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1.0 Introduction

The University of Alabama in Huntsville (UAH) has completed the research proposed under contract NAS8-36955 (Delivery Order 138). The major tasks under this contract were: 1) research into visualization of scientific data sets (browse); 2) studies of standard data formatting procedures; and 3) investigations of approaches for submission of scientific data sets for archival. Summaries of each activity are presented in this document along with travel reports and conclusions and recommendations.

2.0 Browse

The EOSDIS Version 0 prototype IMS, under development by all DAACs, will allow the user to access and display reduced resolution browse products. The purpose of the browse functionality is to help scientists determine the best products available from a particular data set prior to placing an order. Two prototypes are planned, a local browse prototype and an integrated browse prototype. In the local browse prototype scientists will be able to determine the availability and location of browse products but actual display of the products will be done with separate, stand alone software. In the integrated browse prototype scientists will be able to access and view the browse products, on-line, within the IMS.

During this contract initial research into the requirements for both prototypes was begun. The requirements were based on a study of existing systems, including those in use by the seven Distributed Active Archive Centers (DAACs) of EOSDIS V0. The requirements specification also drew from research into the structure of candidate browse products, proposed by each DAAC for the local browse prototype, and products from Eros Data Center (EDC) and Marshall Space Flight Center (MSFC) for the integrated browse prototype.

Issues related to both prototypes were raised and discussed in a meeting held March 17-19, 1992. (See section 5.2 for a summary of this meeting.) Scenarios for both proposed prototypes were developed for study.

The local browse prototype will depend on stand alone software, resident on the user's workstation, for the display. Several public domain image display systems were investigated for possible use. They include the Khorros System, XV, and the XImage package from the National Center for Supercomputing Applications (NCSA). All of these are available free of charge and can be obtained via FTP over the internet. The XImage utility will accept products in the Hierarchical Data Format (HDF). This makes XImage a likely choice for the local browse prototype since all browse products identified thus far will be in HDF. (For more on HDF see section 3.0.)

In another part of the browse research, data sets at the MSFC DAAC were studied to identify one or more browse products for the local and integrated browse prototypes. The SSM/I data set was selected due to its role in existing DAAC activities and its importance to research in Hydrologic processes. Browse products will be prepared from a subset of the Wentz Antenna Temperatures (Ta). Initial progress toward the production of these products was accomplished during the contract period.

3.0 Standard Data Formats

The Standard Data Format (SDF) research is also an EOSDIS V0 task. The purpose of this task is to investigate various data formatting systems to identify those with the best features for EOSDIS. During the period of this contract the results from 1991 were reviewed and summarized. The main result from that work was the recommendation of HDF as the primary data format system. The door was left open for netCDF and CDF, in that order, if HDF is not feasible for certain cases. With this recommendation as the baseline for further work, a new, more detailed, study of HDF was begun. The objective for this work was to determine the ability of the HDF system to support a variety of EOSDIS V0 data sets in a production environment. The analysis also extended to the HDF utilities available for manipulating raster image data sets (RIS8 and RIS24) and Scientific Data Sets (SDS).

The approach at MSFC to meet the FY 92 objectives was to identify a data set for translation and distribution. Since the SSM/I had been used during last year's SDF research and had been studied for the browse effort, it was the logical choice for this task. Algorithms were obtained and studied for possible use in the conversion of Wentz tape format to HDF. These algorithms are currently in use at MSFC by the WetNet project. In addition to generating full resolution SSM/I data sets in HDF, there was also a requirement to produce an SSM/I browse product in HDF (refer to section two above). An algorithm for this was also available from the WetNet project and was obtained for study. The algorithm could not be used as is, since it generates McIDAS images (a proprietary system unavailable for EOSDIS V0).

In addition to the above two tasks, research into data set structures was also begun. This effort involves the study of several EOSDIS V0 data sets to gain a formal understanding of any organizational commonality. Since many data products are similar across data sets, the existence of common data structures is expected. For example, since images are usually two dimensional there should be rectangular array structures in data sets that have images as a part of their content. The discovery of such common structures could suggest corresponding approaches and procedures for the data formatting system. These could then made available as part of the overall standard data format system and potentially applied to numerous data sets.

During the period of this contract the research on this task was begun. The SSM/I data set was identified as the data set for study and the definition of a data model was begun. This data model will be expressed formally in Backus Nauer Form (BNF) and compared to those from the other DAACs.

4.0 Data Submission Procedures

Under this contract, the first draft of a Data Submission Procedures document for the MSFC DAAC was generated. This document, aimed at the scientist submitting a data set for archival at the DAAC, details the types of descriptive metadata required for each data set, and suggests formats for providing the metadata. Use of these procedures will result in data that is easily

inventoried at the DAAC, and easy to access when needed. Future drafts of this document, to be produced when the Data Archive and Distribution System (DADS) of the DAAC is more mature, will contain requirements for data formats, data submission media, etc., as well as procedures for submitting science processing algorithms.

5.0 Travel

Four trips were taken during the duration of this contract. One person attended the System Engineer's Meeting and the first System Level Browse Workshop. Two people attended the IMS retreat and one person attended the second System Level Browse Workshop. Following each meeting detailed trip reports were prepared and submitted informally to the MSFC DAAC Manager, Project Scientist and other DAAC personnel. The following sections are short summaries drawn from those reports.

5.1 System Engineer's Meeting

The System Engineer's Meeting was held February 25-26, 1992 at the Jet Propulsion Laboratory in Pasadena California. As part of this meeting the Standard Data Formats Working Group presented the results from 1991 and discussed plans for 1992. Since a large part of the work under this delivery order relates to data formats it was necessary for a UAH representative to attend.

5.2 System Level Browse Workshops

The System Level Browse team is made up of personnel from the Eros Data Center (EDC), Marshall Space Flight Center (MSFC) and the EOSDIS V0 IMS team. (The MSFC personnel on this team are employed by UAH.) In March the first meeting of the development team was held in Greenbelt Md. The purpose of this meeting was multifold and included the following objectives: 1) define the division of responsibilities among the IMS team, EDC and MSFC; 2) exchange information on browse software developed at EDC and MSFC; 3)

agree on the scope and functionality of the browse prototypes; 4) Develop high level requirements for the prototypes; 5) exchange information on public domain browse software; and 6) develop an implementation schedule. All objectives were met and each part of the team left with specific actions to undertake.

The second meeting of this group was held June 22-24, again in Greenbelt Maryland. This meeting concentrated on design issues. The complete set of graphical interface screens for browse were designed and a detailed plan was produced for implementation of those screens by the three participating organizations.

5.3 IMS Retreat

The EOSDIS V0 IMS Team gathered in Boulder for four days to discuss plans and options for extensions to the distributed inventory search capability demonstrated internally last fall and to NASA Headquarters in February. The first day was devoted to a discussion of issues related to browse as an ordering tool. The rest of the week was devoted to other IMS topics related to the user interface, and to new services such as directory and guide facilities, plus a data ordering capability. All seven DAACs were represented, as well as NASA Headquarters, the EOSDIS Project, The EOSDIS V0 Data Panel, NOAA, CIESIN and the University of Wisconsin.

6.0 Conclusion and Recommendations

The activities of this contract represent only the beginning of a much larger research effort for EOSDIS V0. This contract has allowed initial investigations of browse capabilities, standard data format systems, and data submission procedures. Requirements for browse product displays were produced, a standard data format (HDF) was selected and EOSDIS V0 data sets were identified to support further study of both browse and data formats. The knowledge gained from this study will be incorporated into the design of a browse prototype in the CY 1992 time frame. This prototype, which will include standard data formats, will be used for further research into distributed data management, search and order, and visual display of browse products.

We recommend that the research begun under this contract be extended the the current approaches as well as to new potential technologies, such as

knowledge based systems, neural networks, genetic algorithms, and pattern recognition techniques. Each of these offer much promise for problems inherent in the multidisciplinary nature of Global Change Research, particularly EOSDIS. The capability to supplement scientific research with computer processing techniques to form an integrated science processing environment is vital to the realization of the challenging EOSDIS goals.

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None

16 Abstract

The research proposed on this contract related to the extension of the MSFC Earth Science and Applications Division's (ESAD) data management systems to meet expected demands of future Earth science data sets has been completed. The research adressed graphical user interfaces, data search definition techniques, data formatting capabilities, and plans for a prototype system which would allow scientists to get a visual representation of a data set prior to order. A summary of this work is provided in the attached report.

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