	STATUS
SERIAL	DISTANCE	SEKSYEN	NEGERI	NEGERI
COORD_TYPE	UNITS	LOT	DAERAH	DAERAH
R_EAST	CLASS	SVY_AREA	MUKIM	MUKIM
R_NORTH	LINE_CODE	AREAUNIT	SEKSYEN	SEKSYEN
S_COMMENT	LINE_TYPE	APDATE	TARIKH_BINA	TARIKH_UPDATE
STATUS	ENTRY_MOD	STATUS	SKECTH	SKECTH
GID	PLAN	LOCK_ID	PELAN_AKUI	PELAN_AKUI
	FNODE	GID	PELAN_LOKASI	PELAN_LOKASI
	TNODE	NEGERI	CCDB_STN (Foreign Key)	POINTKEY (Foreign Key)
	ADJPARCEL	DAERAH	GPS_STN (Primary Key)	GPS_STN (Foreign Key)

Before completing physical database, geo-processing stage needs to be applied to avoid databases errors result from improper input. There are five steps required; i) data input editing and refinement, ii) Build topology, iii) define projection, iv) topology editing and v) map matching. The construction of CCDB is at a final step. Based on the conceptual and logical models, the final step is to construct the Cadastral Control Infrastructure database. Figure 6 explained how the identifying of GPS station in the DCDB is done. GPS stations need to be coincided with the boundary marks. In order to find the boundary mark, certified plan and a connection from GPS station to cadastral mark are used.

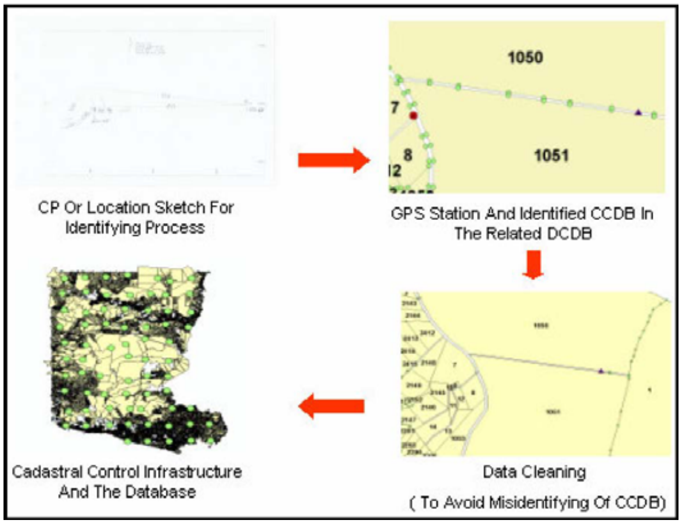

Figure 6: Process of Identifying GPS Station and Cadastral Infrastructure

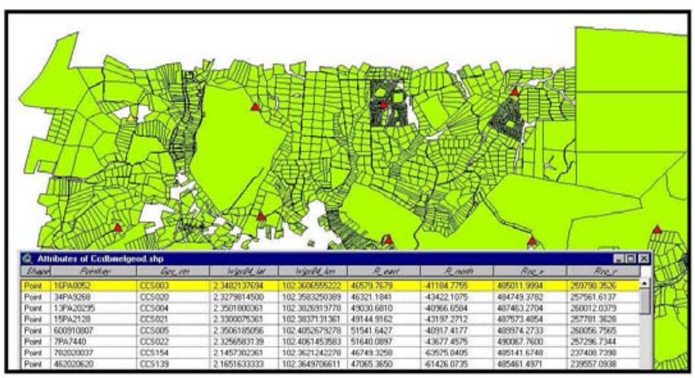

Figure 7: Example of Cadastral Control Database Used In This Study

4.0 CADASTRAL CONTROL INFRASTRUCTURE SYSTEM (CCIS)

4.1 Overview of CCIS

Cadastral data control includes information influence about rights and interests in real property like ownership, boundaries, and land survey information. Cadastral data control means the "core" data that provides a foundation upon which to build more detail. The development of Cadastral Control Information System (CCIS) is one of the initiatives to shift to E – Government. The concept behind these projects is to reduce duplication of effort and increase data sharing capabilities. This is viewed as a long-term effort that will continue to evolve and improve. The CCIS project is a collaborative effort to develop a common Geographic Information System (GIS) cadastral database for the state and implement a method of communicating cadastral information between organizations and the common database.

The common database, or Cadastral control information, will be maintained collaboratively with many federal, state, local, tribal and private organizations. This collaborative effort will reduce duplication of effort and increase efficiency in the collection and maintenance of cadastral data control across the state. However, the Cadastral control information is designed to incorporate much more than land survey information. Building this information base will provide a standard and consistent source of public land and survey information for all to use and share. This project will afford opportunities to service local government operations by providing the data and tools necessary to engage in a strategic GIS direction and improve efficiency in cadastral work operations.

4.2 Online Based System

The tremendous development of computer technologies and telecommunication networks allows for the emerging of CCIS. The Cadastral Control Information System database contains GPS coordinates and related information for cadastral control, which form the cadastral survey authority (DSMM). Cadastral Control Information System (CCIS) applications range from simple, pre-drawn maps on a Web page to network-based collaborative GIS in which users at remote locations share common data and communicate with one another in real time (not yet widely available). The technologies being developed to make CCIS Online applications possible include servers (which stores data and applications), clients (which use the data and applications) and network communications (which control the flow of information between servers and clients).

The basic CCIS service architecture is similar to the client/server model .A model upon which the World Wide Web (WWW; hereafter referred to as the Web) and most other Internet services are based. “CCIS Online” allows registered users access to the database using various search options. Result of the search can be viewed on the screen, printed or saved to file. Online-based CCIS provide information of cadastral control station in GDM2000 coordinates and all related information for cadastral control stations such as image, locality sketch plan, Certified Plan and topography map, as well as coordinates attribute in a tabular format. This information can be viewed, printed and saved through the system. The concept of the system is on-line based introduction and communication between user and system. Network technology provides high-speed communication channels for publishing, accessing and disseminating geographic information via networks.

4.3 CCIS Design Process

The Cadastral Control Information System (CCIS) provides public access to view and query interactive maps. The Cadastral Control Information is for the state of Melaka as a study area utilizes ESRI’s ArcIMS 3.1 technology in the system development process. Figure 8 and Figure 9 show the general methodology for CCIS Development stage.

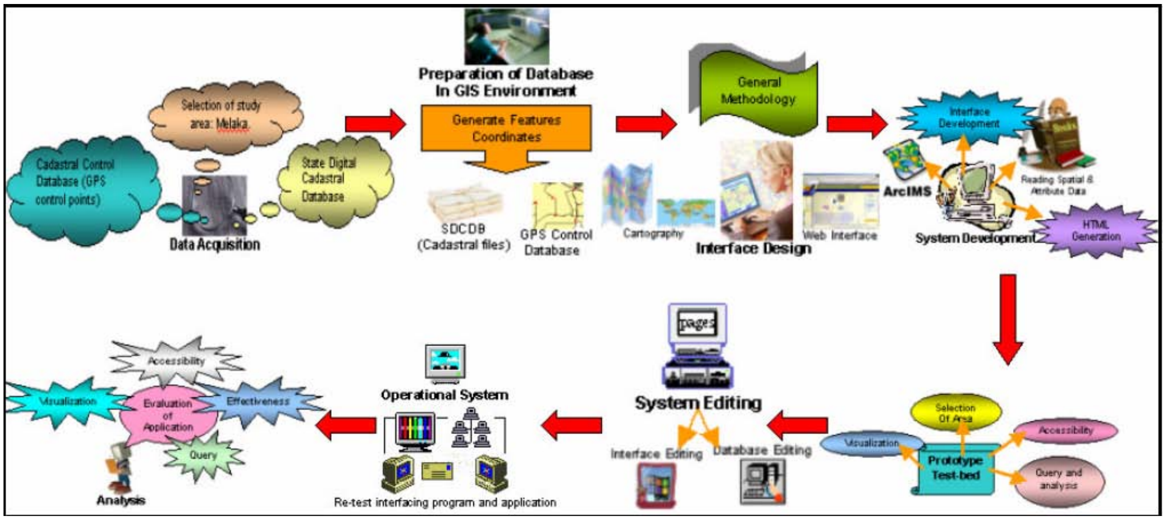

Figure 8: Overview of the General Methodology

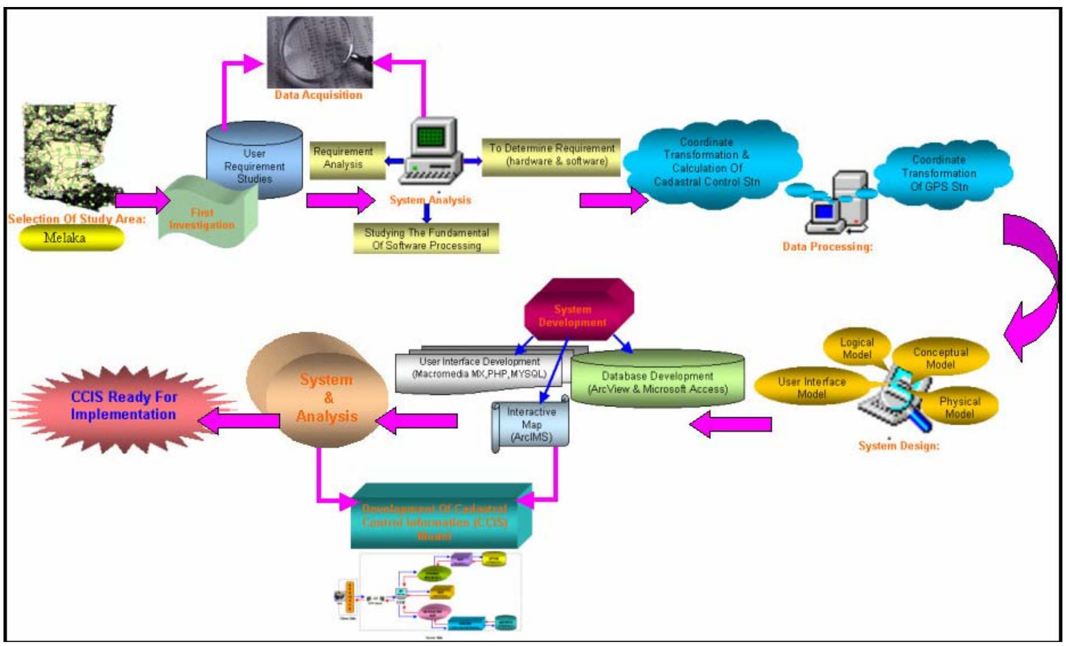

Figure 9: Methodology for CCIS

Table 3 and Table 4 indicate that the CCIS System provides on-line functionalities such as interactive map, on-line Query, E-Commerce and many more. CCIS only requires users to have Internet connection as a basic specification in order to use CCIS.

Table 3: System Requirement Analysis

System Requirement Analysis	
Data	- Spatial (GPS stn/Cadastral Control stn, DCDB data, Certificate plan, Location plan, Sketch plan, Topographic map). - Attribute (All information covering both GPS control and cadastre-monument types, location etc).
Software	- ArcView version 3.1, ArcIMS version 3.1, Macromedia Dreamweaver MX, Microsoft Access 2000, PHP, MySQL.
Hardware	- Personal Computer – Window 2000, Scanner, CD writer.

Table 4: Specification For CCIS System

Aspect	Description
Appearance	Window-Based
Design	User-Friendly
Functionality	1) E-commerce 2) Interactive Map 3) Browse 4) Query 5) Online Payment 6) Zoom 7) Identify 8) Registered Online etc….
User	Multi-User At One Time
User-Comments/Recommendation	Allowed

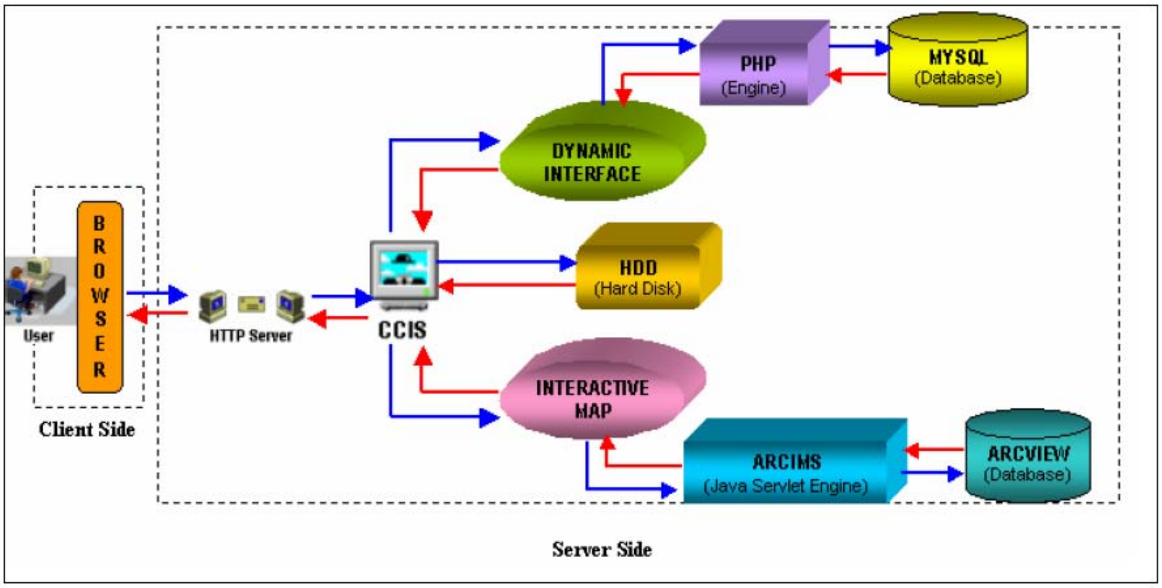

Figure 10 : CCIS System Methodology

Methodology for CCIS was designed based on client-server requirement, which is, contains user and system interaction. The system start to operate when there is a query from a client, then the system will access to the database stored in ArcIMS. Dynamic interface is used for on-line user registration process. On-line registration requires user to provide personnel information for activation phase.

Figure 11 (a) visualizes the main interface of the CCIS system which is contains of overview of related CCIS information. User need to register and acquire approval from administrartor before begin accessing the system as shown in Figure 11 (b). Registered members are allowed to browse and to execute queries on cadastral control through the system (Figure 11 (c)). E-commerce capabilities also have been included in the CCIS system (Figure 11 (d and e)). Figure 11 (f and g) show the interactive map functions provided in CCIS. Related information of the Cadastral Control stations such as map, certified plan, location and table can be accessed through interactive map.

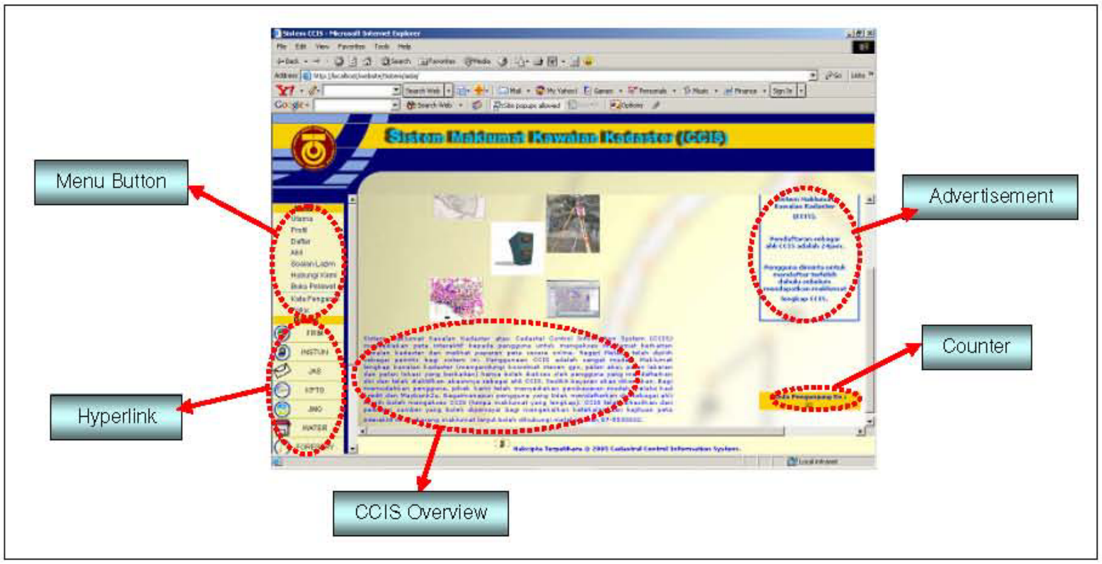

Figure 11 (a): Main Interface of CCIS

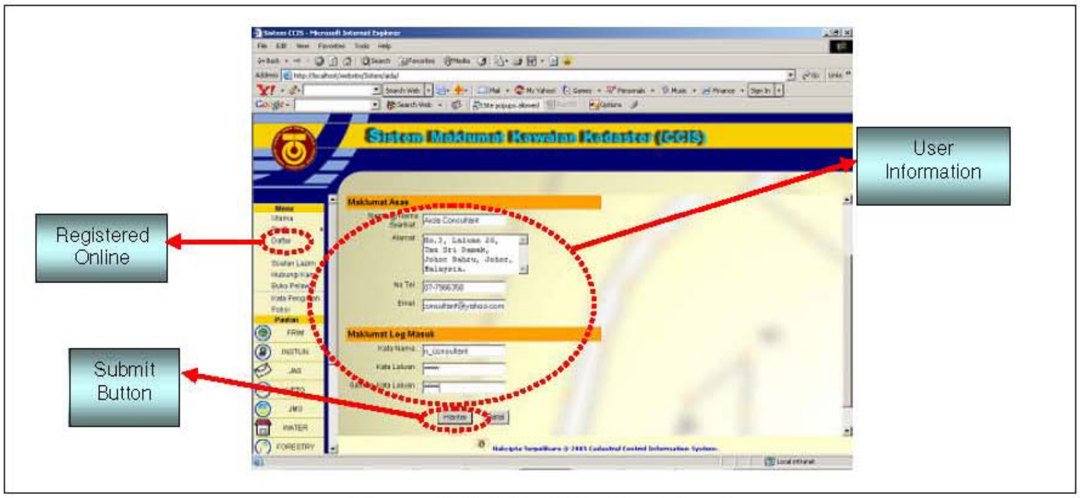

Figure 11 (b). On-Line Registration

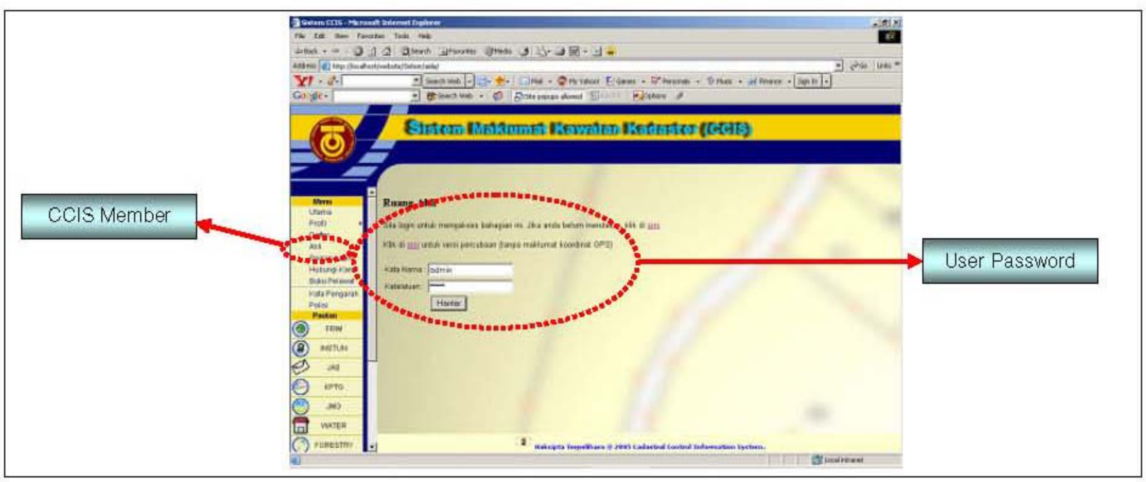

Figure 11 (c): Login Window

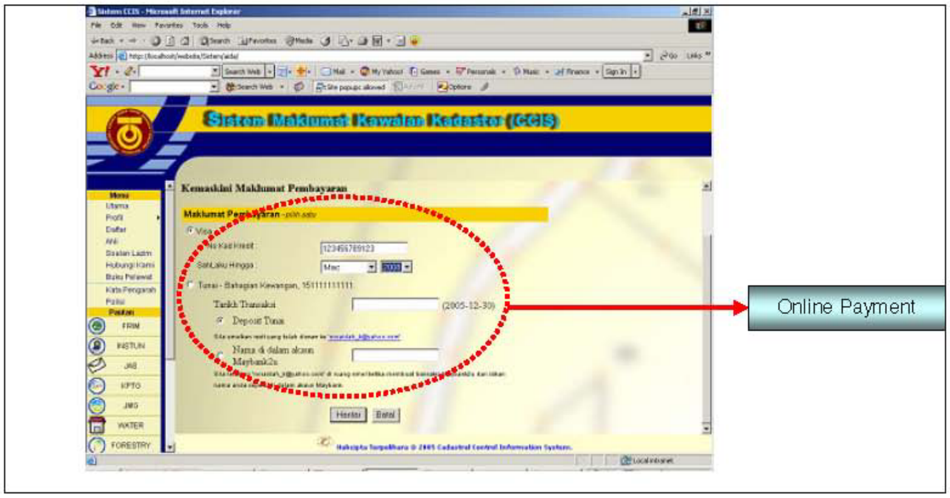

Figure 11 (d): Online Payment Menu

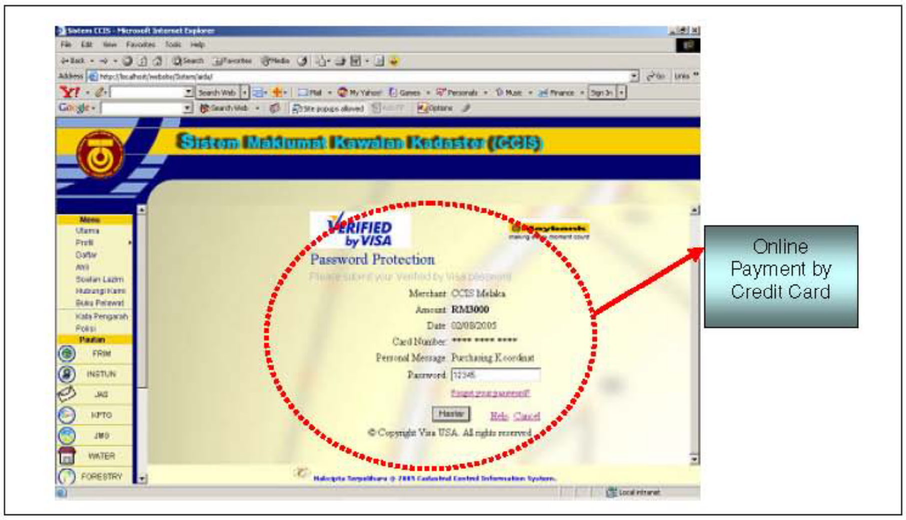

Figure 11 (e) Online Payment Using Credit Card

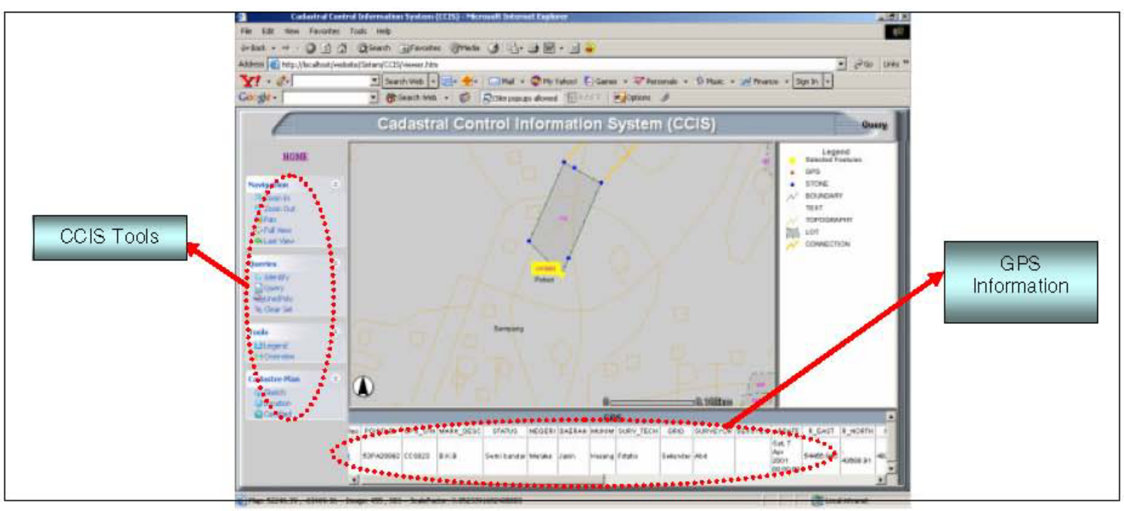

Figure 11 (f): Interactive Map and Query Tool

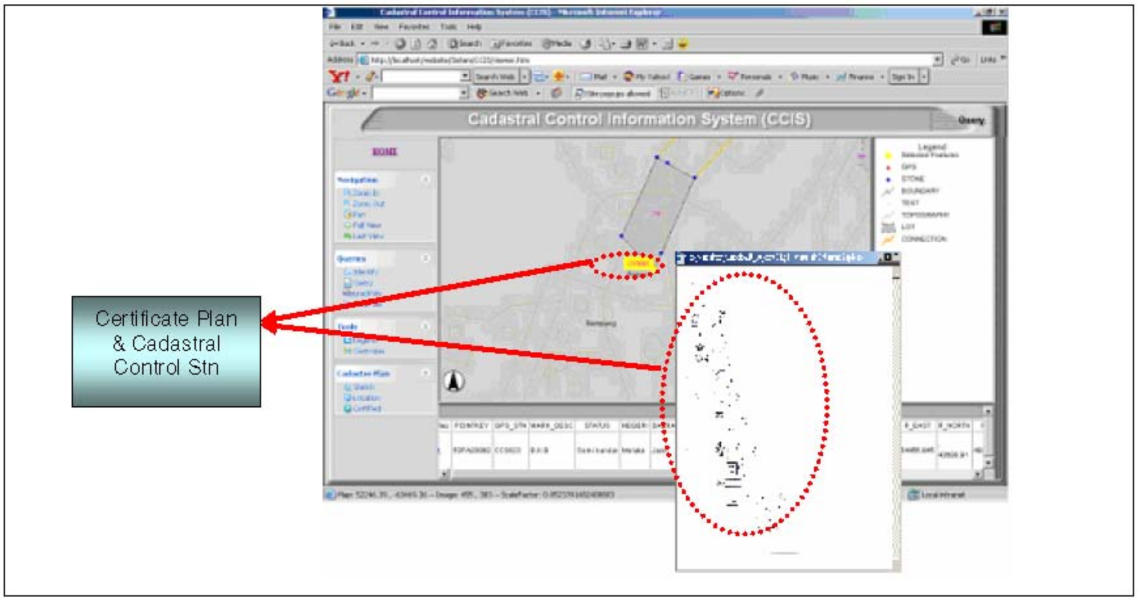

Figure 11 (g): Cadastral Control Location and Related Information

5.0 CONCLUSION

CCIS is the solution for delivering dynamic maps, cadastral data control and services via the web. It provides a highly scalable framework for GIS Web publishing that meets the needs of corporate Intranets and demands of worlwide Internet access. CCIS services can be used by a wide range of clients. Using CCIS, user can access cadastral data control directly through the Internet connection. The development of CCIS will benefits few technical and organisational issue such as coordinating work, standardizing data and tools, speeding up application development, improving and documenting data, resolving data conflicts, and data sharing. CCIS is one of the initiatives to shift to E – Government especially for Department of Survey and Mapping Malaysia (DSMM).

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