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THE AUSTRALIAN HYDROGRAPHIC INFORMATION SYSTEM

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Abstract

The rapid changes in technology created by both the electronic and information ages have generated tremendous forces on the style and procedures of managing electronic hydrographic data acquisition and processing. This technological force is shaping the future direction for hydrographic information management within the Royal Australian Navy (RAN) Hydrographic Office. This paper examines the concept of the RAN Hydrographic Office Hydrographic Information System (HIS) and, in particular, addresses the need for the HIS to be a system undergoing continual development to maintain pace with technological advancement.

INTRODUCTION

The Hydrographic Information System (HIS) was conceived back as early as 1980. The perception of HIS was that it would be a development system that would enable hydrographic information within the Hydrographic Branch to be effectively managed. Henceforth, implementation of HIS would be a staged process. This process will in effect allow the Hydrographic Branch to maintain recognition of the expanding acquisition rate of incoming digital hydrographic data from the RAN's HYDLAPS (Hydrographic Data Logging and Processing System) and LADS (Laser Airborne Depth Sounder) systems as well as from other external survey sources.

The HIS is a tool which will handle raw survey data, survey planning and management and chart information management. As the system is further developed, other functions of the Hydrographic Branch will be incorporated into the HIS concept. These functions include Notices to Mariners, Sailing Directions,

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Geographic Nomenclature and eventually a network solution to other proposed databases which include the Australian Oceanographic Data Centre's HYDRO-COMP system, the RAN Maritime Environmental Database (MEDB) and the Defence GIS Military Database. Continued implementation will be achieved by identifying state-of-the-art hardware and software technology along with developing standards of information management within the Hydrographic Branch.

The specifications developed for the HIS tender were designed to allow flexibility in the solution relating to the current and perceived future direction of geographic information systems developments within Defence, other Commonwealth and State Authorities and private maritime data gatherers. Subsequently, as the first phase of implementing this philosophy, a world-wide request for tender was initiated in May 1985. The successful tenderer was GeoVision Australia Pty. Ltd. with the contract being let during 1986. GeoVision provided a solution to supply hardware and specialized software comprising their Core product versions of the Advanced Mapping System (AMS), Geographic Information System (GIS) and supplementary HIS version software which potentially offered the flexibility required by the Hydrographic Branch.

HYDROGRAPHIC DATA ACQUISITION IN AUSTRALIA

The primary factor affecting the functions and roles of hydrographic activity is the control and coordination of the national asset of hydrographic, oceanographic and marine operational intelligence information. Current activities are being directed towards the integration of the RAN Marine Science Force field activities, with relevant data from other sources, to provide a single information base for all potential users.

The major contributors to the accumulated national resource of hydrographic survey data are the RAN Hydrographic Service, Commonwealth and State Authorities, private companies, private individuals and mariners. Their combined contribution comprises the state of knowledge of Australia's ocean area. The slow accretion of information over two centuries has always been by manual methods and hence the requirement for computer-based technology is being applied to provide more efficient methods for data collection. The current holdings held by the RAN Hydrographic Service amount to some 58,000 hydrographic survey documents, each containing from hundreds to many thousands of soundings.

Within the next six to twelve months, the RAN Hydrographic Service's shipboard sounding output will be fully digital. Many of the other data sources are already digital. Since the advent of digital data-logging systems, their embedded and proprietary processors have dictated that compatibility will be best achieved at the data output level. Anticipated data volumes from Navy's HYDLAPS systems are 750,000 soundings annually and from other sources, 500,000 soundings annually. In addition, during 1991-92, the RAN Hydrographic Service will introduce the Laser Airborne Depth Sounder (LADS), with expected data volumes to be in the order of several million soundings annually. Techniques for analyzing satellite image data for inferring depth will improve and the subsequent increase in data intelligence will be hundredfold. Furthermore, traditional survey data sources will continue apace.

One of the major responsibilities of the RAN Hydrographic Branch, being the lead agency for hydrographic information, is the ability to interact with both data providers and information users by providing an effective data transfer facility. The digital data exchange paths which the Hydrographic Branch must address include:

HIS	<--->	HYDLAPS
HIS	<--->	LADS
HIS	<--->	AUTOCHART
HIS	<--->	public and private survey authorities
HIS	--->	Maritime Command Centre
HIS	--->	Maritime Environmental Data Base (MEDB)
HIS	--->	Military Geographic Information System

Note: <---> indicates direction of data flow.

It therefore becomes critical that hydrographic information be effectively managed and consistently qualified to maintain a standard of information integrity. This qualification process for both existing and future data, in any format or media, will be lengthy and resource consuming.

HIS EXPERIENCE TO DATE

The HIS Function

The functional requirements of the HIS are predicated by the existence of a Hydrographic Data Base (HDB). The HDB is intended as an integrated repository of hydrographic digital data from all sources. Whilst the majority of this data set will be sounding data, the HDB is not constrained to soundings alone.

The HDB is concerned primarily with the storage of soundings and their 'owner' polygons. Sounding data is collected on a survey/mission basis and the survey limits can be defined by polygons. Further, within each polygon denoting a survey area, other polygons will exist which denote groups of soundings collected at various resolutions using various techniques. These polygons will allow effective management of sounding data based on attribute criteria stored during data entry. For more information on the use of polygons as a management tool, the authors suggest that those interested refer to the paper by Burrows (1988).

All survey and sounding information used for the compilation of charts can be managed within the HDB by accessing a separate Chart database using distributed database networking. This facility will in the future be utilized to access other databases i.e. bottom quality, shipwrecks, geographic nomenclature, lights, buoys, beacons, etc. as they are themselves developed.

The organization of the HDB is based around a multi-tiered structure as given in Figure 1. The base level of the HDB will contain all survey data entered, irrespective of age, resolution and overlap. The assessment of this data

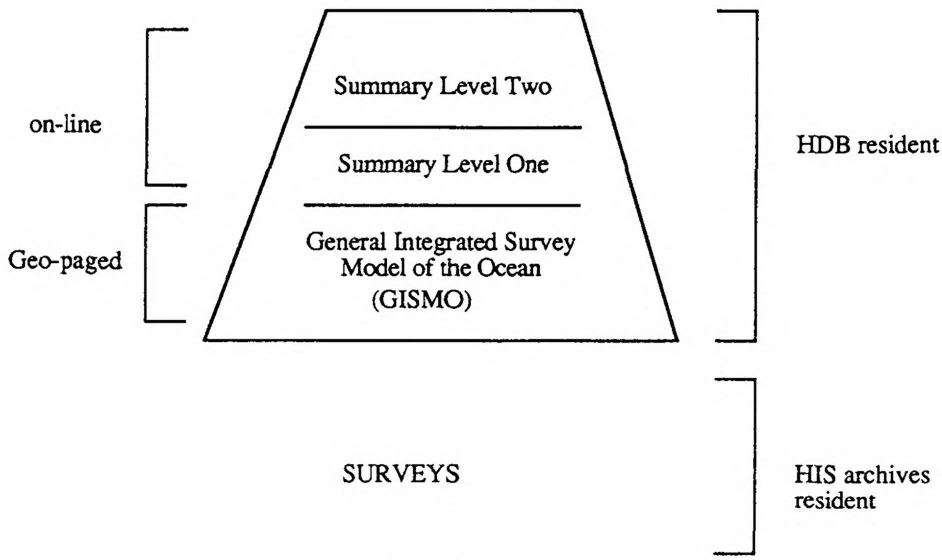

FIG. 1.— HDB Levels.

will then create the next level known as the General Integrated Survey Model of the Ocean (GISMO). The GISMO contains all selected sounding data, from all survey sources, that have been quality controlled and hydrographically approved. The GISMO is a single contiguous model (i.e. no overlap of data) covering the world (albeit at different fidelities and resolutions in various regions). Above the GISMO level are Summary Levels with data being held online. Each Summary Level is a suitably data generalized GISMO level for uses at small scales. A Summary Level will allow a user to rapidly review the data set's spatial distribution over a large geographic area.

System Configuration

The HIS host software is running on two Hewlett Packard 9000/840 minicomputers operating under the UNIX environment. Data-logging, input, archiving and database management are undertaken on these machines. A high speed local area network (LAN) is used to connect stand alone graphic work stations and a colour electrostatic plotter. The work stations are DEC VAXstationII/GPX computers also operating under UNIX and are optimized for interactive graphics performance. The work stations utilize the same spatial-relational DBMS as the HIS host. The configuration for HIS is given in Figure 2.

The hardware was selected at the commencement of the project and it has become apparent since installation that the work stations will not provide the performance or capacity required to download and analyze sounding data sets in excess of twenty thousand points. This problem will be overcome with the purchase of more modern work station technology. Existing work stations will be used for data entry of existing manuscript polygon survey indexes, entry and

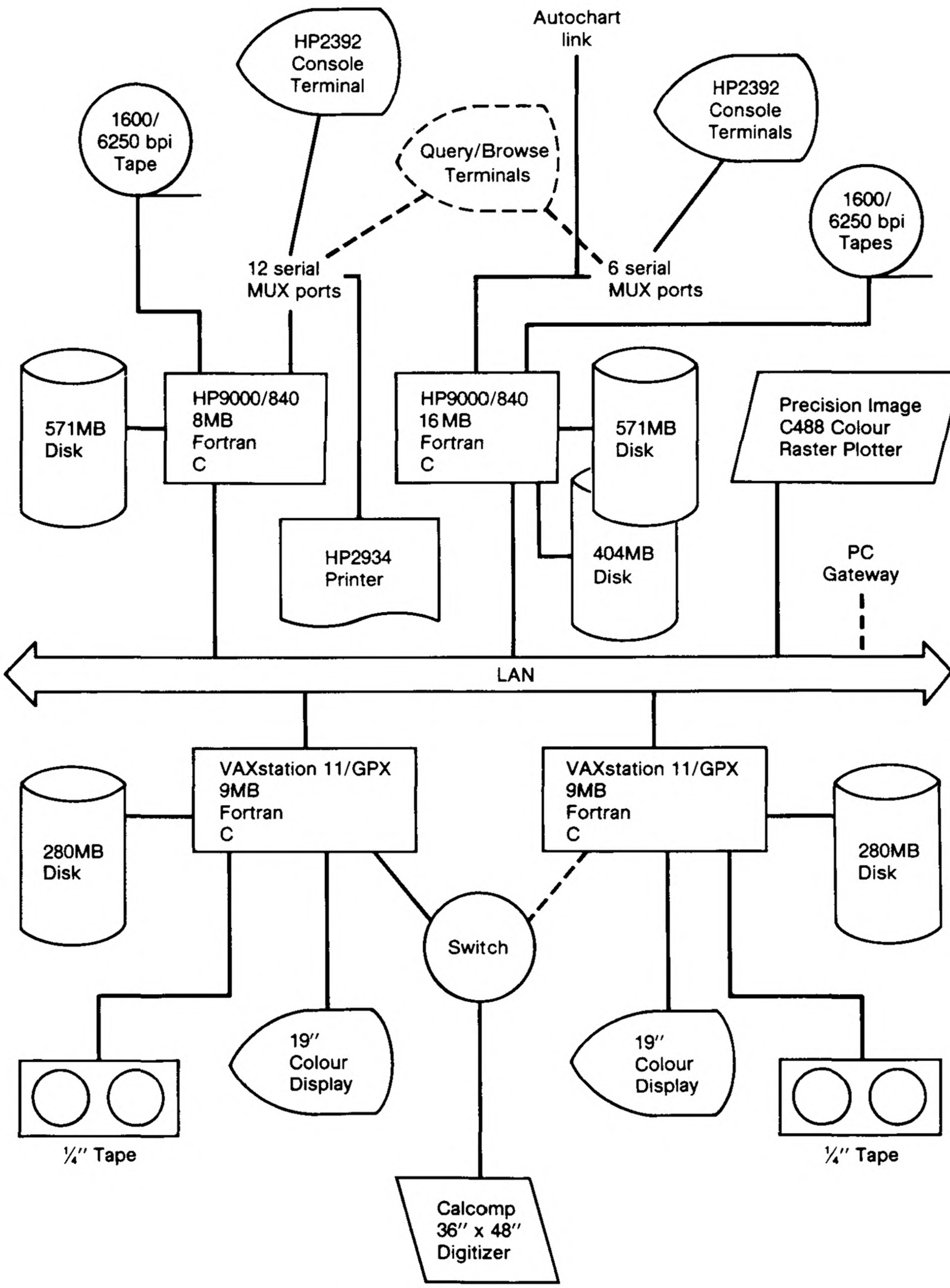

FIG. 2.— HIS System Configuration.

query of chart information, further database definition and software development.

Database Schema Development

The database component of HIS is based on the ORACLE Relational Database Management System using a modified Structured Query Language (SQL) that incorporates the spatial geo-referencing requirements of the GeoVision product. The spatial data sub-system designed for the GIS has a hierarchical quad-tree type indexing scheme which allows for quick searches of data regardless of the data density within the area. The area size of each cell is dependent upon the user-defined number of features within a cell. As the number of features in a cell increases to the maximum threshold, the cell then subdivides and the process continues. This scheme is handled automatically by the GIS and is transparent to the user.

The database schema model as given in Figure 3 has developed iteratively

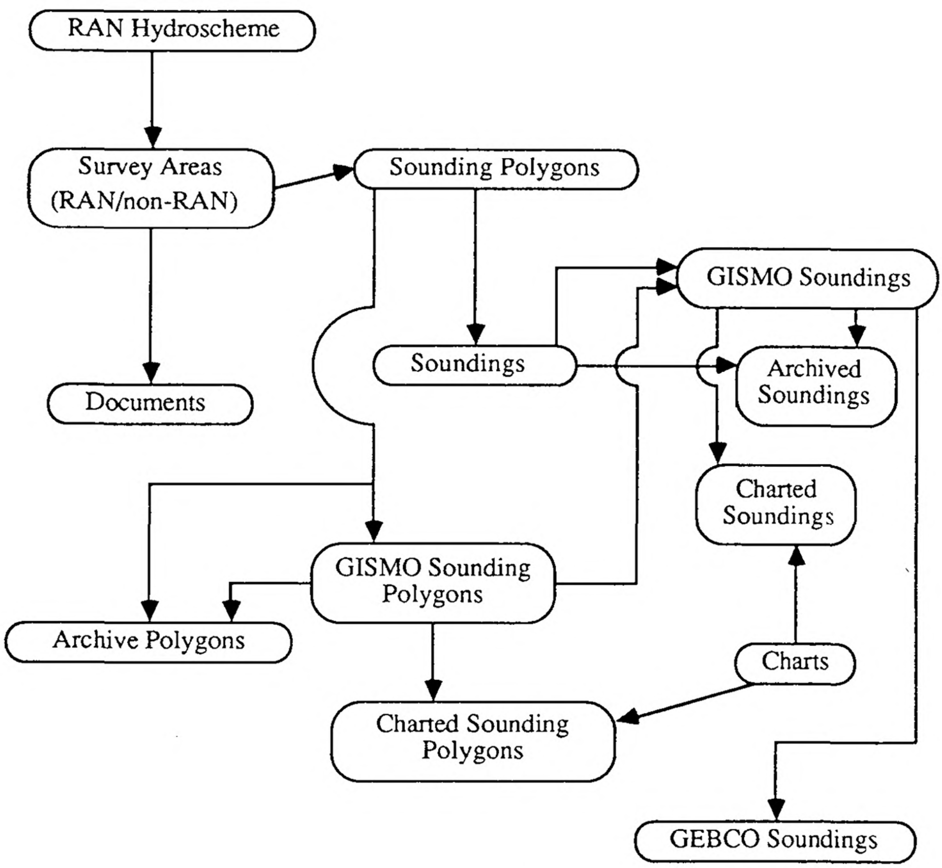

FIG. 3.— HIS Database Schema Model.

over the development cycle of system implementation. The design has attempted to define a complex but achievable HIS database management solution. A specific function of the database developed for HIS utilizes a system generated unique feature number for every graphic entity in the database i.e. points, lines and polygons. The Feature Number of the entity is stored only once in a system table, but can be referenced by any number of user-defined tables. Specific software developed by GeoVision enables features to be related by the feature number of the entity. For example, soundings can be related to a 'owner' sounding polygon; one to many sounding polygons can be related to a single 'owner' survey area polygon; one to many non-graphic survey documents can be related to a single 'owner' survey area polygon.

Specific relational database rules have been enforced on the Feature Relationships software to ensure that if a 'owner' feature number is deleted or altered, then all relationships to 'child' feature numbers are also either deleted or updated respectively. In this way, referential integrity of features in the database is ensured.

The archival of hydrographic data presents a major challenge and the use of the feature numbers and feature relationship software will provide the necessary links between the archive and online data sets. Future development will determine the procedures for holding archived sets offline and/or in separate databases.

FUTURE DEVELOPMENT

HIS is a development system and as such future hardware and software development items have been identified and will continue to be identified as the system use is increased. In any system being established by a vendor, end-user experience must interface with system designers to ensure a functional, yet easy-to-use operator interface. Some areas that have been extensively developed include:

— the capacity to handle a world-wide neutral coordinate system i.e. the GIS spatial coordinate system must be removed from local or national coordinate systems that are often used in mapping or service utilities information systems. Likewise, there is a tendency to favour specific cartographic map projections. The only true neutral coordinate system that will provide full coordinate support from the poles to the equator is latitude and longitude based on a geocentric spheroid datum — a coordinate system that in many GIS/LIS solutions available today, is not properly supported. It is true to say that some markets do not require this coordinate system, but at what cost in terms of time and money, would it take to alter the internal coordinate structures so that products could provide enhanced coordinate functionality?

— the ability to form single polygon structures capable of overlapping with other polygons without the need for setting tolerances for node latching, polygon edge matching and sliver area as is often the case in many systems in use for LIS/GIS.

Upon the availability of appropriate funding, some identified future areas of development include:

— integrated system software for n-parameter spheroid and chart transformations

— near/off-line storage of high-volume sounding sets on optical media

— enhancements to feature relationship software to allow insertion and checks for bulk soundings in non-graphic indirect database attribute tables

— incorporation of scanned images into the database, i.e. diagrams, views, text, etc.

— database recovery and rollback facility in the event of a system crash

— enhancements to polygon overlay routines so as to treat each newly-formed polygon separately rather than creating shared polygon edges — a function more used in LIS applications

— correct contouring around high and low water lines along with the ability to enhance edit functions on the triangulated (TIN) surface model

— standards in the definition of hydrographic 'data quality'

— investigation into optical media technology

— efficient mechanisms for archiving data and the retrieval of such data.

All hydrographic information stored in HIS is managed to suit current chart production practices and will provide a basis for the international electronic chart display and information systems (ECDIS). It is quite possible that the next Autochart system will be developed to not only support current chart production methods but to provide a product in line with ECDIS technology and proposed standards. With this in mind, HIS should be capable of providing the necessary data sets for product compilation.

CONCLUSIONS

The Hydrographic Information System (HIS) has slowly developed over the last ten years and the first phase of implementation has just been completed. Specific set-to-work tasks have been identified and are currently being implemented. The cost of this initial phase was $AUS1.4 million and the system supplied as specified four years ago just meets the expectations of today. The HIS concept has always been identified as one of development and as new technology enters the market place, HIS must be capable of utilizing these trends. As in all cases, continued development requires continued financial support. The RAN will introduce into service over the next decade several new survey platforms and data acquisition systems. The enormous task facing the Hydrographic Branch will be the processing of digital data and the effective management of this data to meet both civilian and defence requirements.

The Australian Hydrographic Information System has developed from a generic land-based utilities/LIS/GIS technology with significant enhancements to address the fundamental differences posed by hydrographic data. The development characteristics of the system have evolved through the close liaison between the RAN Hydrographic Branch and GeoVision system staff. As is the case with the development of ECDIS, any provided system must meet the expectations of the user — a matter which will only succeed by continued development, financial support and closer relationships between user and developer.

Acknowledgement

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Reference

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