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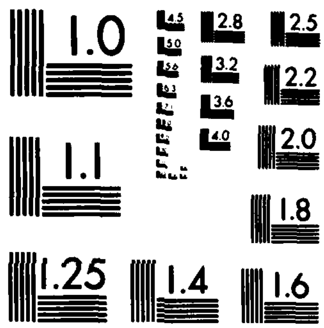

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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With an ever increasing number of new navigation, weapon, and training systems being developed which use digital cartographic information, the Defense Mapping Agency (DMA) can no longer provide system specific, digital products. DMA has adopted an internal digital data exchange format, called Standard Linear Format (SLF), to permit the exchange of digital data between various production elements. The DMA Feature File (DMAFF), a dictionary of cartographic features and attributes to describe those features, has been developed to standardize digital cartographic features.

To test these standards, a digital chart of Portsmouth, Virginai has been produced using the DMAFF features encoded in SLF. This digital prototype is being evaluated for its ability to serve as a multiproduct data base to satisfy both digital and paper chart requirements.

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APPLICATION OF STANDARD LINEAR FORMAT TO DIGITAL HYDROGRAPHIC PRODUCTS

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SUMMARY

With an ever increasing number of new navigation, weapon, and training systems being developed which use digital cartographic information, the Defense Mapping Agency (DMA) can no longer provide system specific, digital products. DMA has adopted an internal digital data exchange format, called Standard Linear Format (SLF), to permit the exchange of digital data between various production elements. The DMA Feature File, a dictionary of cartographic features and attributes to describe those features, has been developed to standardize digital cartographic features.

To test these standards, a digital chart of Portsmouth, Virginia has been produced using the DMA Feature File features encoded in SLF. This digital prototype is being evaluated for its ability to serve as a multiproduct data base to satisfy both digital and paper chart requirements.

INTRODUCTION

Background

The ever-increasing demands for digital MC&G products to support advanced weapon systems, command and control systems, navigation systems, and trainers and simulators, have caused DMA to reexamine its digital data policy. Existing standard digital products were found to no longer support the higher levels of sophistication and increased processing capabilities of these more advanced systems. Separate products had been developed in response to each user's requirement and each of these products was in fact its own, uniquely formatted, on file data base. These products had little commonality, even though some were compiled from similar sources using similar collection criteria. Radar reflectivity information, for instance, collected to support the 15F12 Radar Simulator, is compiled and coded totally differently from similar information collected for the more standard DMA Digital Landmass System (DLMS) products. The demand for digital cartographic products is such that DMA can no longer afford to produce system-specific, single-use data bases and files. In order to meet these challenging new requirements, DMA must provide flexible, efficient and effective digital MC&G products, suitable for multiple use.

DMA DIGITAL DATA POLICY

Near Term Digital MC&G Support

For the near term (present through 1988), DMA is encouraging the maximum use of existing standard data. These standard products include Digital Terrain Elevation Data (DTED) and Digital Feature Analysis Data (DFAD). DTED provides wide area coverage of terrain elevation data in 3 arc second post spacing. DFAD provides wide area, medium scale coverage of selected planimetric features. DFAD was developed to support radar simulators and therefore, is limited in content.

DMA plans to phase out production of all system-specific and single-use data bases by 1988. The production of nonstandard digital products supporting specific requirements validated prior to implementation of this policy (February 1984) will be completed by 1988.

DMA will upgrade the standard digital products to increase their utility and flexibility by:

1. Implementing the DFAD Edition 2 Specification to add more features to the DFAD data base.

2. Implementing DFAD Level 1C (a more general data base than that for standard DFAD).

3. Enhancing DTED accuracy by replacement of data not meeting current accuracy standards.

4. Working with the services and the Office of the Secretary of Defense in formulating transformation policy. This policy will define DMA and system developer responsibilities for transforming data from the DMA standard format to a system specific format.

5. Promoting standardization and development of multiple use data files through a prototype product evaluation program.

Out Year MC&G Support

To support post-1990 advanced system requirements, a major reconfiguration of DMA digital products is necessary. Content of the current DFAD data base will not satisfy the requirements of users in the following decade.

Enhancements are needed in such areas as hydrography, flight information, feature resolution and positional accuracy. The internal DMA requirement for digital production systems and automated cartographic products will also drive major changes to our current digital effort. DMA is currently engaged in an active program to develop digital products capable of supporting these sophisticated applications.

The thrust of this effort will be the development of multiple-use data bases which will support the entire spectrum of MC&G digital requirements. Development of this concept is a dynamic ongoing effort which will involve maximum input from the user community. One key to the development of a multiple-use data base is the implementation of Standard Linear Format (SLF) as an internal exchange format within DMA.

STANDARD LINEAR FORMAT

SLF is a vehicle for the exchange, on magnetic tape, of digital cartographic data. It defines the actual physical record size, structure and placement of coordinate, source and feature descriptive information. While SLF is currently defined as an internal data exchange format, SLF prototype products are being provided to potential Department of Defense users for evaluation. It is believed that SLF will prove to be an effective method of providing common data to a wide spectrum of digital data users in a standard format. This effort will result in the eventual implementation of SLF on all systems within DMA which are processing data for hydrographic, topographic and aeronautical products, providing DMA with the exchange capability and flexibility to satisfy its highly varied digital requirements.

There were three major considerations in the design of this format: portability, flexibility, and efficiency.

Portability—the ease of exchange between many different computer systems-is assured by using Federal Information Processing Standards (FIPS), American National Standards Institute (ANSI) standard tapes, tape labels and American Standard Code for Information Interchange (ASCII) characters, and by the selection of a physical block size which ensures whole-word transfers on computers of all common word lengths (8, 12, 16, 24, 32, 36, 48, and 60 bits).

Flexibility—the accommodation of different digital products—is assured by consideration of current and anticipated product specifications and by employment of a flexible logical data structure known as a "chain-node" structure. The data structure uses two sets of logical records to store cartographic information: (1) a set of numerically described point and linear segments and (2) a set of point, linear, and areal features with associated attributes. Each element of the segment set contains references to associated features, and each element of the feature set contains references to segments representing the spatial description of the feature. In addition to the segment and feature sets, other cartographic data are stored for identifying locational, historical, accuracy, and security characteristics of the data file.

This data structure can be easily expanded to meet future requirements. For example, not all fields of the Data Set Identifier (DSI) record are used for all SLF data types or for all products, but are provided to accommodate those that need them. The DSI record is structured to allow addition of new fields while retaining compatibility with earlier instances of SLF data files.

Product-dependent feature attribute information is isolated in the feature header field of the FEA record, allowing for changes to products or addition of new products without requiring changes to the SLF itself.

Efficiency—is gained in the economical storage of linear and areal data. The chain-node structure eliminates the need for storing redundant line segments which describe coincident or adjoining features and eliminates the potential for spatial displacements commonly introduced when processing redundant segments. Additionally, this linear format allows for easier update and correction because features with identical points or line segments need only be modified once.

The basic objectives of SLF are:

1. To store a string of data only once, no matter how many features it may describe (chain-node format).

2. To provide a standard format for digital data exchange.

The chain-node format of SLF will have inherent advantages over the polygon format currently used for feature data storage. The polygon format (Figure 1) does not identify nodes of feature segments. The whole feature can be identified only as coverage. This procedure resulted in the overlap and gaps problem. Manual overlap could be eliminated in off-line post processing of the digital data but often resulted in the subsequent computer generation of overlap or gaps in the digital data and additional processing was required to eliminate them, where possible.

The chain-node format (Figure 2) will eliminate this problem, avoid double storage of common boundaries, simplify update and correction, and be responsive to thinning and generalization algorithms. Unique node IDs are not stored, but are implied by the start or stop X, Y values of line segments and can be derived if necessary. All line intersections are either the stop or start points of a line segment.

SLF data is stored in four different logical record types, each fixed at 1980 characters (bytes):

DSI (Data Set Identifier) Record

The DSI record contains common descriptive information for the entire data set. It appears at the beginning of the data set and consists of one or more physical blocks; the information within it applies only to the associated data set.

FEA (Feature) Record

The FEA record contains identifying and descriptive information for each feature in the data set, along with a list of keys to the segments (coordinate strings) which make up the features. This record consists of one or more physical records.

SEG (Segment) Record

The SEG record contains the actual coordinate strings for the segments which make up the features. This record consists of one or more physical blocks.

TXT (Text) Record

The TXT record(s) is an optional record(s) which contains free format textual information regarding the data set and/or specific features within it. Figure 3 illustrates how the data sets accommodate feature and line segment information. The feature record identifies the unique features which make up the data set. The segment record contains the actual coordinate strings for the segments which make up each unique feature. All features which include a segment will be so identified.

DMA FEATURE FILE

The DMA Feature File Data Collection Guide, First Edition, August 1984, provides a common menu of features and attributes, along with a standardized coding system, to meet the digital MC&G needs of a comprehensive set of requirements. It is not a product and was not developed to meet the requirements of any single application. The individual product specification determines which features and attributes will be used and defines specific collection criteria such as accuracy and feature granularity. As DMA Feature File is not tied to a specific data base or product line, it can be easily updated and modified to keep pace with a very dynamic requirements base.

The DMA Feature File consists of the following:

1. A comprehensive list of map and chart features, compiled from both existing and anticipated requirements for hydrographic, topographic and aeronautical products. This list is subdivided into broad categories of similar feature types (i.e., Culture, Hydrography, Hypsography, Vegetation, Demarcation, etc.) with each feature assigned a unique 5 digit alpha-numeric identification code.

2. An extensive set of attribute categories which further define the individual features. Examples include light color, bridge clearance, or bottom quality.

3. Standardized definitions for each feature. These definitions are currently being developed in concert with a national digital map standards effort.

4. An appendix fixing the data syntax into a specific feature header format. Currently this format is applied to SLF although other data structures could be used.

Typical feature coding scheme within SLF:

BLOCK 1	SOURCE	XX
	SOURCE SCALE	XXXXXXXX
	COLLECTION SYSTEM	XX
	ACCURACY	XXXX
	CLASSIFICATION	XX
	ETC.	
BLOCK 2	FEATURE IDENTIFICATION	2B020 (DOCK)

ATTRIBUTE 1 (HYC Hydrographic Category)	01 (BULK COAL)
ATTRIBUTE 2 (RSF Radar Significance)	02 (CONCRETE)
ATTRIBUTE 3 (USE Use)	13 (UNDER CONSTRUCTION)

The data in block 2 would be coded as 2B020010213.

PROTOTYPE DIGITAL HYDROGRAPHIC DATA BASE

Background

The initial attempt to produce a digital data base which will satisfy the varied needs of multiple users has resulted in the production of a prototype digital hydrographic data base for the Portsmouth, Virginia area. This product was driven by a Coast Guard request to provide digital navigation data for the Command, Display and Control (COMDAC) System. COMDAC is an integrated command and control system to be installed on the new class of medium endurance cutter. The prototype will also support the Navy's Submarine Advanced Combat System (SUBACS) which will include a digital chart capability.

Discussion

The Hydrography Department at the DMA Hydrographic/Topographic Center was tasked to produce this prototype digital hydrographic data base and generate the resultant data in Standard Linear Format (SLF) using the DMA Feature File (DMAFF) list of features, attributes, and coding structure.

Production Steps

Two National Ocean Service (NOS) charts (1 @ 1:20,000 and 1 @ 1:40,000), were used as source for the sample data cell. Compilation of metric depth curves (NOS charts are in feet) and cultural detail (DMA charts show less detail) were performed in accordance with DMA Harbor and Approach Chart Specifications. All features within the area of interest (shoreline, soundings, depth curves, culture, navigation aids, anchorages, dangers, etc.) on each chart were digitized on the Advanced Cartographic Data Digitizing System (ACDDS) at chart scale. These digital files were then brought to a common scale and reference system and digitally panelled, or merged, together into a composite data file. The final step was to generate the resultant data in SLF/DMAFF format onto magnetic tape in geographic coordinates. The geographic area of coverage is:

UR 37° 08' 00" N   75° 54' 15" W

LL 36° 51' 00" N   76° 24' 00" W

Users should be aware that the data collected at 1:20,000 scale (UR 37° 01' 38" N, 76° 12' 34" W - LL 36° 52' 32" N, 76° 24' 00" W) was not thinned or generalized to match the granularity of the 1:40,000 data. It is the user's responsibility to generalize the data provided according to particular system display needs/capabilities.

Figure 4 is a plot of this digital data which shows the intersection of the 1:20,000 and 1:40,000 scale charts.

One lesson learned during the production of this prototype is that because of software limitations of the ACDDS, common segments between adjacent features were digitized twice. Thus the prototype is not in true chain-node structure, but since most of the features are point and linear features, an evaluation of SLF as an exchange format is still feasible.

CONCLUSION

It is DMA policy that systems developers and users be provided standard digital products whenever possible. While SLF is currently defined as an internal, data exchange format, the Portsmouth Prototype will be provided to potential Department of Defense users for evaluation. It is hoped that SLF/DMA Feature File will prove to be an effective method of providing common data to a wide spectrum of digital data users in a standard format. This should result in the eventual implementation of SLF/DMA Feature File on all systems within DMA which are processing data for hydrographic, topographic or aeronautical products, providing DMA with the exchange capability and flexibility to satisfy its varied digital and hard copy requirements.

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