PROTOTYPE SPECIFICATIONS TO SUPPORT HIGH RESOLUTION-SENSOR SIMULATORS

Ronald J. Pierce
Defense Mapping Agency Aerospace Center
St. Louis AFS, MO 63118

ABSTRACT

The Defense Mapping Agency is developing a follow on Prototype Product Specification for Digital Data to support High Resolution data requirements in the DoD. The computer hardware technology is growing faster than the software technology to enable simulators to portray realism. Both these technologies and the DoD requirements are growing much faster than DMA's ability to produce the digital products required for the multiple applications. The Prototype specification is an effort to narrow the gap of these technologies.

This paper will discuss the development of the High Resolution data Specifications; define and compare parameters of the current and Prototype data; describe the geographical area of coverage; and, discuss user evaluation and validation of the data content.

Introduction

The Defense Mapping Agency has been producing digital data since the early 1960's. This data was generally used to produce relief Maps. It wasn't until 1972 that DMA was directed to produce digital data to support an R&D effort to provide radar displays in simulators for aircrew training. A production specification for digital data for Radar simulation resulted in this R&D effort. This specification was published in 1974 and is called Digital Landmass system (DLMS). The DLMS product is composed of a Matrix of terrain elevations called Digital Terrain Evaluation Data (DTED) and Cultural data called Digital Feature Analysis Data (DFAD). DFAD predicts the radar reflectivity of the earth's surface. The DLMS program supports Weapons Systems Trainers (WST) and operational uses such as cruise missile planning, Firefinder, aircraft mission planning, etc. The DLMS Program requires millions of square nautical miles of DFAD and DTED.

In 1975 DMA was given the responsibility to produce all the Mapping, Charting and Geodesy (MC&G) digital data required by the DoD. With this responsibility it was necessary to insure that all users requirements were reflected in the specification. As experience and user feedback were received using the initial DLMS specifications DMA refined the specification to better support sensor simulation. The first revision of the specification was in July 1977, with three smaller revisions, changes 1, 2 and 3, in 1980-81, resulting in the current product specification. Some of the major changes in these revisions since 1977 are:

a. Standardization of feature descriptors -e.g., Surface Material Code (SMC) 3 Farm structures portrayed as point features.
b. Increase feature identification codes -e.g., from 57 to over 260.
c. Decrease minimum size for strong reflectors -e.g., Bridge.
d. Increase minimum size for poor reflectors -e.g., Desert areas.
e. Expansion of unique features - e.g., Railroad Gantries/Pylons.
f. Standardization of percent of roof cover descriptor - e.g., 0%, 10% and 30%.
g. Portrayal of permanent snow and ice.

Another change, 2nd Edition DLMS, is currently in coordination which will include the addition of LOC's (lines of communication).

PROTOTYPE PRODUCT SPECIFICATION FOR HIGH RESOLUTION SENSOR SIMULATION

In 1978 DMA received an Air Force request to supply digital data to support an out of the cockpit visual simulator. Until this request was received, DMA had only been supporting radar simulation requirements and the specification were designed for that purpose only. With the advent of visual requirements, it became obvious to DMA that a major revision to the digital data specification was required.

Investigations were begun to determine the data elements required for visual simulation. Discussions with various DoD users and contractors revealed that no one had the same requirement for MC&G support. Recognizing the importance of the next generation of specifications, DMA hosted a meeting at St. Louis in Sept 1978 for interested DoD users and contractors to take part in preparing a specification for visual simulation. Personnel in attendance represented Hq Strategic Air Command (SAC), Hq Military Airlift Command (MAC), Hq Tactical Air Command (TAC), Pacific Air Forces (PACAF), Naval Training and Equipment Center (NTEC), Aeronautical Systems Division (ASD), Engineering Topographic Laboratory (ETL), Rome Air Development Center (RADC) and both production centers of DMA, Hydrographic/Topographic Center (DMAHTC) and Aerospace Center (DMAAC). The first meeting resulted in a decision to develop a Prototype Specification for data which was designed to support high resolution sensor simulation including Visual, Synthetic Aperature Radar (SAR), Low Light Level Television (LLLTV) and Infrared (IR). The prototype data will be used to evaluate how well high resolution sensor simulation can be supported by an enhanced DLMS.

This paper covers only the planimetric (cultural and landscape) features. DMA believes that Standard Level I Terrain will be satisfactory for high resolution sensor simulation.

DRAFT SPECIFICATION

The next generation specification is one that must satisfy requirements for all services, therefore, DMA developed a policy on Future Data Bases to include the following major points:

1. Common data elements will be established for multiple applications.
2. The data will be stored in such a way as to permit multiple product generation.
3. The format will be designed to support evolving requirements.
4. In order to save critical manpower, DMA will produce to the most stringent requirements where multiple products are scheduled.

Utilizing this guideline and meeting with the various users and their support organizations, a prototype product specification was prepared and published in December 1979. Five areas in the continental U.S. were selected to be compiled to this specification and production was initiated.

SPECIFICATION CHARACTERISTICS

The Prototype Specification consists of geographically defined areas (manuscripts) which contain two separate levels of information. This information describes the geographic location and the associated descriptive information defining natural and man-made features on the surface of the earth (similar to current DLMS). Level V (for visual) which is similar to Level I DLMS, is comprised of relatively large geographically defined areas containing a description and portrayal of natural and man-made features presented in a standardized digital format. Level V data is designed to cover large expanses of the earth's surface; therefore, it is designed to contain a generalized portrayal of features. Level V is meant to support the generation of high detail by using Computer Image Generation (CIG) and Synthetic Break-Up (SBU) techniques. CIG and SBU are processes by which descriptions of large homogeneous areal features (regions) are used with computer software to break features into component parts. It is expected that these techniques will be employed by the user as required.

MAJOR DIFFERENCES BETWEEN LEVEL V AND LEVEL I

1. Level V includes more features.
   Level V specification includes all Lines of Communication (LOC) such as roads, railroads/powerlines, etc., and streams, lakes and ponds. Level I was developed for radar simulation and generally contains only radar significant features.
2. Level V utilizes microdescriptors
   Microdescriptors (feature attribute attachment) are multipurpose descriptors which describe additional (visual) characteristics of a feature. By using this information as the basis for statistically based feature generation, a more realistic breakup can be performed than by purely random means. Four microdescriptors were developed for Level V.
3. Level V has unique Surface Material Code for asphalt (SMC 14).
   Asphalt was included in SMC 9 in the DLMS specification.
4. Level V portrays isolated structures (SMC 4) including composition structures that are not radar significant but are visually significant.
5. Feature Area Code (FAC) #1, of Level V is the most predominant background feature in the given area. In the DLMS specification, feature #1 is always normal soil.

6. No feature separation criteria is included in Level V. DLMS has an areal feature separation of 500 feet. Level V, without this separation, can be utilized to generate more realistic scenes by showing continuous streams/features regardless of width.

7. Level V portrays wood obstructions 50-150' high. DLMS portrays only those obstructions over 150'.

TERRAIN ANALYSIS DATA

In the fall of 1981, DMA was asked to expand the Level V format to accept the data elements of terrain analysis using DMAHTC's Draft Production Specifications for the Tactical Terrain Data Base (1:50,000) dated September 1981. DMAAC created three additional microdescriptors and coordinated with HTC and Army personnel on common data elements. An area in Ft. Lewis, Washington was selected as a test. In order to compare the density of data and evaluate content, Level V and Level V enhanced with terrain analysis, were both compiled over Ft. Lewis.

Figure 1 is a portion of the manuscript of the Ft. Lewis area compiled to the current 1977 DLMS specifications. Figure 2 is the same area compiled to the Level V specifications and Figure 3 is the Terrain Analysis Specifications. The correlation of the data from these three specifications is extremely close. Level V is compatible with Level 1 but defines the features in more detail. The terrain analysis manuscript is compatible with the Level V, and also portrays much more detail. Figure 4 shows the Level V and terrain analysis data merged and plotted into a manuscript for both Air Force and Army programs. This is the new Prototype High Resolution Specification capable of multiuse. It has common data elements and can be expanded to accept new requirements.

DATA DENSITY

The density of the data, as well as the resources required to produce Level V or enhanced Level V, can increase 3-5 times over the current Level 1. In order to handle this magnitude of data, and have a specification that is as flexible to support multiple products, three additional microdescriptors are required. These microdescriptors plus the four developed for Level V can be used when necessary to further define a feature to satisfy a specific product requirement. The available microdescriptors are as follows:

1. Vertically composite feature (e.g., tower on a building).
2. Homogeneous area descriptor (e.g., residential area).
3. A pattern definition (e.g., street or field pattern).
4. Combination of 2 and 3.
5. Vegetation
6. Transportation
7. Surface Drainage

Figure 5 will be used as an example of data stored on a microdescriptor. For purposes of this example, feature number 97 will be utilized (Table 1).

The Feature Analysis Data Table contains all the data recorded by the analysts for this feature. The top line is the primary descriptive information which is determined for all features (Table 2) and the succeeding lines will be microdescriptor information, if required. Feature number 97 is a forest area and requires the microdescriptor number 5 to satisfy the user requirement in this geographic area. (Table 3)

PROTOTYPE TEST AREA

The five geographic areas selected by the users for testing the Level V specification are as follows:

Area 1 - A rectangle around Norfolk, VA and NAS Oceana containing approximately 450 SNM.

Area 2 - A 15 mile radius circle centered on the main runway at Barksdale AFB, LA (700 SNM).

Area 3 - An area around Little Rock AFB, AR containing 1850 SNM.

Area 4 - 100 SNM over New York City covering Manhattan, Island.

Area 5 - Fallon, Nevada. An area of approximately 1400 SNM.

These five areas will provide the user all types of culture and landscape information from large cities to desert areas and allow them to evaluate the adequacy of the specification.

An additional area, No. 6, covering Ft. Lewis, Washington, has been produced containing both Level V and terrain analysis data. This area contains 250 SNM.

Other areas are being compiled to the terrain analysis enhanced Level V specification and should be completed by the end of 1982.

TABLE 1

FEATURE ANALYSIS DATA TABLE

```
96  2  4000  4  1    3      4  56  10                              2
96  1  10   32 10
96  5                                                              1
97  2  953112              18                                     1
97  5  3  9 11     4  2  0  0        3  1 1 2  8
98  2  4000  4  1    3      4   56   10                            2
98  1  10   32 10
98  5                                                              1
99  2  953112              18                                     1
99  2  3  9 11    4  2  0  0        3  1 1  2 8
```

CODED DESCRIPTIVE DATA FOR FT. LEWIS, WASHINGTON

TABLE 2

FEATURE ANALYSIS
DATA TABLE (FADTP)
PRIMARY DESCRIPTOR

- FAC NUMBER-97
- FEATURE TYPE-2
- FEATURE IDENTIFICATION CODE-9531
- SURFACE MATERIAL CATEGORY-12
- PREDOMINANT HEIGHT-18
- NUMBER OF MICRODESCRIPTORS-1

TABLE 3

VEGETATION
MICRODESCRIPTOR #5

FAC NUMBER-97
MICRO TYPE-5
CANOPY (SUMMER) CLOSURE-3
STEM DIAMETER-9
STEM SPACING-11
VEGETATION ROUGHNESS FACTOR-4
UNDERGROWTH-2
TREE CROWN DIA-0
HEIGHT OF LOWEST BRANCH-0
SPECIFIC TYPE-3
QUALIFIER-1
STATE OF GROUND-1
DEPTH OF SMC ROUGHNESS-2
(MED & HEAVY TANKS)-8
ROUGHNESS (LARGE WHEEL VECH)-0
ROUGHNESS (WHEEL VECH)-0
ROUGHNESS (FOOT TROOPS)-0
CLOSURE RATED CONE INDEX-0

Figure 1 - Current DLMS Level I

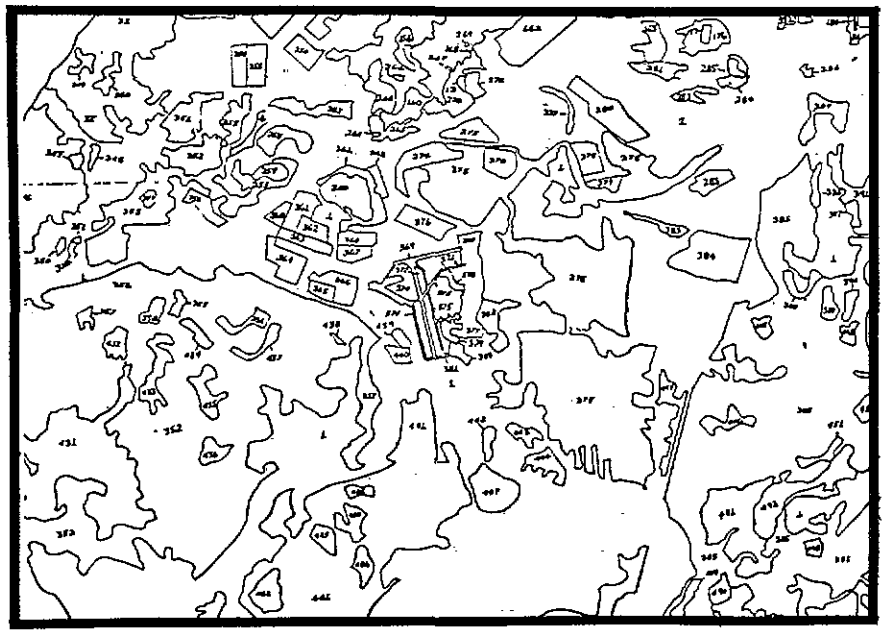

Figure 2 - Level V

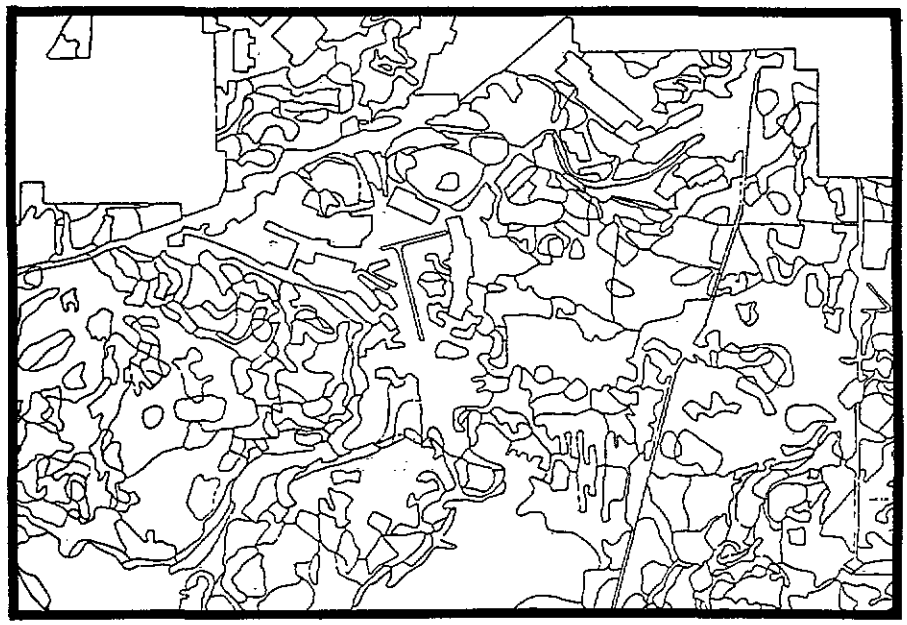

Figure 3 - Terrain Analysis

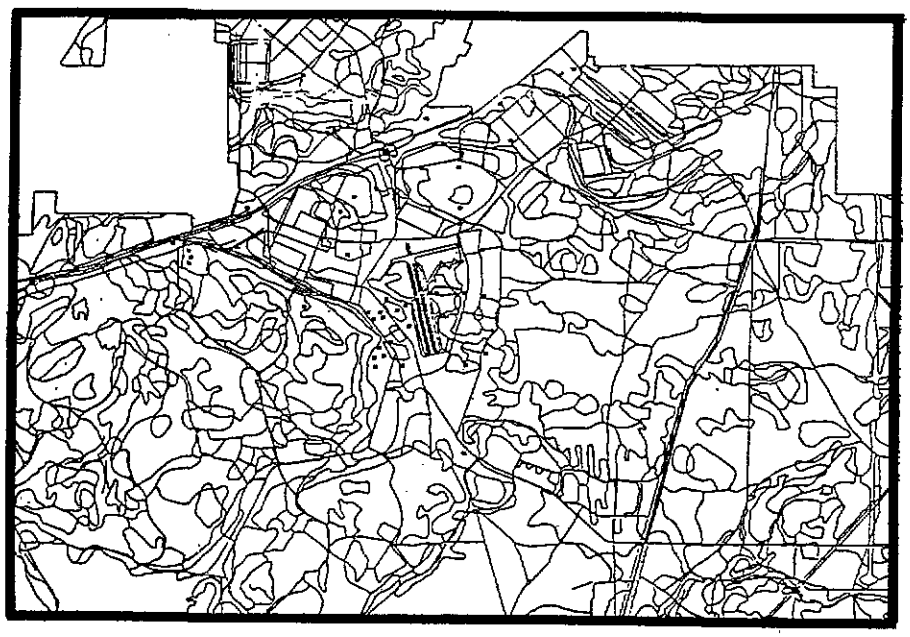

Figure 4 - Level V and Terrain Analysis

Figure 5 - Ft. Lewis, Washington Manuscript (Areal Features)

SUMMARY

Six domestic areas have been compiled using the new specification. These areas total approximately 5000 square nautical miles. The areas will be made available to the users for test and evaluation of the data content. DMA will be requesting comments on the specification as to the ability to satisfy current and future requirements. ASD is working with interested simulator contractors and is soliciting their comments. The Federal Republic of Germany and the United Kingdom have also indicated interest in the new specification. A copy of the specification and a magnetic tape of the Ft. Lewis area is being provided these NATO countries for their evaluation and comments.

An evaluation plan is presently being developed by a committee headed by HQ DMA with members from each service, DMAHTC and DMAAC. The purpose of this plan is to establish milestones to insure that all comments are considered in the revision of the final specification. The goal is to have a specification that will support an all purpose multiuse digital data base in 1985.

REFERENCES

1. Defense Mapping Agency; 1977; "Product Specification for Digital Landmass (DLMS) Data Base" St. Louis AFS, MO.

2. Defense Mapping Agency; 1979; "Product Specifications for a Prototype Data Base to Support High Resolution Sensor Simulation," Washington, DC.

3. Faintich, M. B.; 1981; "Increased Sensor Simulation Capability as a Result of Improvements to the Digital Landmass System (DLMS) Data Base." Proceedings of the Image Generation/Display Conference II, June 10- 12, 1981, Scotsdale, Arizona, pages 181-196.

About the Author

Mr. Ronald J. Pierce is a Physical Scientist at the Defense Mapping Agency Aerospace Center St. Louis AFS, MO. He is presently responsible for the development of a multiuse Digital Data Base for the DoD in the past 1985 time frame. He has had extensive experience in collection of Digital Terrain Elevation data, target derivation, chart compilation and various programs in the fields of geodesy and photogrammetry. He received his BS degree from the University of Tulsa in Geology and graduate studies in geodesy at Ohio State University.