KERTAS 10

Dr. Teng Chee Hua
Pengarah Ukur Seksyen Penyelarasan Kadaster
JUPEM

Coordinated Cadastral System

COORDINATED CADASTRAL SYSTEM FOR PENINSULAR MALAYSIA

by

Dr. Teng Chee Hua
Department of Surveying & Mapping Malaysia

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ABSTRACT

The Department of Survey and Mapping Malaysia (DSMM) has been adopting computerized system for many of its processes since 1969 and currently there are about 6.3 million surveyed parcels captured within the Digital Cadastral Database (DCDB). With the advancement of ICT it is becoming more advantageous to introduce Coordinated Cadastral System (CCS) for the purpose of further improving the efficiency of the cadastral surveying system. As the name implies, CCS is a cadastral system that is based on coordinates and as such will enable synergistic integration with other systems such as Geographical Information System (GIS) and Global Positioning System (GPS) to enhance data acquisition, storage, processing and management operations. Before CCS can be utilized in the daily operations various elements need to be put in place to address the weaknesses of the present system. The most tedious task would be the re-coordination of all the states DCDB to form a seamless homogenous National DCDB (NDCDB). This paper will outline the various efforts undertaken by DSMM towards achieving such environment.

1. INTRODUCTION

Since 1996, DSMM has collaborated with the University of Technology Malaysia to determine the feasibility of implementing the CCS model for Peninsular Malaysia. The study was funded by the Land Surveyors Board of Peninsular Malaysia. Among the early objectives of the study include an investigation on the suitability of using GPS in cadastral survey, the adoption of a geocentric datum for the country, the possibility of using rectified skew orthomorphic projection (RSO) in cadastral survey for Peninsular Malaysia and issues related to legal traceability, standards and specification of GPS equipment for cadastral survey. Subsequent studies also looked into developing a control infrastructure for cadastral survey, establishing methodology for the re-coordination of the DCDB, analyze the effect of integrating the DCDB with mapping dataset and address institutional issues related to the implementation of CCS. Figure 1 shows the CCS conceptual model developed for Peninsular Malaysia.

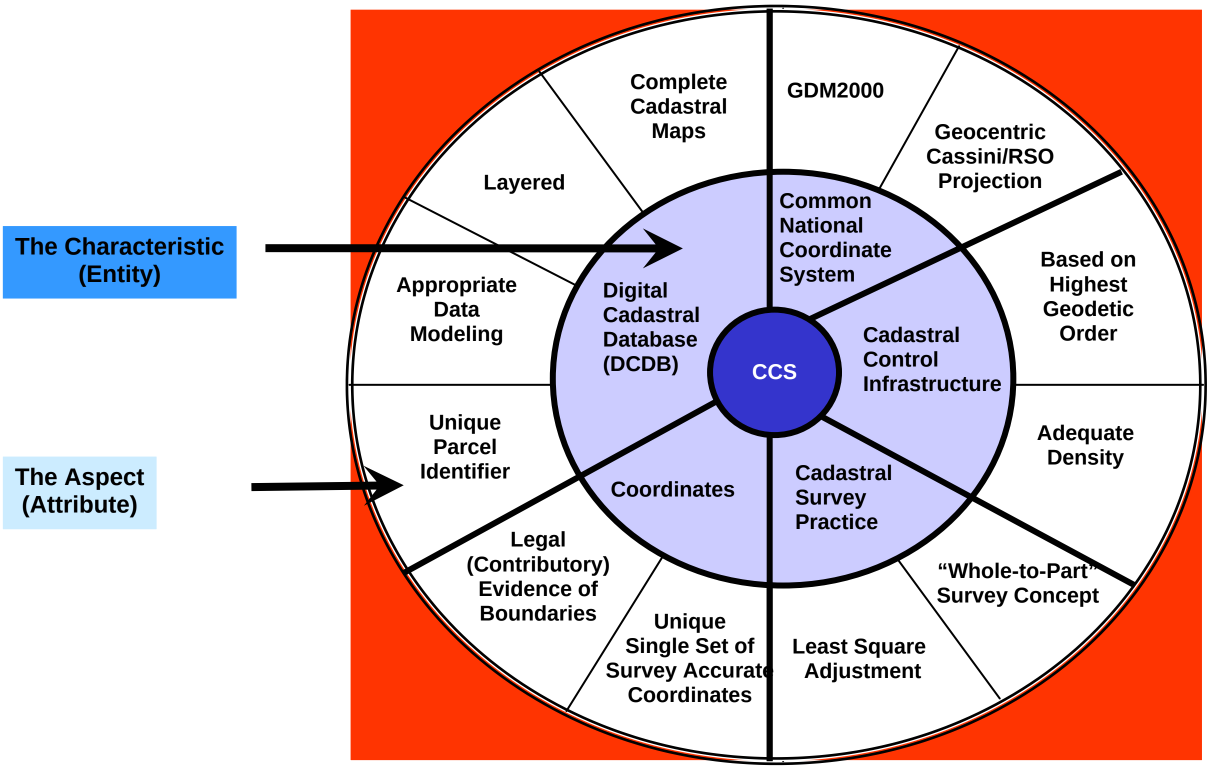

Figure 1: CCS Conceptual model for Peninsular Malaysia

The study culminated in a pilot project conducted within the state of Malacca as a precursor towards the implementation of CCS for the whole country. The pilot project was divided into four phases namely the establishment of cadastral control infrastructure, development of applications for the checking and re-coordination of the DCDB, drafting of new survey regulations for future surveys carried our in CCS environment and to present a cost benefit analysis on the implementation of CCS.

2. CADASTRAL CONTROL INFRASTRUCTURE

Cadastral Control Network is an important characteristic of the CCS pilot project implemented in the state of Malacca. The infrastructure was developed by systematically coordinating selected boundary marks of cadastral parcels to the Geocentric Datum of Malaysia (GDM2000) using GPS technology. GDM2000, which was launched in August 2003 is based on ITRF2000 and is connected to 17 other ITRF permanent reference stations in the region using 4 years of GPS observation data. There are currently 238 primary geodetic control stations through out the country available for cadastral controls. Table 1 summarizes the types and number of control used in the pilot project.

Table 1: Grid Spacing for Cadastral Control Network

Network	Grid Spacing	Number of Station	Reference Station
Primary (A)	10 km x 10 km	23	PMPGGN
Secondary (B)	2.5 km x 2.5 km	172	Primary
Tertiary (C)	0.5 km x 0.5 km	360	Secondary
Total		555	

The primary cadastral control network was established using 6 calibrated dual frequency GPS's with geodetic antennae. The observations were conducted using simultaneous static method for 15 days from 23 November 2004 to 7 December 2004. Observations were carried out with two sessions of 3 hours each at interval of 15 seconds.

The secondary and tertiary cadastral control network was established using rapid static method with 2 base stations and 4 rovers. Each rover station was occupied for 1 hour for the secondary and 30 minutes for the tertiary controls. The field survey for both secondary and tertiary controls was conducted between 28 January 2005 and 4 March 2005.

All processing were performed in the 3D environment (Latitude and Longitude) and the average taken before being projected to the plane RSO and Cassini-Soldner coordinates systems for the next phase of the adjustment. The maximum different between two based stations is 4cm in the latitude/longitude and 6 cm in the height.

The working group also conducted a test using the recently established MyRTKNet service and recommended that future control establishment utilizes RTK methodology which will expedite the observation and reduce processing time. In places where there are no mobile communication coverage, post process virtual reference system may be used.

3. RE-ADJUSTMENT OF DCDB

Early studies had been conducted using datasets that are keyed-in manually to form the database before being extracted for least squares adjustment, which is a time consuming process. Obviously, for the large cadastral network it would be desirable to design and implement a database conversion system that will partly automate the processes of re-adjustment. Figure 2 shows the various modules developed within the refined re-adjustment phase. Basically, the refined re-adjustment module consists of three main modules: (1) Cleaning Module, (2) Re-coordination Module, and (3) Re-population or Re-projection Module.

The cleaning process basically ensure that the database information are keyed-in correctly especially the bearings and distances obtained from certified plans. The networks of land parcels are checked for topological correctness which will assist the process of data selection for subsequent re-coordination. Duplicated and missing information were corrected. Connection lines were added where necessary to prevent island lots. The cleaning process also checks the misclosure of individual parcel based on the class of survey that had been carried out previously.

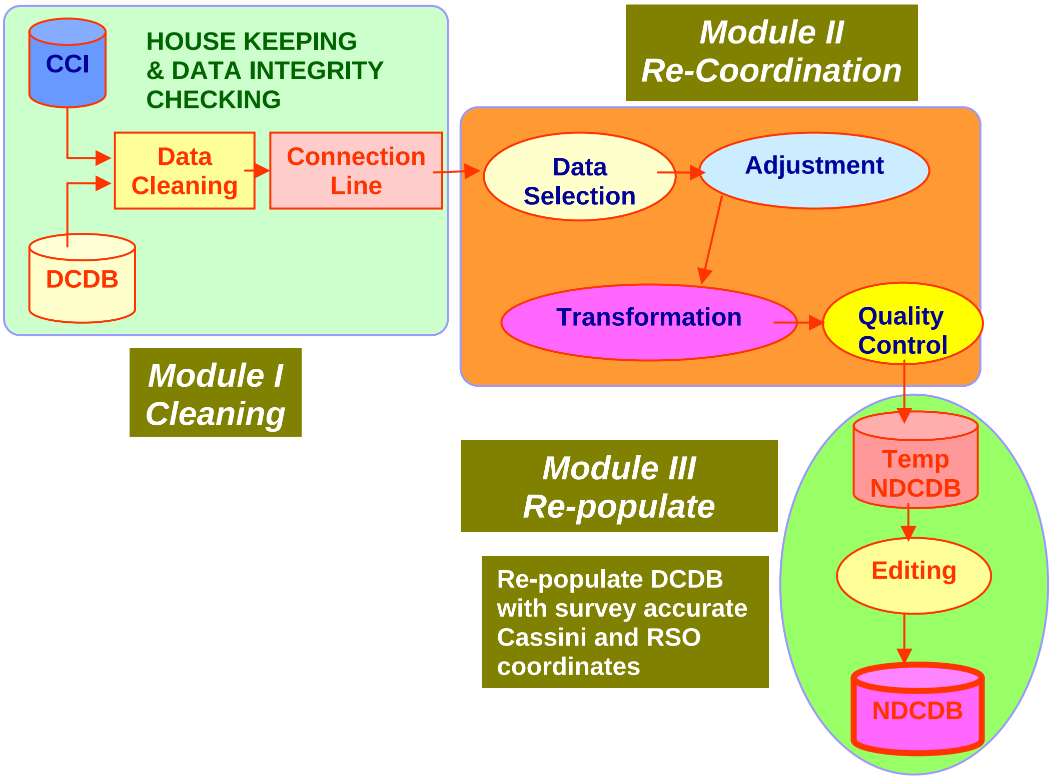

Figure 2: Re-adjustment modules for phase 2

Re-coordination was performed for blunder detection, network checking and network building using StarNet least squares adjustment software. Statistical test was conducted for overall data integrity assessment. Global test criterions have been specified such as the Chi Square Test at 95 % confidence level with an error factor close to 1. The quality control stage is to test the adjusted coordinates with the ground truth coordinates obtained by RTKNet methodology.

The re-population module is designed to re-populate existing DCDB with a new geocentric based Cassini and RSO coordinates (rigid coordinates). The new GIS-ready DCDB (or NDCDB) will eliminated the non-uniqueness of coordinates problem that was inherent in the previous DCDB. Attribute information may differ slightly with the current NDCDB. As a result, NDCDB will provide a homogenous and systematic coordinate system for cadastral and GIS applications.

4. SURVEY REGULATION

At this phase the working group is given the tasks to review the present survey regulations and to propose new survey regulations. They are also required to review existing laws related to the implementation of CCS. The group has simplified the field survey procedures to allow for GPS to be used for cadastral survey. Existing methods will still be allowed with the added advantage of using coordinates and least square adjustment. Intersection and resection will be acceptable even for long distances. The expected accuracy achievable under the new CCS environment will be 5 cm for urban area and 10 cm for rural area. After much discussion the group recommended that section 396 of the National Land Code be maintained as boundaries marks will still be planted based on coordinates. The group also conducted a field survey based on adjusted NDCDB and found the new procedures to be simpler and fulfill accuracy requirement.

5. COST BENEFIT ANALYSIS

A cost benefit analysis was conducted to determine the cost viability of implementing CCS for the whole nation. The previous CCS pilot studies have shown that CCS is technically and operationally viable. However, a comprehensive cost benefit analysis will provide decision-maker with the necessary information to evaluate alternative system development, enhancement, or improvement. The analysis provides the estimated costs of developing and operating each feasible alternative and the benefits to be derived. The cost benefit analysis is not simply a method of determining the least cost alternative, but a means of determining the most cost effective alternative. For the purpose of comparison, two alternatives (1) the status quo and (2) enhancement and improvement to current system were considered for the proposed development and implementation of CCS.

The results of the analysis indicate that the development and implementation of CCS has the highest benefit to cost ratio over improvement to current system and status quo. Table 2 shows the relative value comparison when the qualitative (intangible) benefits were considered together with the quantitative benefits of each of the alternative. The 2.31 ratio can be translated as for every RM1.00 invested, the return is RM2.31

Table 2: Cost/Benefit Analysis

ALTERNATIVE	CONVERTED COST (CC)	CONVERTED BENEFIT (CB)	BENEFIT TO COST RATIO CB/CC
STATUS QUO	4.23	2.10	0.49
IMPROVEMENT TO CURRENT SYSTEM	6.30	3.70	0.59
DEVELOPMENT OF CCS	6.43	14.9	2.31

The results of the cost benefit analysis showed that the development and implementation of CCS for Peninsular Malaysia is economically viable.

6. CONCLUSION

The CCS Pilot Project for the State of Malacca has been achieved successfully. The next stage would be to roll out the implementation to all the other states. The core group has taken initiative to transfer their knowledge to selected staff in all the other state to ensure smooth transition during the Ninth Malaysian Plan with the implementation of e-Cadastre.

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