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The first Applied Information Systems Research Program (AISRP) Workshop provided the impetus for several groups involved in information systems to review current activities. The objectives of the workshop included: (1) to provide an open forum for interaction and discussion of information systems; (2) to promote understanding by initiating a dialogue with the intended benefactors of the program, the scientific user community, and discuss options for improving their support; (3) create an advocacy in having science users and investigators of the program meet together and establish the basis for direction and growth; and (4) support the future of the program by building collaborations and interaction to encourage an investigator working group approach for conducting the program. For individual titles, see N93-29223 through N93-29241.
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APPLIED INFORMATIONS SYSTEMS RESEARCH WORKSHOP

PREFACE

The first Applied Information Systems Research Program (AISRP) Workshop provided the impetus for several groups involved in information systems to review current activities. Investigators representing fifteen of the twenty-two Office of Space Science and Applications (OSSA)/Information Systems Branch (ISB) NASA Research Announcement awards were in attendance. Attendees also included representatives from the Science and Technology divisions of NASA, directors of NASA's Centers of Excellence, specific research institutes, and members of the academic and remote sensing arena.

The objectives of the workshop are outlined:

- To provide an open forum for interaction and discussion of information systems research activities.
- To promote understanding by initiating a dialogue with the intended benefactors of the program, the scientific user community, and discuss options for improving their support.
- Create an advocacy in having science users and investigators of the program meet together and establish the basis for direction and growth.
- Support the future of the program by building collaborations and interaction to encourage an investigator working group approach for conducting the program.
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ACKNOWLEDGEMENTS

We wish to gratefully recognize the following persons for the skillful support given towards the success of this first Applied Information Systems Research Program (AISRP) workshop. The capable efforts and contribution of each individual are greatly appreciated. Thank you.

- Elaine Hanson/Colorado Space Grant Consortium, University of Colorado, for hosting the workshop
- Susan Solari/Colorado Space Grant Consortium, University of Colorado, for hosting the workshop and making local arrangements
- Karen Friedman/National Center for Atmospheric Research (NCAR), for giving assistance with local arrangements, especially for the workshop reception held at NCAR
- Anne Novomy/NASA HQ, Code SM, and Leslie Emerson/Center for Space and Advanced Technology (CSAT) for providing registration and on-site logistical support
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APPLIED INFORMATIONS SYSTEMS
RESEARCH WORKSHOP

SYNOPSIS

The workshop proceeded according to the agenda provide herein, (see Appendix, attachment A). The first day was given to programmatic presentations. Joseph Bredekamp/NASA HQ, ISB, provided the overall context for the program. Representatives of OSSA Science Disciplines and of the Office of Aeronautics, Exploration and Technology reviewed current as well as planned data and information systems activities. Presentations were also made on the Center of Excellence in Space Data and Information Sciences (CESDIS) and the Center for Aerospace and Space Information Sciences (CASSIS). These Centers work to encourage collaborations between government, academia, and industry.

Following this, presentations were made by the participating principal investigators of the Applied Information Systems Research Program. In attendance to these presentations were scientists, software developers, program managers, technologists and computer systems personnel. This diversity of audience allowed for evaluation of the broad issues regarding use, development, and maintenance in information systems.

Presentations topics included visualization and associated analysis, data management including distributed databases, and software tools for modeling. Several presentations highlighted remote sensing, software development, and high performance computing. Many of the activities reported on are based on existing and commercial products, but all included advances in the field.

The final day of the workshop was devoted to discussions centered toward three key topics; technology transfer options, technical issues and future interaction.

Technology Transfer Options

This discussion yielded three different directions for information diffusion, specifically across disciplines within OSSA, from OAET to OSSA, and across the broader science community. Issues and options for each direction area differed.

Across disciplines within OSSA, consensus was made that the at-large science community needs to be made aware of the tools and techniques under development for the Applied Information Systems Research program. Several attendees suggested that the transfer activity be made a formal, explicit part of the program. Some encouraged OSSA to provide the infrastructure to support and disseminate results. Others suggested that the technology transfer responsibility for results be made part of the NRA award.
OSSA to OAFT

Workshop attendees agreed that a closer interaction between the two organizations was needed, but the mechanism was unclear. Attendees agreed that OSSA should be the 'implementing' code.

Broader Science Community

All agreed that outreach is important. There was also agreement that many options are already available, and need to be fully utilized. The group considered several other options. It was suggested that the Computer Software Management Information Center (COSMIC) at the University of Georgia be considered a candidate for functioning as the software distribution mechanism for the agency

Discussion's of technical issues emphasized a variety of interchange issues. Further discussion of these topics and development of additional topics, was delegated to future splinter group discussions. Overall, the discussion emphasized the need to consider user requirements, both current and future, during the tool development.
APPLIED INFORMATIONS SYSTEMS
RESEARCH WORKSHOP

FOLLOW-ON ACTIONS

Two near-term actions were identified. The first is to poll investigators to identify current computing platforms being used, preferred mode of operation, etc. The second action is to establish a set of test dataset suites, to help compare and evaluate effectiveness of various software tools.

Since this was the first meeting of the Applied Information Systems Research activity, many of the continuing logistics aspects were discussed as well. The preferred format seemed to be an annual meeting, with 'splinter group' sessions for specific topics or subsets of the group to be included at the same meeting. As additional topics warrant, interim 'mini workshops' should be convened as well.

Future meetings will continue to include both the science and project communities, as well as investigators in the program. Future meeting sites will continue to require infrastructure for demonstrations of tools (workstations, network access, etc.) In the interim, a network bulletin board will be established for rapid and timely communications.
APPLIED INFORMATION SYSTEMS RESEARCH WORKSHOP

JULY 22-24, 1991

BOULDERADO HOTEL
Boulder, Colorado

AGENDA

MONDAY, JULY 22, 1991

11:30 a.m. Registration
1:00 p.m. Welcome and Logistics
1:15 p.m. Program Overview
2:00 p.m. Office of Space Science and Applications
          Data Environment and Future Plans
          -Earth Observing System Data
          and Information System
          -Planetary Data System
          -Astrophysics Data Systems

4:00 p.m. Office of Aeronautics, Exploration and
          Technology Information Systems Program
4:20 p.m. Center of Excellence in Space Data and
          Information Sciences (CESDIS)
4:40 p.m. Center for Aerospace and Space
          Information Sciences (CASIS)
5:00 p.m. Adjourn
APPLIED INFORMATION SYSTEMS RESEARCH WORKSHOP

JULY 22-24, 1991

BOULDERADO HOTEL
Boulder, Colorado

AGENDA

TUESDAY, JULY 23, 1991
8:30 a.m.  Principal Investigator Presentations
12:00 p.m. Lunch
1:00 p.m.   Principal Investigator Presentations
5:30 p.m.   Reception at the National Center for Atmospheric Research

WEDNESDAY, JULY 24, 1991
8:30 a.m.  Flight Project Office Information Systems Testbed (FIST)  Patricia Liggett
8:50 a.m.  Intelligent Data Management  Bill Campbell
9:15 a.m.  Open Discussion
           - Where we go from here to work together on program: potential collaborations, subgroups, future workshops, etc.
           - Technology Transfer and Infusion
12:00 p.m. Adjourn
## APPLIED INFORMATION SYSTEMS RESEARCH WORKSHOP

### P.I. PRESENTATIONS
(Morning Session)

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<td>Experiment’s Laboratory for Visualized Interactive Science</td>
<td>Ms. E. Hansen Univ. of Colorado</td>
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<tr>
<td>Grid Analysis and Display System (GRADS): A Practical Tool for Earth Science Visualization</td>
<td>Dr. J. Kinter Univ. of Maryland</td>
</tr>
<tr>
<td>A Distributed System for Visualizing and Analyzing Multivariate and Multidisciplinary Data</td>
<td>Dr. A. Jacobson JPL</td>
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<tr>
<td>Advanced Data Visualization and Sensor Fusion: Conversion of Techniques from Medical Imaging to Earth Science</td>
<td>Dr. R. Savage Hughes</td>
</tr>
<tr>
<td>Development of an Expert Data Reduction Assistant</td>
<td>Dr. G. Miller STSCI</td>
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<tr>
<td>System of Experts for Intelligent Data Management (SEIDAM)</td>
<td>Dr. D. Goodenough Canada Centre for Remote Sensing</td>
</tr>
<tr>
<td>Construction of an Advanced Software Tool for Planetary Atmospheric Modeling</td>
<td>Dr. R. Keller NASA/ARC</td>
</tr>
<tr>
<td>Knowledge-based Assistance for Science and Analysis Using Large Distributed Databases</td>
<td>Mr. T. Handley, Jr. JPL</td>
</tr>
<tr>
<td>Multi-Layer Holographic Bifurcative Neural Network Systems for Real-Time Adaptive EOS Data Analysis</td>
<td>Dr. Hua-Kuang Liu JPL</td>
</tr>
</tbody>
</table>

### LEGEND:
* P.I. Presentation not given/ ** P.I. not in attendance
APPLIED INFORMATION SYSTEMS RESEARCH WORKSHOP

P.I. PRESENTATIONS
(Afternoon Session)

A Distributed Analysis and Visualization System for Model and Observational Data
Mr. M. Arrott
Univ. of Illinois

An Interactive Environment for the Analysis of Large Earth Observation and Model Data Sets
Professor K. Bowman
Univ. of Illinois

A Land-Surface Testbed for EOSDIS
Dr. W. Emery
Univ. of Colorado

Geographical Information System for Fusion and Analysis of High-Performance Remote Sensing and Ground Truth Data
Mr. A. Freeman
JPL

Development of a Tool-Set for Simultaneous, Multi-Site Observations of Astronomical Objects
Dr. Chakrabarti
Univ. of CA/Berkeley

SAVS: A Space Analysis and Visualization System
Dr. E. Szuszczewicz
Science Applications International Corp.

Planetary Data Analysis and Display System: A Version of PC-McIADS
Dr. S. Limaye
Univ. of Wisc., Madison

Interactive Interface for NCAR Graphics
Mr. R. Lackman
National Center for Atmospheric Research

The Development of Generic and Extensible Software to Support the Study of Space Science Data
Mr. G. Goucher
NASA/GSFC

VIEWCACHE: An Incremental Database Access for Autonomous Interoperable Databases
Assoc. Prof. Nick Roussopoulos
Univ. of MD

A Spatial Analysis and Modeling System for Environmental Management
Mr. C. Vermillion
NASA/GSGC

Introduction to CADET: Center for Advanced Data Evaluation Technology
Ms. Cathy Schulbach
NASA/ARC

Topography from Shading and Stereo
Professor B. Horn
MIT

Multivariate Statistical Analysis Software Technologies for Astrophysical Research Involving Large Data
Mr. G. Djorgovsici
JPL

High Performance Compression of Science Data
Dr. J. Storer
Brandeis Univ.

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APPLIED INFORMATION SYSTEMS
RESEARCH PROGRAM WORKSHOP

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NOTES:

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Applied Information Systems Research Program

Workshop Objectives

- Exchange information on status and plans of research efforts
- Initiate dialog with OSSA science disciplines and other related NASA efforts
- Establish basis for conducting program
  - Means to facilitate communications and collaborations
  - Advocacy building
  - Technology transfer and infusion
  - Future directions

Office of Space Science and Applications

Information Systems Strategy

- Science discipline divisions provide primary focus for discipline-specific data management systems that integrate project data plans and on-going research needs into total research capability
- Provide robust, multi-discipline infrastructure
  - Architecture, policies, standards, practices, etc. to promote interoperability and resource sharing
  - Access to high performance computing
  - Network services
  - Information services (directories, catalogues, etc.)
- Apply and exploit advances in technology to evolve and enhance systems capabilities
<table>
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<td><strong>Objective:</strong></td>
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THE EARTH OBSERVING SYSTEM
DATA AND INFORMATION SYSTEM

Sara J. Graves
NASA
CODE SED
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Major System Drivers of EOSDIS

- Mission life: 15+ years
- International partners: Japan, European Space Agency (ESA), and Canada
- Interdisciplinary research: Climate, hydrologic system, biogeochemistry
- Multidisciplinary research: Land, oceans, atmosphere
- Multiple instruments: MODIS, HRIR, IITF, SAFIRE, ...
- Multiple platforms: EOS-A, EOS-B, EPOP-M, JPOP, EPOP-N
- Distributed system architecture: GSFC, EDC, LPI, JPL, ASF, MSFC, NSIDC, investigator sites
- Large number of users: >500 AO scientists and thousands of users
- Massive data volume: >50,000 TB
- Massive data processing: As much as 60 Mbps input, 500 Mbps output
- Metadata: Comprehensive directory, catalogs, inventories, and browse products

EOSDIS Major Functions

- Mission planning, scheduling, and control
- Instrument planning, scheduling, and control
- Effective resource management
- Communications
- Computational facilities at Investigator sites to support research
- Production of standard data products
- Production of special data products
- Archiving and distribution of data and research results
**EOSDIS Strategy**

- Work with the users to meet their needs
- Make data easily accessible for research users
- Begin development immediately
- Use lessons learned from current efforts
- Build on existing infrastructure
- Utilize open, distributed architecture
- Evolve with advances in technology and Earth science

---

**EOSDIS Research Users**

Research users must abide by the stipulations outlined in a "Research Agreement."

- Publish in the open literature results of research based in whole or in part on data obtained from EOS.
- Make available to the research community the derived data, algorithms, and models at time of acceptance for publication.
- Data used only for the researcher's bona fide research purposes.
- Data may be copied and shared among other researchers provided that they are covered by a Research Agreement or the researcher who obtained the data is willing to take responsibility for compliance.

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**EOSDIS Design Implications**

- EOSDIS is one system even though distributed.
- DAACs are the institutionalization of EOSDIS.
- Each new step should advance us towards the Integrated EOSDIS.
- The EOSDIS users are the researchers, not the general public.
- Results as well as data must be archived.
- System must be evolvable to survive.
- Meeting user needs must be paramount.
- Respond to DAAC User Working Group.
- The payoff is in improved efficiency/effectiveness of the research.

---

**Early EOSDIS Objectives**

- Provide increased utility to scientists.
- Improve access to existing data sets.
- Produce new research-quality geophysical products.
- Provide better metadata/data services.
- Maintain existing services.
- Build EOSDIS infrastructure/unifying capabilities.
- Build working relationship between DAACs, Project, and users.
- Implement first communications links, standards, etc.
- Prototype/test evaluate DIS elements and standards.
- Produce results to guide continuing development.
- Adopt Earth system science vs. "Earth sciences" view.
What is the EOSDIS Version 0?

Version 0 is the first manifestation of EOS that anyone will see.

Version 0 is the working prototype of NASA’s Earth science data system.

Version 0 is SCFs, DAACs, networks, and IMS.

Version 0 is populated by:

- Existing data
- Pathfinders
- In situ, aircraft, and field campaign measurements
- Predecessor missions
- Modeling and other research results

Why is EOSDIS a Distributed System?

- Recognizes the distributed nature of Earth science community
- Recognizes the existing distribution of assets and capabilities
- Provides for diversity of styles in data use
- Provides for multiple prototypes
- Ensures capability to interface with external systems

Early EOSDIS Pathfinder Data Sets

For existing data important for global change:

- Level 1 data to active working storage/safe archive
- Scientists (academic, agency) develop/select community-consensus algorithm/products
- Generate and validate the derived products
- Make data and products accessible through Distributed Active Archive Centers (DAACs) and metadata/browse services by Information Management System (IMS)
- Working with NOAA, start with four data sets
- AVHRR—SST and vegetation products
- GOES—Products TBD
- TOVS—Vertical profile products
- SSMI— Sea ice, precipitation, etc.
- Others TBD—Science needs to drive selection
Version 0 - Version 1

Time scale of Version 0 is from now until
Our needs require Version 1
Our means are adequate to implement Version 1
Transition from Version 0 to Version 1 should feel like a continuous activity
EOSDIS is an evolutionary system
Hardware and software will be coming and going forever
Service to the community is preserved by being institutionalized
Continuity of DAACs and network
Meet user expectations, listen to user advice, and obtain user support
AN OVERVIEW OF THE PLANETARY DATA SYSTEM

Randy Davis
Univ. Of Colorado
Boulder, Co
(303) 492-6867
An Overview of the Planetary Data System

Presented at the Applied Information Systems Research Workshop by Randy Davis, University of Colorado, Laboratory for Atmospheric and Space Physics, 22 July 1991.
PDS Project Organization

Sample Discipline Node (Atmospheres)

The PDS Discipline Nodes

How Users Access the PDS

1. Users can read and download PDS data holdings through the HSSDC home page. Without a NASA login, access is limited to the Discipline Node's Subnodes.
2. Users can access and order data directly from the Discipline Node. Data that is available for download is indicated as such.
3. Small Data Set of a Discipline is held in a Subnode of a Discipline. Examples of Subnodes are indicated by the Subnode icon.

PDS Project Organization

Sample Discipline Node (Atmospheres)

The PDS Discipline Nodes

How Users Access the PDS
Standards Being Embraced or Examined

- Operating Systems
  - VMS
  - Unix
  - Macintosh OS
  - MS DOS

- Programming Languages
  - FORTRAN
  - C

- Networks
  - DECnet
  - TCP/IP

- Database Management
  - Commercial RDBMSs
  - Homegrown Systems

- Data Analysis
  - IDL

- Computers
  - VAX
  - VAXstation
  - DECstation
  - Sun
  - Macintosh
  - IBM PC

Concluding Remarks

- Thanks to CD-ROM, PDS is moving from distributed databases to distributed database

  - Planetary CD-ROM disks are available for use in your work

- The common denominator computer hardware configuration for planetary science is changing:
  - From a VAX and a VT-100
  - To workstations with sophisticated graphic capabilities
  - Macs and MS DOS machines may become more important since good tools are available on these platforms

- The planetary community is striving for consistent and robust communication interfaces between scientists, flight project systems, and the discipline archive (PDS)

- We in the PDS welcome discussions on how to make your research more useful and available to planetary scientists

  - PDS is a working system, with stringent quality and configuration control, but good new technology will always be considered
ADS PROJECT REVIEW
INTRODUCTION & ADS OVERVIEW

Alice Bertini
CASA
Univ. Of Colorado
Boulder, Co
(303) 492-6422
ADS PROJECT REVIEW

Introduction & ADS Overview

Alice Berlinski
CASA/University of Colorado

What is the Astrophysics Data System?

- Response to Needs Recognized by Various Studies
  - CODMAC Reports I (1982) and II (1985)
  - Astrophysics Data Systems Study (1988)
  - Information Systems Strategic Planning Project (1990)
- Common Themes of Studies
  - Large influx of data -> Terabyte/year
  - Knowledge of data holdings - what? where?
  - Access to data and meta-data - catalogs, data products, archives, documentation
  - Multi-level access with security - networks, on-line/off-line access, authentication
  - Applicability into 21st Century - flexible, extendable, evolvable
  - Science driven system - enhance or enable science research e.g., "fan chromatic"

ADS Project Review

Introduction

Status of System Now

- Operational System
  - 100 Registered Users
  - 16 Databases from 5 nodes
  - 600 Queries 1st Month
  - 10,000 Records 1st Month
- Transition from Development to Operations
  - Internal re-organization of project in progress
  - Emphasis on operation of system
  - Project plan based on providing science services to users

NASA Mission Data Volume

Year

Gigabytes


NASA Mission Data Volume

ADS Project Review

Introduction

Status of System Now

- Operational System
  - 100 Registered Users
  - 16 Databases from 5 nodes
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- Transition from Development to Operations
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NASA Mission Data Volume

Year

Gigabytes

ADS Project Review

Top Level Organization Chart

- [Top Level Organization Chart]

 ADS Project Review

Overview

**Science Objectives of ADS**
- Provide Information on Existence and Location of Data Holdings
- Provide Access to Data Holdings
- Provide Sufficient On-Line Information on Data for Scientific Use
- Provide Tools for Selection, Retrieval, and Manipulation of Data
- Provide Tools for Information Retrieval (Textual Data Access)
- Provide Access to Data Processing Services
- Provide Tools for Data Processing, Visualization

**Major Milestones of ADS**
- Astrophysics Data System Workshops: 1987, Report 1988
  Working Group Formed 1988
- Internal Alpha Release 1 - Q2 1989
  User Interface Prototype
- Internal Alpha Release 2 - Q4 1989
  Distributed Data Access Prototype
- External Data Release 1 - Q2 1990
  Distributed Data Base Access via MPS Prototype Command Language
- External Data Release 2 - Q1 1991
  Database Server
  Notice Environment
  Operational Testing
- Operational System Release 1 - Q2 1991
  16 Catalogs On-Line with Documentation
  100 Registered Users

**Scientific Based Scenarios Imply Functional Requirements**
- Cross Correlation of Catalog Data
  Coordinate Conversion
  Sky String, Distance Test (Search in Cone) Combining Data
  Export Results

- Location of Data/Objects
  Name Resolution
  Browse Data Data
  Order Data Set/Immediate Transmission Visualization

- Data Processing (Examples)
  Source Detection with Custom Parameters
  Deconvolution of Images
  Spectral Fitting
  Flat Fielding
ADS Project Review

Overview

Scientific Based Sensors Imply Functional Requirements

- Simple User Scenario
  What sources are seen in both X-ray and IR space observations?
  Is there a correlation of X-ray and IR Beams for a class of objects?

- Actions
  Get X-ray sources over some range of parameters, e.g., RA, DEC, Class
  Get IR sources in some range of parameters
  Compare source lists
  Plot flux vs flux

- Functions
  Access Remote Databases
  Convert Coordinates
  Match Objects by Position
  Extract Interesting Measurement Data
  Plot Results
Future Functional Milestones

- Catalog Access Tools
  - NED Interface Q3 '92
  - Name Resolver Q2 '92
  - Locate Data on an Object (P Q3 '92) Q2 '94
- SIMBAD Interface 3

- Data Set Access
  - Data Archive Capability (P Q2 '92) Q4 '92
  - Image Display (P Q2 '92) Q2 '94
  - Graphics Display (P Q3 '93) Q3 '94
  - Proprietary Data Access Q1 '94
  - Data Analysis Tools 7

- Text Retrieval
  - Distributed Documentation Q4 '92
  - Text Database Indexing Scheme Q3 '94
  - Keyword Augmentation to Indexing Q2 '95
  - Text Retrieval System Q4 '95

Scientific Project Enabled by Functionality of ADS

- On-Line Astronomical Literature and Documentation
  - Scanned Literature from Astronomical Journals
    - Data Archive
      - Document Retrieval Technologies
        - Indexing, Retrieval
        - Transmission and Viewing of Documents
          - Display of Graphs and Images
          - Display of Scanned Text in a New Function
OAET COMPUTER SCIENCE & DATA SYSTEMS PROGRAMS

Paul Hunter
NASA/OAET
CODE R
Washington, D.C.
(202) 453-2704
CONCURRENT PROCESSING RESEARCH - FY94
506 43 1-1

OBJECTIVE:
Concurrent processing research is to develop algorithms that may efficiently and cost-effectively utilize the vast numbers of processors and high-speed connections between processors for applications in NASA problems.

ACHIEVEMENTS:
During FY94, 10 algorithms were developed in two in the area with the newly acquired INS/2, a commercial massively parallel (MPP) machine, and of the Hypercube Parallel Processor (HCPP). The algorithms were designed to exploit the best performance of each computer.

- Enhanced Execution of Programs on CONCERT: This approach was used to simulate the degree of scaling of a parallel processor using a program written by the LPS. We demonstrated on the MPP simulation of large-scale distributed systems, and on the execution of small-scale distributed systems, by using the Concurrency and Communication (CONCERT) tool.
DISTRIBUTED ACCESS VIEW INTEGRATED DATABASE (DAVID) SYSTEM

Due to the diversity of computers, operating systems, management systems, network protocols, etc., NASA space scientists have to learn many different access methods in order to obtain data. For example, in NASA’s Space Astrophysics Program, Astrophysics observations such as the International Ultraviolet Explorer (IUE), Hubble Space Telescope, Gamma Ray Observatory (GRO) etc. generally have one or more data centers for the analysis and distribution of data. The heterogeneity of its data centers makes Astrophysics multi-mission research almost impossible.

The DAVID approach to the heterogeneous distributed systems problem is as four levels. At the lowest level, we develop universal object management systems to provide uniform access to heterogeneous database images, spreadsheet, manifACT, etc. management systems. At the second level, we develop “book” and “file” management systems to provide uniform access to local area networks of computers containing “books”, “files”, and other data objects. At the fourth level, we develop consortia of libraries to provide access to sets of libraries.

The DAVID software is being used on the NSSDC Data Archive and Distribution System (NDAAS) as a front end and to distribute IUE observational data.

Technical Contact: Barry E. Jacobs, GSFC, (301) 968 5681.
PROBLEM:
NASA space scientists have to learn many different access methods in order to obtain data/software.

SOLUTION:
Distributed Access View Integrated Database (DAVID)

DAVID Concept
- Universal object type management systems: database, spreadsheet, software tool, index, image, etc.
- Aggregate Sets of Related Objects: books, series, links.
- Libraries: Collections of holdings

DAVID Approach
- Universal object type management systems: database, spreadsheet, software tool, index, image, etc.
- Aggregate Sets of Related Objects: books, series, links.
- Libraries: Collections of holdings

OBJECTIVES:
INTelligent DATA MANAGEMENT PROCESSES

The objective of the Intelligent Data Management project is to research and implement a knowledge base and database
based system for querying and retrieving knowledge based information. This project aims to develop a system that
is able to understand and interpret complex queries, as well as to provide answers in a structured and
meaningful way. The system will be able to analyze and interpret large amounts of data, and will be able to
provide users with relevant and accurate information.

The project will develop a system that can automatically interpret
and respond to queries, and will be able to provide accurate and
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will be able to provide users with relevant and accurate information.
1. Introduction

A. What is PCEE

The Portable Common Execution Environment (PCEE) project is a research effort addressing the life cycle support of large, complex, non-uniform, distributed computing applications with Mission and Safety Critical (MASC) components. Such applications typically have extended lifecycles (e.g., 30+ year) requirements, such as the NASA Space Station Freedom Program. PCEE focuses on the systems software, the software to applications, and the system architecture necessary to reliably build and maintain such systems. The requirements extend from the target system environment to the execution environment, and ultimately to the host environment. The execution environment serves as the single logical point of software and hardware, and provides a consistent software system environment across all host environments. The scope of the effort is necessarily broad, as it addresses the problems faced in a project such as the Space Station Freedom Program. However, substantial research foundations to support development across the breadth of the project. Furthermore, with a foundation and framework which addresses the broad scope, these can be developed with the expectation that they can and will scale down appropriately to support software engineering to less demanding applications.

As an core, PCEE consists of a set of facilities for the management of distributed computing services and resources in a non-uniform, secure and safe environment. Its primary aim is to provide a portable interface to a task oriented, distributed, mission set of computing systems. In doing so it provides a framework that is consistent across both environments. It is therefore possible to use the same set of software and hardware in both environments. The environment can be characterized by a single logical point of software and hardware, and provides a consistent software system environment across all host environments. The execution environment serves as the single logical point of software and hardware, and provides a consistent software system environment across all host environments. The scope of the effort is necessarily broad, as it addresses the problems faced in a project such as the Space Station Freedom Program. However, substantial research foundations to support development across the breadth of the project. Furthermore, with a foundation and framework which addresses the broad scope, these can be developed with the expectation that they can and will scale down appropriately to support software engineering to less demanding applications.
Machine Learning in the Knowledge-Based Software Engineering Environment (KBSEE)

Description: A machine learning environment that is constructed to only apply current technology to current needs. It is the result of a process that involves modeling, analyzing, and controlling an ongoing software project. The model is constructed with the goal of improving software engineering processes, and to build an understanding of the process. It is the result of a process that involves modeling, analyzing, and controlling an ongoing software project.

Significance: A process for human directed machine learning can improve the current approach to developing software systems. The software used in this experiment is the KB SEE, a software system for the KB SEE, a software system for the KB SEE. The KB SEE system is designed to adapt to current requirements and to model current processes. It is the result of a process that involves modeling, analyzing, and controlling an ongoing software project.

Static: An experiment is in progress to incorporate machine learning in a software engineering environment. The software used in this experiment is KB SEE, a software system for the KB SEE, a software system for the KB SEE. The KB SEE system is designed to adapt to current requirements and to model current processes. It is the result of a process that involves modeling, analyzing, and controlling an ongoing software project.

Technical Contacts:
- Workstation Code 512 Information Technology Section
- Darnell 114, 512
- 3131 320-1111

The Software Management Environment

The Software Management Environment (SME) is a software tool designed to assist in managing, analyzing, and controlling an ongoing software project. The model is constructed with the goal of improving software engineering processes, and to build an understanding of the process. It is the result of a process that involves modeling, analyzing, and controlling an ongoing software project.

During fiscal year 1990, the SME was extended and improved to include functionality for expert assessment of project problems and for extracting its ability to model the project environment. With these enhancements in place, the SME has been released for use by software managers within the Flight Dynamics Division of the QFC. By utilizing the SME, an ongoing software development project within Flight Dynamics, the managers will be able to effectively compare, predict, and analyze key project parameters. This release of the SME represents the first use of the tool on actual projects and will provide valuable insight into the accuracy and usefulness of the tool, as well as help to establish future research needs for the SME.

During the next year, the SME will be prepared for release to other organizations outside of Flight Dynamics. This planned release will begin to establish the usefulness of such a tool in an environment beyond the one for which it was originally designed. Other planned research includes the development of an overall project assessment function and to begin examining ways of providing guidance to managers for solving development problems.

Technical Contact: Jon Veltri, QFC, 3131 320-1111
ESC, or Encyclopedia of Software Components

TASK DESCRIPTION:
- a hypertextual software cataloguing and retrieving system
- an electronic metaphor of an encyclopedia
- organizes software into a dynamic, linked knowledge structure
- multiple access modalities — goal-directed searching, browsing with hypertext tracing
- distributed contents
- contents in many programming languages and at many levels of granularity
- contents in many forms: code, documentation, graphics, etc.
- Encyclopedia Construction Kit supports user contributions and specialized handbooks

NASA NEED AND SIGNIFICANCE:
- an interchangeable software parts technology is greatly needed
- such a technology has existed for hardware for over a century
- reuse will not be widespread until it is easier and cheaper to find software than to write it anew

CURRENT STATUS:
- conceptual prototype: June 1990
- prototype runs on color Macintosh systems
- Activities for 1991:
  - collect feedback on interface and contents
  - update the conceptual prototype
  - engineer insertion and retrieval mechanisms
  - conduct preliminary investigation of roles of AI (artificial intelligence)

Technical contact: Dr. Brian Bechman, JPL, (818) 354-1252
SPACE DATA SYSTEMS PROGRAM

- Includes: GSFC, JPL, LaRC, ARC
- Supports: VLSI Design @ U. Idaho

**Program Drivers**
- Ambitious future space instruments
- Long-duration, high-humidity requirements
- Time delay for insertion of commercial technology
- Transition activity for externally developed technology (e.g., DoD)

**SPACE DATA SYSTEMS STATE-OF-THE-ART-ASSESSMENT**

<table>
<thead>
<tr>
<th>MIRION</th>
<th>PROC TYPE</th>
<th>MIRION</th>
<th>READNESS AS</th>
<th>FUNCTIONAL PERFORMANCE</th>
<th>CPU/COMB. CAP</th>
<th>RAM/BOARD</th>
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<tr>
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<td>LEVEL 10</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**CASE for ALS**

**Conventional Approach**
- Engineering Design → Software Design → Code

**ALS Advanced Development Program**

**Avionics & Software**

**CASE for ALS**

**Diagram**

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SPACEFLIGHT OPTICAL DISK RECORDER

The concept of high-capacity data storage has been identified as an enabling capability for future NASA missions, including multi-year missions (Mars Surveyor, and planetary exploration by the 1990's and beyond). The Synthesized Optical Disk Recorder (SODR) program has been established to develop components and systems based on multi-rate optical disk technology, which form the basis for high-performance mass storage systems. Three major technology development areas: 1) high capacity optical media; 2) masked rewrite technology, and 3) a multi-rate optical head assembly. Fundamentally, the objective is to demonstrate high data rate. The objective of the Synthesized Optical Disk Recorder (SYODR) program is to develop a high capacity on one side exceeds the read and write data rate of any other known disk storage device.

During the past year, a new laser structure was developed which enables more efficient (spawning) laser beam, which has been used to produce 8,000 hours of stable operation. Class IIb substrate media have been qualified and evaluated for environmental testing. Multi-penetration optimization for harsh environments is proceeding. This technology is directly transferable to a companion Air Force program. NASA sponsored NASA/MSFC/Industry working groups has been formed to establish a standard for 16-inch (40-cm) media and standards.

An associated modular concept to be developed at NASA to produce a configurable, expandable system supporting the use of multiple drives and modules to obtain data rates in excess of 1 megabyte per second, a goal that exceeds any other known or planned optical recording device or light tape recorder and capacities up to 8 terabytes (810 gigabytes).

The current work represents significant technology and development toward development of a completely high capacity optical disk drive and controller. NASA and NASA funding is being used to initiate procurement of a prototype model to be used in a demonstration in FY 94.

Technical Contact: Thomas A. Smith, NASA, 604-504-1827

DATA STORAGE TECHNOLOGY

DESCRIPTION: The purpose of this task is to evaluate the state of magnetic recording technology for achieving high data rate and high capacity data storage.

SIGNIFICANCE: The significance of this work is to identify an attractive method for simultaneously achieving high data rate and high capacity recording with high reliability, effective data rate, and low mass, volume, and power.

CURRENT STATUS OF ACCOMPLISHMENT: The evaluation results indicate that the development of MR head technology is an extremely viable and promising technology. Results indicate that storage density using MR heads is already greater than optical storage densities. The results also indicate that reliability figures using MR heads are one to two orders-of-magnitude greater than those achieved with tape head technology. MR heads can be developed to achieve 200 Mbps and terabyte storage in tape recordings with low mass, volume, and power. Additionally, high performance and compact memory modules can be designed which can offer higher performance than block access optical and magnetic optical disk drives. Discussions and developments in these organizations have been established with corporations participating in this program including Applied Magnetics, IBM, Rockwell, Goulds, and StorageTek. Discussions are underway with these organizations to support us technically in our follow-on FY 95 baseline demonstration effort.

TECHNICAL CONTACT: Dr. Romney R. Kaid, JPL, (818) 354-3054.
ADSP CHARACTERISTICS

- The engineering model contained 73 total boards (excluding interfaces) which included 26 unique designs.
- The boards contained a total of approximately 28,000 ICs, nearly filling two electronics racks and consuming about 15 kW of power.
- At the 20 MHz maximum clock rate, the processor could sustain about seven billion floating point operations per second, the approximate compute rate required to process Seasat data at real-time rate.
- Magellan added five additional boards for special radiometric compensation and multilook control, resulting in a processor capable of processing the Magellan SAR data at least four times faster than the real-time acquisition rate.
- The V/0 computer system limits the actual processing rate to approximately real-time. This rate is still about four times faster than back up (engineering SAR processor), which is built from the most efficient commercial hardware available when the ADSP was complete in 1988.

WHAT IS THE ADSP?

DESIGN ATTRIBUTES

- Flexible SAR processor
- Over 6 Gigaflops peak compute rate
- Real time rate capability for missions such as Seasat and SIR-B
- 150 Megabytes of memory
- About 35,000 integrated circuits

HIGH PERFORMANCE COMPUTING & COMMUNICATIONS PROGRAM

- Includes: ARC, GSFC, LaRC, LeRC, JPL
- Supports: CESDIS, RIACS, ICASE
- Program Drivers
  - NASA mission needs for high-performance computation in
    - Aeronautics/Astronautics
    - Space & Earth Science
    - Exploration
  - Support for nationally & globally networked collaboration
  - Highly trained scientists & engineers for future missions
GOAL AND OBJECTIVES

GOAL:
- ACCELERATE THE DEVELOPMENT AND APPLICATION OF HIGH PERFORMANCE COMPUTING TECHNOLOGIES TO MEET NASA SCIENCE AND ENGINEERING REQUIREMENTS

OBJECTIVES:
- DEVELOP ALGORITHM AND ARCHITECTURE TESTBEDS CAPABLE OF FULLY UTILIZING MASSIVELY-PARALLEL CONCEPTS AND INCREASING END-TO-END PERFORMANCE
- DEVELOP MASSIVELY-PARALLEL ARCHITECTURES SCALABLE TO SUSTAINED TERAFLOPS PERFORMANCE
- DEMONSTRATE TECHNOLOGIES ON NASA RESEARCH CHALLENGES
  - INTEGRATED AEROSPACE VEHICLE SYSTEMS
  - EARTH AND SPACE SCIENCE PHYSICAL PHENOMENA
  - SPACEBORNE APPLICATIONS

NASA NEEDS

- NASA NEEDS TERAFLOPS \(10^12\) COMPUTATIONAL CAPABILITIES TO ADDRESS GRAND CHALLENGES, THE SOLUTIONS OF WHICH, ARE ESSENTIAL TO ACHIEVING NASA'S MISSION
- CONVENTIONAL APPROACHES WILL NOT PROVIDE THE PERFORMANCE NECESSARY TO SOLVE GRAND CHALLENGES IN COMPUTATIONAL AEROSCIENCES, EARTH AND SPACE SCIENCES AND REMOTE EXPLORATION AND EXPERIMENTATION
- COMPUTATIONAL AEROSCIENCES
  - INTEGRATED, MULTIDISCIPLINARY SIMULATIONS OF AEROSPACE VEHICLES THROUGHOUT THEIR MISSION PROFILES
- EARTH AND SPACE SCIENCES
  - MULTIDISCIPLINARY MODELING AND MONITORING OF THE EARTH AND ITS GLOBAL CHANGES AND ASSESSMENTS OF THEIR IMPACT ON THE FUTURE ENVIRONMENT
- REMOTE EXPLORATION AND EXPERIMENTATION
  - EXTENDED-DURATION HUMAN EXPLORATION MISSIONS AND REMOTE EXPLORATION AND EXPERIMENTATION
**EARTH AND SPACE SCIENCES**

**Computing Speed and Memory Requirements**

<table>
<thead>
<tr>
<th>System</th>
<th>Memory (PB)</th>
<th>Speed (MFLOPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing System</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>New System</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

**Objectives**

- Develop computational models and methods for scalable, parallel computing systems.
- Accelerate the development of computing system hardware and software technologies capable of sustaining a teraflops performance level on computational aero-space applications.
- Demonstrate and evaluate computational methods and computer system technologies for selected aerospace vehicle and propulsion systems models on scalable, parallel computing systems.
- Transfer computational methods and computer system technologies to aerospace and computer industries.

**Candidate Applications**

- Powered lift vehicle
- High-speed civil transport
- Aerobraking
- National aero-space derived vehicles

**Computational Aerosciences**

**Goal**

Develop necessary computational technology for the numerical simulation of complete aerospace vehicles for both design optimization and analysis throughout the flight envelope.

**Objectives**

- Develop multidisciplinary computational models and methods for scalable, parallel computing systems.
- Accelerate the development of computing system hardware and software technologies capable of sustaining a teraflops performance level on computational aero-space applications.
- Demonstrate and evaluate computational methods and computer system technologies for selected aero-space vehicle and propulsion systems models on scalable, parallel computing systems.
- Transfer computational methods and computer system technologies to aerospace and computer industries.

**Candidate Applications**

- Powered lift vehicle
- High-speed civil transport
- Aerobraking
- National aero-space derived vehicles
REMOTE EXPLORATION AND EXPERIMENTATION

GOAL
DEVELOP SPACEBORNE COMPUTING TECHNOLOGY WHICH WILL ENABLE HIGH PERFORMANCE, FAULT-TOLERANT, ADAPTIVE SPACE SYSTEMS FOR A NEW GENERATION OF MISSIONS TO EXPLORE THE EARTH AND SOLAR SYSTEM

OBJECTIVES
DEMONSTRATE THE FEASIBILITY OF 1000-FOLD INCREASE IN SPACEBORNE COMPUTER SYSTEMS PERFORMANCE

DEMONSTRATE A PARALLEL, SCALABLE ARCHITECTURE
- LOW WEIGHT AND LIMITED POWER
- AFFORDABLE
- FAULT TOLERANT

DEMONSTRATE A SOLID PROTOTYPE-TO-FLIGHT SYSTEM ENGINEERING PATH

CANDIDATE APPLICATIONS
ANALYSIS OF DATA FROM THE TROPOSPHERE EMISSION SPECTROMETER, AN EARTH OBSERVING SYSTEM INSTRUMENT
INTEGRATION OF ROBOTIC ALGORITHMS FOR SENSING AND MANIPULATION ASTROPHYSICS MISSIONS
ROBOTICS

NATIONAL RESEARCH & EDUCATION NETWORK
CESDIS
THE CENTER OF EXCELLENCE IN SPACE DATA AND INFORMATION SCIENCES

Raymond E. Miller
CESDIS Director And
Professor Of Computer Sciences
University Of Maryland
College Park, MD
(301) 286-3805
CESDIS
The Center of Excellence
in Space Data and
Information Sciences
NASA Goddard Space Flight Center
Greenbelt, MD

Raymond E. Miller
CESDIS Director
and
Professor of Computer Science
University of Maryland at College Park
College Park, MD

CESDIS MISSION
To bring together computer scientists from
university, industrial, and government
laboratories to:

- Conduct computer science
  research having application to
  Earth and space science;

- Focus attention on accessing,
  processing, and analyzing data
  from space observing systems; and

- Collaborate with NASA space
  and Earth scientists.

GOALS TO BE
ACCOMPLISHED BY:

- Funding research projects selected on the basis of peer
  reviewed proposals;

- Supporting additional research personnel for projects funded
  by NASA through other programs;

- Providing a computer science research environment on-site
  at GSFC and encouraging visits by project personnel;

- Conducting workshops and conferences;

- Organizing seminars for GSFC, university, and Industrial
  Earth, space, and computer scientists;

- Administering fellowships established by industrial associations;

- Developing areas for collaborative efforts through contacts
  established by Director and Staff Scientists;

- Producing technical report series of papers prepared by
  CESDIS members.

CESDIS

DIRECTOR
Raymond Miller

HPCC PROJECT
COORDINATOR
Michael MacDonnell
Administrative Assistant II

ADDITIONAL RESEARCH TASKS
Brown - Jeffrey Vitter
           - Paul Howard
Peres - Eric Fapengs
University of - Noah Friedland
           - Michael Lavelle
Maryland

George - Raymond Lanier
         - Scott Edmonson
University - Hermann Holger
           - Daniel Starnes
University of - H. T. Kung
           - Douglas Smith

Carnegie - Harry Newell
           - Cray Fellowship

CESDIS CENTRAL RESEARCH
Staff - Kenneth Salem
       - David Bents

Director - Raymond Miller

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<table>
<thead>
<tr>
<th>TASK GOALS AND ACCOMPLISHMENTS</th>
<th>TASK GOALS AND ACCOMPLISHMENTS:</th>
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<tbody>
<tr>
<td>DUKE UNIVERSITY</td>
<td>GEORGE WASHINGTON UNIVERSITY</td>
</tr>
<tr>
<td>Parallel Compression of Space</td>
<td>A Knowledge-Based Advisory</td>
</tr>
<tr>
<td>and Earth Data</td>
<td>System for General Scientific</td>
</tr>
<tr>
<td>PERIOD OF PERFORMANCE:</td>
<td>Data Visualization</td>
</tr>
<tr>
<td>October 1988 - September 1991</td>
<td>PERIOD OF PERFORMANCE:</td>
</tr>
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<td></td>
<td>September 1988 - August 1991</td>
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<tr>
<td>GOALS</td>
<td>GOALS</td>
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<tr>
<td>• Develop parallel algorithms</td>
<td>• Investigate and specify</td>
</tr>
<tr>
<td>and architectures for</td>
<td>visualization vocabulary to</td>
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<tr>
<td>lossy and lossless data</td>
<td>embody essential concepts</td>
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<tr>
<td>compression.</td>
<td>required for scientific</td>
</tr>
<tr>
<td>• Design compressions</td>
<td>visualization.</td>
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<tr>
<td>applicable to large variety of</td>
<td>• Incorporate user interface</td>
</tr>
<tr>
<td>data.</td>
<td>for visualization - naive users.</td>
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<tr>
<td>• Design good parallel vector</td>
<td>• Develop system design</td>
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<tr>
<td>quantization algorithm.</td>
<td>extendable for knowledge</td>
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<td></td>
<td>refinement and new visualization</td>
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<td></td>
<td>techniques.</td>
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<tr>
<td>ACCOMPLISHMENTS</td>
<td>ACCOMPLISHMENTS</td>
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<tr>
<td>• Devised several algorithms,</td>
<td>• Compiled 145 rules and</td>
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<tr>
<td>investigated their</td>
<td>principles pertaining to</td>
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<tr>
<td>theoretical aspects, and</td>
<td>expressiveness of visualization</td>
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<td>evaluated performance against</td>
<td>techniques.</td>
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<td>USC Image database to</td>
<td>• Implemented primitive</td>
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<tr>
<td>compare results with</td>
<td>rendering algorithms.</td>
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<td>existing schemes using same</td>
<td>• Designed VISTA (Visualization</td>
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<tr>
<td>images.</td>
<td>Tool Assistant) and</td>
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<tr>
<td>• Developed multiresolution</td>
<td>completed first prototype.</td>
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<tr>
<td>lossy methods capable of</td>
<td>• Conducted preliminary test of</td>
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<td>controlling amount of</td>
<td>prototype using data</td>
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<tr>
<td>information lost by trading</td>
<td>supplied by GSFC NSSDC.</td>
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<tr>
<td>off between compression rates</td>
<td></td>
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<tr>
<td>and distortion.</td>
<td></td>
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<tr>
<td>Stanford University</td>
<td>University of North Carolina</td>
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<tr>
<td>Computer Assisted Analysis of</td>
<td>at Chapel Hill</td>
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<tr>
<td>Auroral Images Obtained From</td>
<td>Image Pattern Recognition</td>
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<tr>
<td>High Altitude Polar Satellites</td>
<td>Supporting Interactive</td>
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<tr>
<td>PERIOD OF PERFORMANCE:</td>
<td>Analysis and Graphical</td>
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<tr>
<td>January 1989 - December 1991</td>
<td>Visualization</td>
</tr>
<tr>
<td>GOALS</td>
<td>PERIOD OF PERFORMANCE:</td>
</tr>
<tr>
<td>Develop, implement, evaluate,</td>
<td>September 1988 - August 1991</td>
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<tr>
<td>and utilize advanced computer</td>
<td></td>
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<td>software tools whose purpose</td>
<td></td>
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<td>is to automate the analysis</td>
<td></td>
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<td>of global auroral images</td>
<td></td>
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<tr>
<td>obtained from DE-1 and Viking</td>
<td></td>
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<tr>
<td>satellites.</td>
<td></td>
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<tr>
<td>ACCOMPLISHMENTS</td>
<td>ACCOMPLISHMENTS</td>
</tr>
<tr>
<td>• Completed implementation</td>
<td>• Have explored nature of image</td>
</tr>
<tr>
<td>and testing of “snakes”</td>
<td>regions formed by some</td>
</tr>
<tr>
<td>algorithm for finding</td>
<td>coherence of intensity, edge</td>
</tr>
<tr>
<td>auroral oval inner boundary.</td>
<td>surround, orientation, or</td>
</tr>
<tr>
<td>• Have made progress on</td>
<td>texture, across scales based on</td>
</tr>
<tr>
<td>extending technique to</td>
<td>2 image description techniques:</td>
</tr>
<tr>
<td>regions where daylight overlaps</td>
<td>Multiscale Orientation Fields</td>
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<tr>
<td>aurora and to simultaneously</td>
<td>and Spatial Spectrum</td>
</tr>
<tr>
<td>find both inner and outer</td>
<td>Classification.</td>
</tr>
<tr>
<td>boundaries.</td>
<td>• Beginning to apply to Landsat</td>
</tr>
<tr>
<td>• Project personnel met with</td>
<td>images obtained from GSFC.</td>
</tr>
<tr>
<td>13 GSFC and NASA HQ scientists</td>
<td>• Applied algorithm to Hubble</td>
</tr>
<tr>
<td>to discuss potential</td>
<td>data in effort to reduce</td>
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<tr>
<td>collaborative efforts.</td>
<td>blurring of images without</td>
</tr>
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<td></td>
<td>destroying frequency spectra.</td>
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</table>
ADDITIONAL RESEARCH TASKS

Brown University: Jeffrey Vitter and Paul Howard
Data Compression Algorithms

Penn State University: Eric Fargason and Michael LaVallie
Advanced Statistical Methods for Improved Data Analysis of NASA Astrophysics Missions

University of Maryland: Noah Friedland
Simulated annealing, neural networks and Markov random field methods to solve inversion problems in atmospheres sounding

George Washington University: Burt Eeders and Herman Helgert
Concepts, plans and experiments to utilize the Advanced Communications Technology Satellite in supercomputing networking

George Washington University: John Sibert and Cindy Starr
Computer graphics tools and techniques for scientific visualization

George Washington University: Renald Lohten
Computer codes for simulation of 3D compressible magnetohydrodynamical flows

Stanford University: Philip Scherrer and Richard Bogart
Astrophysics: Electrons and for the Astrophysics Community

Carnegie Mellon University: Douglas Smith (Cray Fellow) and K.T. Kung (Advisor)
Intermediate Language and Virtual Architecture for High Performance Image Processing

WORKSHOPS

AUGUST 1989
Computing Challenges in Managing Future Massive Image Systems

OCTOBER 1990
The Role of Computer Science in Mission to Planet Earth

TECHNICAL REPORT SERIES

Technical reports from CESDIS research projects.
Currently have 74 reports.

FUTURE PLANS

- Develop industrial associates program
- Fund additional research associated with HPCC and EOS
- Run small specialized workshops
- Continue to cooperate in organizing and running conferences e.g., Data Compression Conference Workshop on Parallel Algorithms
- Build more collaborative efforts
NASA TRENDS AND CESDIS ROLE

- NASA missions are moving from using state-of-the-art computing techniques and technologies to missions requiring major advances in computing hardware, software, algorithms, and communications.

- Advanced computing needs lie at the center of the NASA missions.

- Many areas of computer science research have a direct bearing on NASA needs.
  Database systems, distributed computing systems, networking and communication, AI/Expert Systems/Neural Nets, Human/Computer Interfaces, Computer Graphics, Visualization, Pattern Recognition, Algorithms, Software Engineering, Robotics, etc.

CESDIS PROPOSED HPCC ACTIVITIES

FY 92

- Hire Associate Director for HPCC.
- Help manage Goddard NRA peer review.
- Staff and run evaluation activity for space and Earth science grand challenge problems on various high-performance test-bed architectures.
- Prepare and issue CESDIS call-for-proposals in HPCC research.

OVERALL CESDIS PLANS

1992 - 2000

Build a community of computing science researchers who collaborate with space and Earth scientists on problems of interest to NASA, through peer-reviewed proposal research at universities, through collaboration with industrial researchers, and by building a small core of about 5 full time researchers at CESDIS, plus a similar size University of Maryland group of faculty and graduate student researchers.

FY 93 - 97

- Build research activities for HPCC in:
  - Relative evaluation for high performance computers in space and Earth science applications.
  - Numerical techniques for parallel computation.
  - Management of massive amounts of data in distributed systems.

- Support education of Ph.D.'s in areas of HPCC research funded through:
  - peer reviewed projects
  - post-docs
  - graduate fellowships
CASSIS BACKGROUND

Professor Michael J. Flynn
Departments of Electrical Engineering and Computer Sciences
Stanford University
Stanford, CA
(415) 723-1450
CASIS

Background

Prof. Michael J. Flynn
Department of
Electrical Engineering
and
Computer Science
Stanford University

Some special facilities/centers:
• Center for Integrated Systems
• Center for Telecommunications
• Center for Reliable Computing
• Center for Concurrency Studies
• Program in Manufacturing Science

CASIS — Past
• 10 years
• Supports about 20 research students per year
  About 110 total
• About 5 supported students receive Ph.D. each year
  About 35 total
• Over 300 supported reports, publications, etc.

CASIS — 1991
Supported faculty and research areas:
Telecommunications
Professor F. Tobagi
Professor J. Cioffi
Neural Nets
Professor A. Peterson
Professor T. Kailath
Concurrent Processors
Professor M. Flynn
Professor Monica Lam
Data Analysis & Management
Professor G. Van Etten
Professor J. Vossen
Professor M. Levoy
Programming Environments
Professor M. Linton

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Data Visualization
Data Recognition
Data Transmission
Data Processing

Data Visualization

1) Ice analysis and computer vision tools may be used to extract information and parameters from image data.

2) The extracted parameters from the data may be used as automatically generated indices of image databases.

3) The extracted information may be also used as automatically generated geometric primitives for visualization.

Examples of CASIS Research in Information Extraction from Data

1) Generating sea ice motion vectors from radar images.

2) Extracting area and boundary information from UV satellite images of aurora.

3) Finding curvilinear features in radar images.
EXPRESSNET
A Unidirectional Broadcast Bus Local Area Network with A conflict-free round-robin Media Access Protocol

Basis for many network Concepts used in High Speed , Fiber Optic Local Area Networks, Including the Metropolitan Area Network Standard DQDB (IEEE802.6)

Described in Most Important Textbooks
Tanenbaum; Stallings; Gallager and Bertsekas; etc.
Fiber Optic Communications

- Impairment: Dispersion distorts pulses resulting in Intersymbol Interference (ISI)
- Goal: Find simple signal processing techniques to compensate for ISI, allowing for improved data rates and distances

Application Specific Systems Development
- avoiding the software bottleneck for key applications
  - gas dynamic/fluid flow
  - pattern recognition/neural nets
  - finite element analysis

Computing

Concurrency Studies

Optimizing Compilers
  for Large Scale Multiprocessors

Parallel Architect's Workbench

Parallel Processor Software support
- GEM
- scheduling optimization
Architectures for Lattice Gas Cellular Automata

- Main application domain: fluid flow simulation
- Approach One
  - Until recently, most fluid flow models are based on partial differential equations (e.g., Navier-Stokes equations).
  - Solution usually involves numerical techniques with large numbers of floating point operations.
- Approach Two
  - Lattice gas cellular automata are new discrete models of fluids.
  - The fluids are made up of idealized particles that move according to simple rules.
  - Collections of large numbers of these particles can show overall continuous behavior which agrees with results predicted by Navier-Stokes equations.
  - This approach involves only logical operations and does not require floating point arithmetic.

The Computer Architect's Workbench

- The AWB is a set of software tools to predict the relative performance of alternative computer and system architecture features
  - Actual applications are used as benchmarks
  - High quality compiler support
  - Low requirements on hardware descriptions
- Trace Driven at basic block granularity

AWB: A General Research Tool and a Problem Solving Tool

- Research Tool
  - Architecture and Instruction Caches
  - Architecture and Data Buffering
  - Optimization and Instruction Architecture
- Design Tool
  - ASIC alternatives
  - Cost/Performance Analysis
  - Specific Workload Evaluation

Current Research

- The Effects of Programming Paradigms on the Instruction and Data Streams of a Shared Bus Multiprocessor
- Increasing the Performance of Shared Bus Multiprocessors
  - Effects of shared caches
  - Compiler techniques
    - Prefetch of data
    - Write and Flush
    - Utilizing relationships between variables
  - Processor Architecture
APPLIED INFORMATION SYSTEMS
RESEARCH PROGRAM WORKSHOP

PRINCIPAL INVESTIGATORS PRESENTATIONS
(A.M. SESSION)
PRINCIPAL INVESTIGATORS PRESENTATIONS

PROGRAM PLAN FOR AN EXPERIMENTER'S LABORATORY FOR VISUALIZED INTERACTIVE SCIENCE

Elaine R. Hansen/P. I.
Colorado Space Grant Consortium,
Univ. of Colorado
Boulder, CO
(303) 492-3141

Marjorie K. Klemp/Co.I.
Sally W. Lasater/Co.I.
Marti Szczur/Co.I.
Joseph B. Klemp/Co.I.
I. PROGRAM GOALS AND OBJECTIVES

GOALS

- Provide a capability that will help scientists of the '30's to interactively visualize data in order to better understand the large, complex, and multidimensional data sets of our future space missions

- Provide an Interactive Visualization Environment to support science research within and across NASA science disciplines

- Provide an Interactive Visualization Environment that can be easily tailored by the scientists themselves to best fit their individual research problems and display preferences

- Enable general members of the Space Science Community to use advanced visualization tools at an affordable price

- Capitalize on existing information systems techniques, technologies, and tools

OBJECTIVES

- Provide a multidimensional, visualization capability based on the research needs of NASA scientists

- Support interactive, exploratory analysis

- Handle multiple, simultaneous, and diverse data sets (ingest, present, manipulate)

- Provide a user interface that is intuitive for and responsive to the needs of the general science user

- Provide software that will run on a variety of popular, affordable workstations
II. CONCEPT FOR ACHIEVING OBJECTIVES

- First and Foremost, product must have a suitable acronym!

IVE (Interactive Visualization Environment)
IVAN (Interactive Visualization Analysis Node)
ELVIS (Experimenter's Laboratory for Visualized Interactive Science)

II. CONCEPT FOR ACHIEVING OBJECTIVES

- Process

- Early and Continual Focus on the Science Users through Interviews, observations, and participative design

- Parallel Design of all aspects
  - The user interface design must start at the same time or before software design

- Early and continual user testing with prototypes to enable feedback to the design process
  - User testing of user interface, functions and services, help, documentation, training, etc.

III. BUILDING BLOCKS

1. 3D Data Generation and Rendering, "PolyPaint"
   - Foundation system developed by NCAR
   - Key individuals are Joseph Klemp (PolyPaint Originator and Lead), William Boyd, (Systems designer/programmer), Matt Irvin (Programmer, summer student, Physics Grad at MIT in Academic Year)
   - "Poly" Features
     - Polygon generation for contour surfaces within any specified subset of a three-dimensional grid volume
     - Contour surfaces that enclose either higher or lower values
     - Coordinate transforms for 3D data in non-Cartesian coordinates
     - Line normal vectors that are calculated either separately for each polygon vertex or averaged among polygons sharing that vertex
     - Polygon generation for planar surfaces cutting through the data domain
     - Polygon generation for surfaces defined by the values of a two-dimensional data array
     - Polygon generation for two-dimensional contour lines (represented as ribbon surfaces) with a specified contour interval in any coordinate plane
     - Polygon generation to convert a three-dimensional curve into a ribbon-like surface
IV. PLANS

- Plans have been reduced and stretched to fit available funding levels

(hoping for more funding!)

IV. PLANS

- Integrate software components
- User interactions and evaluations

MILESTONES

- System data flow in 1 1/2 years
- Complete system with limited users, data types, handlers in 3 years
PRINCIPAL INVESTIGATORS PRESENTATIONS

GRID ANALYSIS AND DISPLAY SYSTEM (GrADS): A PRACTICAL TOOL FOR EARTH SCIENCE VISUALIZATION

James L. Kinter III/P.I.
Univ. of Maryland
Dept. of Meteorology
College Park, MD
(301) 405-5384

Brian E. Doty/Co.I.
NOTES:

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THE GRID ANALYSIS AND DISPLAY SYSTEM (GRADS): A PRACTICAL TOOL FOR EARTH SCIENCE VISUALIZATION

JAMES L. KINTER III
BRIAN E. DOTY

CENTER FOR OCEAN-LAND-ATMOSPHERE INTERACTIONS
DEPARTMENT OF METEOROLOGY
UNIVERSITY OF MARYLAND
COLLEGE PARK, MD 20742

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
APPLIED INFORMATION SYSTEMS PROGRAM WORKSHOP
BOULDER, COLORADO

22-24 JULY 1991

**SCIENTIFIC VISUALIZATION = 3:**

**I SEE**

**SCIENTISTS → DATA**
- Quantitative
- Interactive
- View + Manipulate

**YOU SEE**

**RESULTS → JOURNALS**
- Quantitative
- Publication Quality
  - Legible
  - Informativ
  - Comparable

**WE SEE**

**IMAGES → PUBLIC**
- Qualitative
- Aesthetic

---

**GrADS - Design Goals**

- **INTEGRATE**
  - Data access, manipulation and display

- **ACCESS**
  - Four-dimensional data sets
  - Controllable access to one, two or three dimensions

- **MANIPULATION**
  - Data operations through programming and functions

- **DISPLAY**
  - All standard techniques
    - Line graphs, contour maps, vector fields, streamlines, cross-sections
  - All standard map projections and marks

- **INTERACTIVE**
  - Mouse sensing
  - Context of data
  - Dynamic data display characteristics
  - Language
  - Programmability

- **EASE OF USE**
  - Short learning curve
  - User feedback

- **HARDCOPY**
  - Typewriter-quality hardcopy

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**ORIGINAL PAGE IS OF POOR QUALITY**
GrADS Gridded Data Set

- The generalized view of the data is 4-Dimensional. Spacing may be non-linear except in time.
  - X, Y, Z, T = Longitude, Latitude, Height, and Time
  - Any number of variables
- Data resides on disk in binary format. Data sets are easily created or read by FORTRAN programs.
- X varies fastest, then Y, then Z, then each variable, then time.
  - Variables may have different numbers of levels, but must have same number of X, Y, and T elements
  - Use separate data set for different scaling

GrADS Station Data Set

- Each data element arbitrarily located in space and time.
- Data resides on disk in a structured format. Subroutines are provided for creating the data set from FORTRAN programs.
- A utility is run to create a 'map' of the station data set, allowing efficient I/O access for any data request.

GrADS Data Description File

- Name of binary data set
- Defines scaling between grid coordinates and world coordinates
- Describes each variable
  - Abbreviation to be used for the variable within expressions
  - Number of levels provided
  - Units value (not currently used)
  - Long name of variable
DSET /DATA/REANAL/ANALYSIS.DAT
UNDEF -9.99E33
TITLE REALIZED GLOBAL FIELDS FROM DEC 82
   * 
XDEF 144 LINEAR 0.0 2.5
YDEF 73 LINEAR -90.0 2.5
ZDEF 12 LEVELS 1000 850 700 500 400 300 250 200 150 100 70 50
TDEF 20 LINEAR 00Z6DEC1982 6HR
   * 
VARS 5
  Z 12 99 GEOPOTENTIAL HEIGHTS
  U 12 99 U WINDS
  V 12 99 V WINDS
  RH 6 99 RELATIVE HUMIDITY
  TV 12 99 VIRTUAL TEMPERATURE
ENDVARS

Example 1

Examples using the data sets from the descriptor files shown earlier (files have been opened).

SET LON -90
SET LAT 40
SET LEV 850
SET TIME 00Z6DEC1982 18Z10DEC1982
DISPLAY TV
DRAW TITLE 850mb Virtual Temperatures at 90W, 40N
DRAW YLAB Degrees Kelvin

Notes: 
• A 1-D slice of TV (a basic variable) is being displayed
• We get a graph by default
Example 2

CLEAR
SET LON -140 -60
SET LAT 15 65
SET LEV 500
SET T 1
DISPLAY Z
DRAW TITLE 500mb Heights
DRAW XLAB 00Z December 8, 1982

Notes: • If X and Y are varying, a map is automatically drawn.

Example 3

CLEAR
SET LON -90
SET LAT -90 90
SET LEV 1000 50
SET T 1
DISPLAY U
SET CSTYLE 3
DISPLAY TV
DRAW TITLE U Winds / Virtual Temperatures

Notes: • Vertical Cross Section
• Multiple DISPLAYs without CLEARing result in overlaid contours
PRINCIPAL INVESTIGATORS PRESENTATIONS

A DISTRIBUTED SYSTEM FOR VISUALIZING AND ANALYZING MULTIVARIATE AND MULTIDISCIPLINARY DATA

Allan S. Jacobson/P.I.
Jet Propulsion Laboratory
Pasadena, CA
(818) 354-0693

Mark A. Allen/Co.I.
Michael J. Bailey/Co.I.
Ronald G. Blom/Co.I.
Leo Blume/Co.I.
Lee S. Elson/Co.I.
A Distributed System for Visualizing and Analyzing Multivariate and Multidisciplinary Data

Investigator Team:
Jet Propulsion Laboratory
Allan S. (Bud) Jacobson - Principal Investigator
Mark A. Allen
Ronald G. Blom
Lea S. Elson
San Diego Supercomputer Center
Michael J. Bailey
Silicon Graphics, Inc.

The Linked Windows Interactive Data System (LinkWinds)

1. A visual data exploration/analysis environment with data displayed in a series of interdependent windows. Interdependence is established at user's discretion by "linking" visuals and controls.

2. A standard graphical user interface with additional "linking" rules. Results in an intuitive interface accessible with a minimum of training.

3. A user accessible applications prototyping environment.

4. Implemented with an object-oriented programming model, with "links" establishing message flow paths. There is an underlying command language (Lynx) based upon scheme.

5. A multi-user science environment (MUSE) requiring a minimum of network band-width.

The Linked Windows Interactive Data System (LinkWinds)

Program Objectives

1. Develop LinkWinds tools and controls specific to at least two science disciplines and demonstrate them in current research activities.

2. Adapt LinkWinds to X-Windows for execution in a network environment.

3. Use adapted LinkWinds to demonstrate cooperative and interactive televirtualization and analysis by geographically separated science teams.

Development Approach

1. Employ an incremental development process using rapid prototyping of applications.

2. Work with users and developers in a tight loop throughout the process.

3. Provide software and workstations to users to stimulate product use in research activities.
The Linked Windows Interactive Data System (LinkWinds)

Application Development Cycle

User "What's needed?"

- Determine Requirements
- User Validation
- Finalize Application

Developer "What's possible?"

- Implement Prototype
- Demonstrate Prototype

The Linked Windows Interactive Data System (LinkWinds)

Linking Rules

1. If an empty window appears, link a data object to it.

2. Link control symbols to other windows in order to manipulate them.

The Linked Windows Interactive Data System (LinkWinds)

User Interface Design Philosophy

1. Users are impatient and want to get started quickly on productive work. They are discouraged by large manuals.

2. Users learn from self-initiated exploration, making mistakes and correcting them.

3. Users refer to documentation only when the software doesn't conform to their expectations. Then they skip around in manuals or online help to find the answer to current problem.

The Linked Windows Interactive Data System (LinkWinds)

Future Plans

1. Port to X-Windows, using OSF Motif toolkit, for expansion to other platforms.

2. Implement an applications generator to support user application development.

3. Expand MUSE capabilities:
   - Session Management, Floor Management,
   - Telepointers, Network clipboard

4. Implement hardcopy and video output.
PRINCIPAL INVESTIGATORS PRESENTATIONS

DATA REDUCTION EXPERT ASSISTANT

Glenn E. Miller/P.I.
Space Telescope Science Institute
Baltimore, MD
(301) 338-4738

Mark D. Johnston/Co.I.
Robert J. Hanisch/Co.I.
Data Reduction Expert Assistant
AISR Workshop
22-24 July 1991

Glenn E. Miller
Mark D. Johnston
Robert J. Hanlach
Space Telescope Science Institute
3700 San Martin Dr.
Baltimore, MD 21218

Data Reduction

The process of converting raw instrumental output into physical measurements

Data Analysis Systems

- IRAF - Image Reduction and Analysis System (NOAO)
- STSDAS - Space Telescope Science Data Analysis System (STScI)
- MIDAS - Munich Interactive Data Analysis System (ESO)
- IDL - Interactive Data Language
- ...Many other systems

Very successful approach
- widespread distribution of these systems
- systems written for one wavelength extended to serve others
- incorporation of independently developed packages

Philosophy of These Systems

- Modular operators which work on standardized types of data files
- Command Language to execute single commands or scripts of commands (in interactive or batch mode)

Advantages:
- Flexibility for the user:
  - Individual commands can be chained (or "pipelined") to construct powerful, customized procedures
- Ease of development:
  - Well-defined methods for adding new modules. Thus many programmers and scientists may independently contribute to the growth of a system.
- Standardization
Disadvantages

- Learning a system isn’t easy
  Commands can be complex with many parameters and even experts don’t know the entire system. Users may have to learn more than one system, especially if they work at different institutions or their work is multi-disciplinary/multi-spectral

- Difficult to capture expert knowledge
  Manuals, on-line help, local gurus have drawbacks

- Data management problem
  A few night’s observations can result in hundreds of data files which must each pass through many reduction steps

Useful Goals - But can it be done?

Yes:

- Expert systems/artificial intelligence technology in routine use at the STScI to support operations

- Prototype data analysis assistant developed by one of us in 1987

- Doesn’t require specialized hardware - the same workstation which runs IRAF (e.g. a Sun 4) can run expert system software

Expert Assistant

An alternative approach which builds on the foundation of these systems

- Gather information about the available data (typically from header information in the data files).
- Develop a plan for data reduction based on the user’s goals, actual properties of the data and on limitations of available resources (e.g. disk space).
- Translate the plan into explicit reduction commands for a specific data analysis system.
- Monitor the plan and its execution for problems (e.g. missing calibration files) and alert the user.
- Be extensible to incorporate new types of data reduction, new analysis modules and new data analysis systems. The Expert Assistant will provide users with tools for this purpose.
- Present powerful and effective user interface including mouse-and-menu graphics (which is also found in non-expert systems) and natural language interface.
Implementation Considerations

- Choose language suited to symbolic processing, expert systems, and other artificial intelligence paradigms
- Ability to construct powerful user interface
- Provide flexibility for porting to other workstations
- Low cost for our users (existing data analysis workstation, plus minimal if any software licenses)

Choices:
- Common Lisp
- Well-tested Lisp utility library at SIsc
- Object Oriented (Common Lisp Object System)
- X-based window system
- Mole? CLIM? Gnome?

Summary

Expert Assistant will significantly enhance research by removing much of the burden of routine data reduction from scientists and freeing them to focus more attention on the physical interpretation of the results. It will also alert the user to problems encountered in the reduction process.

Technically feasible

Innovative in use of expert systems/AI technology but built on foundation of existing data analysis systems

Project oriented towards developing a useful tool that will run on commonly used systems

An explicit design feature of this work is independence of any particular scientific discipline or data analysis system, which allows it to be applied to multiple scientific disciplines.

How to Best Involve the Scientific Community?

Lead Users:

- Involve scientists in use and independent evaluation of expert assistant as soon as possible (in addition to scientific input of PI and Co-PIs)

- We feel that it is important that this tool be used with real data reduction problems as early as possible.

- Even the initial versions of the Expert Assistant will be sufficiently powerful to pay back the Lead Users for their investment of time.
PRINCIPAL INVESTIGATORS PRESENTATIONS

OVERVIEW OF THE SYSTEMS OF EXPERTS FOR INTELLIGENT DATA MANAGEMENT (SEIDAM)

David G. Goodenough/P.I.
Canada Centre for Remote Sensing
Ottawa, Ontario
(613) 952-2760

Ko Fung/Co.I.
Joji Iisaka/Co.I.
OVERVIEW OF THE SYSTEM OF EXPERTS FOR INTELLIGENT DATA MANAGEMENT (SEIDAM)

by

David O. Goodanough, Ko Fung, Jogi Baake,
Maia Robson, Cornelius Ruzhigbo

CANADA CENTRE FOR REMOTE SENSING
1547 Merivale Road, Ottawa, Ontario K1A 0Y7

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Fax: 613-952-0672
E-mail: DG@CCRS.COR

NASA CCRS PFC

WHICH AGENCIES ARE INVOLVED?

- ENERGY, MINES AND RESOURCES CANADA
  - CANADA CENTRE FOR REMOTE SENSING
- FORESTRY CANADA
  - PACIFIC FORESTRY CENTRE
- U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
  - APPLIED INFORMATION SYSTEMS RESEARCH PROGRAM
- INDUSTRY, SCIENCE AND TECHNOLOGY CANADA
  - STRATEGIC TECHNOLOGIES BRANCH

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OUTLINE

- PROPOSAL SELECTED BY NASA IN NOV. 1991 THROUGH COMPETITION FOR THE APPLIED INFORMATION SYSTEMS RESEARCH (AISR) PROGRAM
- INTRODUCTION
- MULTIPLE DATA SOURCES INTEGRATION
- SEIDAM STRUCTURE
- MACHINE LEARNING
- USER INTERFACE
- SPATIAL KNOWLEDGE EXPERT SYSTEM
- DIGITAL TERRAIN MODEL (DTM) AND SEGMENTATION EXPERT SYSTEMS
- SYSTEM VALIDATION
- TASKS AND PLANS

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SEIDAM - OTTAWA TEAM

CCRS
David Goodanough - Principal Investigator
Ko Fung - Co-Investigator
Jogi Baake - Co-Investigator

Michael Robson, Cornelius Ruzhigbo
Alain Menard, Jean-Francois Maunder, Karl Steen

University of Ottawa
Stan Matlin, Dan Charlebois

NASA CCRS PFC
SEIDAM OBJECTIVE

TO CREATE A SYSTEM OF EXPERTS FOR INTELLIGENT DATA MANAGEMENT (SEIDAM) WHICH WILL INTEGRATE REMOTE SENSING DATA FROM SATELLITES AND AIRCRAFT WITH GEOGRAPHIC INFORMATION SYSTEMS AND MANAGE LARGE ARCHIVES OF REMOTELY SENSED DATA FOR DYNAMIC SELECTION OF DATA SOURCES AND SENSOR CHARACTERISTICS FOR RECOGNITION OF FOREST OBJECTS APPROPRIATE FOR ENVIRONMENTAL FOREST MONITORING.

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SEIDAM

WHY USE MULTIPLE DATA SOURCES?

- A SINGLE DATA SOURCE MAY NOT BE ABLE TO CAPTURE ALL THE SIGNIFICANT CHARACTERISTICS NEEDED TO IDENTIFY AN OBJECT.
- A SINGLE DATA SOURCE MAY BE SUBJECTED TO SYSTEMATIC ERRORS AND NOISE.
- MULTIPLE DATA SOURCES MAY PROVIDE COMPLEMENTARY INFORMATION.
- REDUNDANT INFORMATION FROM MORE THAN ONE DATA SOURCE INCREASES THE ACCURACY AND CERTAINTY OF OBJECT IDENTIFICATION.
- ONE IS MORE LIKELY TO HAVE DATA AVAILABLE AT THE DESIRED TIME.
- HISTORICAL GIS INFORMATION CAN GUIDE RECOGNITION PROCESS.

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INTEGRATION OF INFORMATION

Levels of data fusion

<table>
<thead>
<tr>
<th>recognized object</th>
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<tbody>
<tr>
<td>derived components</td>
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<tr>
<td>derived attributes</td>
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<tr>
<td>sensor measurements</td>
</tr>
</tbody>
</table>

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PROBLEMS WITH MULTIPLE DATA SOURCES

- COSTS OF ACQUISITION
- COMPLEXITIES OF HANDLING MULTIPLE SENSORS:
  - VARIABLE SPECTRAL CHARACTERISTICS OF SENSORS.
  - VARIABLE SPATIAL RESOLUTIONS OF SENSORS.
- HIGH RESOLUTION SENSOR MAY RESOLVE CLOSELY SPACED OBJECTS, TRUE BUT GIVING TOO MUCH DETAIL.
- LOW RESOLUTION SENSOR MAY NOT RESOLVE OBJECTS OF INTEREST.
- OBJECTS WILL VARY IN SHAPE AND TEXTURE FROM SENSOR TO SENSOR.
- DIFFERENT SENSORS MAY HAVE DIFFERING VIEWING GEOMETRIES, MAKING MATCHING AND REGISTRATION OF SPATIAL OBJECTS DIFFICULT.
- VARIABILITIES DUE TO DIFFERENT RESPONSES TO THE ATMOSPHERE.
- VARIATIONS DUE TO DIFFERING RECORDING CRITERIA, FORMATS AND STANDARDS.

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MISMATCHES BETWEEN GIS DATA AND REMOTE SENSING DATA

- Sensor resolution may not be sufficient to record spatial features used for polygon delineation.
- GIS features may not be visible in images due to non-stationarity of objects (e.g., crops, water boundaries, burns, etc.).
- Generalizations used for base map may create spatial displacements with respect to image data.
- Different GIS sources may have spatial errors between their respective base maps.
- Image objects reflect seasonal variations.

Object Recognition Approach

1. CONVENTIONAL STACK APPROACH
   - 1.1 maximum likelihood with or without prior probabilities.
   - OR 1.2 logistic classifier.
   - OR 1.3 feature selection followed by classification.

2. SYMBOLIC APPROACH
   - 2.1 derive attributes from the minimum number of data sources.
   - AND 2.2 object identification based on the attributes.
   - OR 2.3 dynamically select new data source if partially successful in object identification.

Symbolic Integration Approach

- Knowledge-Based Methodology
- Object-Oriented approach
- Objects are grouped into an hierarchy according to the ease of recognition from imagery
- Available data sources are ranked and selected automatically to derive attributes required for object recognition
- Attributes are derived from the optimum data sources on an as-needed basis
- Object instances are distinguished by the use of derived attributes from selected data sources
- The search space is limited by pruning unlikely instances
DATA SOURCE SELECTION

- Select data source with best coverage of the ground area.
- Select data source with lowest inherent errors such as geometric and sensor errors.
- Select data source with optimum spatial resolution. We don't want too coarse a resolution so that desired objects can not be identified. Also, we don't want too fine a spatial resolution so that desired objects become too complex in the image.
- Select best wavelength intervals of the sensor measurements for the desired objects.
- Select data sources for which there exist implemented algorithms to derive the required attributes.
- Select data source with lowest cost pre-processing required.
- Select data source with the least computational cost of the analytic algorithms.

COMBINATION OF ATTRIBUTES FOR OBJECT RECOGNITION

- Combination through weights on the attributes
- Neural Net Methods (e.g. majority voting)
- Bayesian Approach
- Dempster-Shafer rules of combination
- Fuzzy Logic
- Endorsement Methods

CONFLICT RESOLUTION FOR THE ENDORSEMENT METHOD

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<td>Inconsistent</td>
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</table>
Objectives of work on applying learning and planning in SEIDAM:

- to facilitate the development of new experts
- to re-use previous designs, particularly in the areas requiring specialized AI-related expertise
- to evaluate usefulness of Machine Learning technology in deployment of Expert Systems, with a Remote Sensing focus

Programming-by-example helps build interfaces

LEAR: LEarning Advisor Rules

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Human-Computer Interface (HCI) Considerations

**Purpose of the HCI**
- System prompts users to take action
-Generates level of knowledge
-Organizes the information on the screen
-Improves flexibility of the user

**Benefits of the HCI**
-Complex set of tasks become less intimidating by relating tasks to the goal and to other tasks
-Communicate at the level of the user
-Adapt to the level of the user
-Event-driven dialogue rather than predictable

**Development Considerations**
-Communication strategy
  -Level of abstraction (target user)
  -Consistent presentation rules and terminology
  -Consistent presentation
  -Amount of freedom available to the user
  -Informs the user
  -What happens, what is happening
SEIDAM: Implementation of Spatial Knowledge for Operations

SEIDAM

Spatial Knowledge Expert System

Background Demands:
Conventional image analysis for remote sensing:
- Little integration and utilization of spatial knowledge
- Multi-sensor data integration for different resolutions
- Need more intelligent data abstraction

Emerging of supporting technologies:
- Artificial Neural Network Computing
- CCRS' developed method "Pixel Swapping" to treat image spatially and spectrally in a unified way

Experience:
- CCRS' long term experiences with image analysis and expert system development

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Spatial Knowledge: OBJECTIVES

1. Develop spatial knowledge acquisition methods and system:
   - Investigation of Neural Networks capability:
     Spatial information extraction, multi sensor data fusion
     Data abstraction methods for high resolution spectral data
     Image indexing methods
     Integration of Pixel swapping functions to image computing system
   - Develop an expert system for spatial information analysis system
     Embedding or linked with neural networks and pixel swapping functions
   - Collect spatial knowledge observed in remote sensing data and crea
     pilot knowledge bases
   - Validate spatial knowledge acquired for remote sensing

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Spatial measurements knowledge

Geometrical measurement:
- Classical geometrical measurement:
  - Area, class, moment, direction and ellipticity length, direction
  - Additional geometrical measures:
     Fractal Dimension
     Statistical and Structural Texture measures

Geometrical shape characterization:
- Point like, line like, region like

Spatial structure:
- Tree-like, network like, spatially clustered

Association:
- Hit, Overlapped, Included
  - Positively associated, negatively associated or randomly associated

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CONCLUSIONS FOR DTM SYSTEM

1. Elevation, slope and aspect from DTM improve significantly object recognition accuracies.
2. Expert system improves uses of DTM.
3. Expert systems offer the possibility of distributed, national access to DTMs from provincial and federal sources.
4. DTMs are essential for multisource integration.
5. Expert prototype successfully tested with image and DEM of mountainous terrain in B.C.
6. In the future, generate revised accuracy estimates for each point in the DTM.

Adaptive grid size with DEM for slope & Aspect generation.
SEGMENTATION Introduction

- SEGMENTATION is a complex process with knowledge distributed over several levels of the recognition procedure.
- Users are unfamiliar with the many issues to be considered in choosing the best edge operator, the best segmentation method, sensor characteristics, and the most appropriate spatial and spectral features.

Expert Systems can simplify access to this powerful but complex process!

Prototype Flow Chart

GIS polygons updates:
- Use labelled segments to update GIS polygons:
  - leave polygons that match segments
  - split polygons covering multiple segments classes
  - redraw polygon limits to match segments classes
  - update GIS database with new polygon attributes
- Difficult cases can be submitted to forest inventory experts and/or local foresters for human labeling.
SEGMENTATION CONCLUSIONS

• The expert system supplies and speeds up the segmentation process
• Great advantage over standard programming techniques:
  - our prototypes being incorporated into an operational system for segmentation.
  - 'Intelligence' of our expert is easily improved with new knowledge as soon as it becomes available

CONCLUSIONS #2

• We still need to work on GIS updating process from segments of remotely sensed images:
  - Segmentation parameters?
  - Improve segment classification
  - Establish RULES for labelling segment classes from GIS
  - Rules to modify GIS polygons from classified image segments?
  - Expert to be tested on several forest inventory maps

WHAT RESEARCH WILL BE DONE?

WHAT METHODS SHOULD BE SELECTED TO ANALYZE REMOTE SENSING AND GIS DATA IN ORDER TO MONITOR A FOREST?

1) AUTOMATED METHOD:

• SELECTION OF HISTORICAL GIS DATA AND ATTRIBUTES
• ESTIMATION OF GIS LABEL AND BOUNDARY ACCURACIES
• SELECTION OF THE REMOTE SENSING DATA
• ENDORSEMENT METHOD LABELLING OF SEGMENTS TO CREATE NEW FOREST POLYGONS WITH IMPROVED ACCURACIES, MORE CONSISTENT LABELS, AND CHANGED AREAS IDENTIFIED

2) IMPROVE EXISTING METHODS FOR FOREST INVENTORY:

• TOPOGRAPHIC CORRECTION OF SATELLITE DATA
• POINT TO AREAS OF CHANGE
• AUTOMATICALLY SEGMENT AREAS OF CHANGE
• ESTIMATION OF GIS LABEL AND BOUNDARY ACCURACIES
• INTERACTIVE CREATION OF NEW ROADS
• UPDATE GIS
WHAT RESEARCH WILL BE DONE? #3

HOW DO THESE RESULTS GET COMBINED WITH FOREST CANOPY MODELS TO MAKE IMPROVED ESTIMATES OF FOREST STAND PRODUCTIVITY?

- CHARACTERIZATION OF LAND SURFACE FROM DTM AND ESTIMATION OF SITE QUALITY FROM SOILS, GEOLOGY, HYDROLOGY, AND DTM ANALYSIS
- INTEGRATION OF GIS & RS RESULTS WITH FOREST CANOPY MODELS FOR SHORT AND LONG-TERM PRODUCTIVITY ESTIMATION ON A POLYGON BASIS
- EXPERIMENTATION WITH AIRBORNE IMAGING SPECTRUMETER DATA FOR CHEMICAL INPUTS INTO MODELS

WHAT RESEARCH WILL BE DONE? #4

- WHAT COMPUTING SCIENCE AND ENGINEERING RESEARCH WILL BE DONE?
  - CREATION OF EXPERT SYSTEM SHELL IN OMNITUS PROLOG WITH CGL (GRAPHICAL USER INTERFACE) FOR UNIX AND VMS
  - RETAIN EXISTING SOFTWARE INVESTMENT
  - DISTRIBUTED PROCESSING WITH INTELLIGENT AGENTS
  - OBJECT-ORIENTED (FRAMES)
  - ABILITY TO PAUSE AT USER'S CONVENIENCE
  - MACHINE LEARNING FOR CREATION OF EXPERT SYSTEMS TO CONTROL TASKS AND FOR LEARNING FROM EXPERIMENTS
  - 150 EXPERT SYSTEMS WILL BE CREATED WITH WINDOW INTERFACE
  - DISTRIBUTED GIS AND RELATIONAL DATA BASE ACCESS

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### HOW WILL SEIDAM BE TESTED?

The Pacific Forestry Centre and CCRS are selecting three test sites, three near Invermere, British Columbia, and one on the west coast. Data collection from aircraft and satellites is being planned for the summer of 1992.

CCRS has previously collected data over the Invermere sites. These data have included several years of TM, HRV, MOD-1, and NOAA AVHRR aircraft data previously collected include CCRS SAR, AVHRR, AIRS, and AMSR. More than 150 forest inventory GIS files have been acquired, data corresponding to the test sites have been obtained from federal and provincial sources.

**SEIDAM will be tested at CCRS, PFC, and possibly NASA-ARC for these sites and for other remote sensing data. Some industrial contractors may also choose to evaluate the SEIDAM methodology.**

### HOW WILL SEIDAM BE TESTED? #2

CCRS has conducted field work in the rocky mountain trench previously.

For aircraft calibration, optical measurements of lakes and homogeneous targets are made and bar corner reflectors and active radar calibrators are deployed.

A grid of markers is laid out for multi-sensor registration.

Ecological samples will be taken with their locations defined by GPS ground equipment. Measurements will be made of chlorophyll, nitrogen, lignin, and other chemicals.

The west coast site has an extensive history of ecological monitoring.

Where possible, GPS positioning will be used to define aircraft location.

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### Artificial Intelligence Research Projects

<table>
<thead>
<tr>
<th>SEIDAM</th>
<th>SHERI</th>
<th>PIKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(System of Experts for Intelligent Data Management)</td>
<td>(January 1991 - January 1995)</td>
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</tbody>
</table>

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### SEIDAM Software Status

- More than 45 expert systems created; implementing Motif interface for user interface
- Posted Shell and Expert Systems to Unix
- Posted Shell and Expert Systems to other platforms (Sun, Macintosh...)
- Research, develop and integrate new Expert Systems
  - Segmentation, digital terrain model, textures, spatial knowledge, endowment labeling with fuzzy methods, GIS input/output, intelligent land information system, forest productivity and monitoring, etc.
- Interface Expert System and RDBMS (through INGRES, O, Polygon and SQL)
- Plan knowledge acquisition experiments for SEIDAM validation
- Integrate Object Oriented Database
- Use Machine Learning to accelerate the development of new experts
**SEIDAM**

**TASKS AND MILESTONES**

- Project Approval by NASA: Nov. 1, 1990
- Submit Final Proposal to ISTC: June 26, 1991
- SEIDAM Overall System Design: Sept. 20, 1991
- Remote Sensing data ES: Apr. 30, 1992
- GIS ES: May 30, 1992
- Field Data ES: June 30, 1992
- airborne data acquisition: July, 1992
- Data Fusion ES: Nov. 30, 1992
- Data Source Selection ES: Feb. 1, 1993
- Initial Network development for data fusion: Mar. 31, 1993
- Method Selection ES: May 30, 1993
- Data Interpretation Model ES: July 15, 1993
- Solution Planning ES: Sept. 30, 1993
- Final SEIDAM Validation: Nov. 1, 1993
- Final Report to NASA/CCRS: Dec. 30, 1993
- Project Completion for NASA portion: Mar. 31, 1994

**SEIDAM**

**FINAL REMARKS**

We are delighted to have the opportunity to join our colleagues in the applied information systems research program. Please feel free to contact us at the numbers given on the first viewgraph. If you are interested in interacting with the SEIDAM project, please contact Dr. David Goodenough.

We thank the National Aeronautics and Space Administration for supporting this project.

We also thank the Canada Centre for Remote Sensing, of Energy, Mines and Resources Canada, and the Pacific Forestry Centre of Forestry Canada.
PRINCIPAL INVESTIGATORS PRESENTATIONS

THE SCIENTIFIC MODELING ASSISTANT:
AN ADVANCED SOFTWARE TOOL
FOR SCIENTIFIC MODEL BUILDING

Richard M. Keller/P.I.
Michael H. Sims/P.I.
NASA Ames Research Center
Moffett Field, CA
(415) 604-3388
The Scientific Modeling Assistant:
An advanced software tool for scientific model-building

Richard M. Keller
Michael H. Sims
Principal Investigators

David Thompson
Michal Rimon
Project Staff

Christopher McKay
Jennifer Dungan
Science Collaborators

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Artificial Intelligence Research Branch
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Funded by the Applied Information Systems Research Program
Supported by the Information Systems Division
of NASA's Office of Space Science and Applications

Project Goal: Build a specialized software tool to assist in Scientific Model-building

Analysis & visualization facilities
Interactive graphical interface

FEATURES
Intelligent assistance
High-level modeling language
Libraries of data sets, equations, subroutines, physical quantities

TECHNIQUES
Object-oriented programming
Artificial intelligence
Symbolic manipulation

Methodology
- Study existing scientific modeling software
- Design tool to meet scientists' needs
- Relimplement models with our new modeling tool

Initial Focus Areas
- Planetary Atmospheric Modeling:
  "Titan Greenhouse Model" (C.P. McKay, NASA Ames)
- Earth Ecosystem Modeling:
  "Forest BGC" (S.W. Running, U. of Montana)

Overview of the Scientific Modeling Process

1. Conceptualization
2. Model-building
3. Experimentation
4. Analysis & Interpretation
Outline

1. Project Introduction
2. Problem & Approach
3. Case Study:
   Modeling planetary atmospheres
4. Summary

Problems and Opportunities

Problems:
- Labor intensive
- Difficult to understand, share, and modify

Root causes:
- Scientist - programmer gap
- Wrong level of abstraction
- Implicit knowledge buried

Potential payoffs:
- Improve scientific productivity
- Foster scientific communication
- Disseminate modeler's expertise

Manual Approach to Model-building

The scientists' plea: "Spare me the programming details!"

- Variable declarations, storage allocation
- Scientific units bookkeeping & conversion
- Data structure manipulation & management
- Documentation
- Symbolic manipulation
- Interfacing with scientific datasets
- Numerical programming:
  - ODEs, integration, interpolation, convergence
1. Project Introduction
2. Problem & Approach
3. Case Study:
   - Modeling planetary atmospheres
4. Summary
Prototype Modeling Tool Provides:

- Library of relevant:
  - data sets
  - physical variables
  - equations
- Mechanisms allowing user to select and apply equations to data and compute new physical variables
- Model/data display features:
  - data dependency network
  - plotting/graphing facility
  - tabular display
- Model management environment:
  multiple models and multiple scientists

Outline

1. Project Introduction
2. Problem & Approach
3. Case Study:
   Modeling planetary atmospheres
4. Summary
Status

- Completing development and evaluation of first prototype
- Redesigning system Interface and Internals
- Adding additional domain knowledge
- Moving toward more portable system
- Investigating other domains: Ecosystem modeling

Major Milestones

- FY 1991: Completion and evaluation of Initial "alpha" prototype
- FY 1992: Design and implementation of a "beta" version prototype that will be used by a small group of atmospheric scientist-users
  Begin development of ecosystem model
- FY 1993: Enhance system and make available to a group of Cassini Mission scientists who are involved in instrument design
  Make system available to ecosystem scientists
PRINCIPAL INVESTIGATORS PRESENTATIONS

DATAHUB
KNOWLEDGE BASED ASSISTANCE FOR
SCIENCE VISUALIZATION AND ANALYSIS
USING LARGE DISTRIBUTED DATABASES

Thomas H. Handley Jr./P.I.
Jet Propulsion Laboratory
Pasadena, CA
(818) 354-7009

Donald J. Collins/Co. I.
Richard J. Doyle/Co.I.
Allan S. Jacobson/Co.I.
DataHub

Knowledge-based Assistance for Science Visualization and Analysis Using Large Distributed Databases

Team
Data Management: T. Handley (P), P. Li
Science: D. Collins (CO-I)
Visualization: M. Wade
Research: T. Maddox (Summer Faculty)

Applicable Technologies

- Knowledge Representation
- Data Discovery and Management
- Inheritance and Reasoning Assistance
- Management and Analysis of Complex Information
- Man-machine Interface
- Exploratory Data Analysis

Objectives

- Scientific Data Models
  - Data-driven analysis
  - Data transformations
  - Data semantics
  - Analytical-related knowledge about data
  - Data discovery, ingestion, extraction...
- Self-describing data structures
- Intelligent assistant system(s) with some knowledge of data management and analysis built-in.
- Use of mature expert system technology to aid exploratory data analysis, i.e., expert systems, neural nets, classification systems.
- Capture and encode knowledge about the data and their associated processes. Encode scientific knowledge into the routines, processes and procedures.
- Provide data management services to exploratory data analysis application(s) i.e., LINKWINDS.
Logical Access Methods
Transformation Operators

- Data format conversion operator
  - MCSST DSP → MCSST HDF SDS
- Raster conversion operator
  - MCSST HDF → MCSST HDF Raster 8-bit
- Resampling operator
  - MCSST HDF Raster 8-bit Global → MCSST HDF 360x180
- Mapping between collected data and known facts
  - Ocean data versus LandMask
- Filling in missing data
  - Use local data to fill
  - Use data selected from other time frame
  - Use data selected from other correlated dataset
- Dataset registration
  - Warping
  - regridding
  - Registration
- Other map projections

Logical Access Methods
Update Operators

- Transaction
  - Atomic action
  - Traceable unit
  - Recoverable Unit
  - Result datasets stored in user area
- Example

```
Begin-Xin
DSP → HDF SDS
HDF SDS → HDF Raster 8-bit
HDF 8-bit → HDF 360x180
End-Xin
```
An Intriguing Solution
(Summer Research Fellow)

- The development of intelligent assistant systems with some knowledge of data management and analysis built-in.
- LinkWinds: allowing users to select data sources and link them with various transformation procedures that analyze and display data.
- Graphical Representation of Knowledge (GROK): nodes and links (graphs) are a useful visualization of the grouping and ordering of general knowledge.
- Science Analysis Assistant (SAA): an embedded formalism for advising scientists about the salience of data.
- The goal is to reduce the difficulty of managing or exploring complex or large datasets or knowledge bases.
Our Hypothesis
(Summer Research Fellow)

- A high level of satisfaction with LinkWinds: maybe because it is a comfortable reflection of the data analysis skills and processes of its development team.
- The combination of procedures linked by the user can lead to the identification of interesting features of the original dataset and the possible discovery of new knowledge.
- Emergent behavior seems to be a result of the linking process which is driven by the user’s domain specific and general knowledge and experience.
- The process of data analysis is well-represented by a graph of connected data, analysis and display procedures.

Possible Outcomes
(Summer Research Fellow)

- Salience measures which are locally interesting (from data perspective) and globally interesting (from the domain specialist’s perspective).
- Concurrent data exploration paths.
- Experimental trials to determine if algorithms faithfully represent user preferences and goals.
- Machine learning techniques used to generalize data analysis algorithms.

Research Objectives
(Summer Research Fellow)

- Investigate how information (from 1) the original data, 2) analysis and display procedures and 3) the user may be combined to facilitate knowledge discovery in a dataset.
- Explore the development of algorithms which represent how information regarding analysis goals and hypotheses, transformation procedures, and metadata may be combined to facilitate the discovery of knowledge.
- Seek to develop dataflow representations of the information between these sources.
- Characterize interaction dynamics of information top-down in a goal-driven manner from the user towards the data and the analysis and display procedures and bottom-up in an event-driven manner.
- Use resulting metadata to characterize and classify the analysis and display procedures.
- Classify the cooperative or competitive information flow dynamics.
Science

The primary productivity of phytoplankton in the ocean is largely responsible for the assimilation of carbon into the oceanic environment and thus in part the removal of carbon from the atmosphere. Because the ocean is thought to be a primary sink for atmospheric carbon, the basin-wide and global distribution of ocean primary productivity is of central importance in the global budget of carbon. To understand the global productivity of the oceans, the interplay between the physical and biological structures must be known. The biological population of the ocean is highly variable both spatially and temporally at all time and space scales. The global nature of this problem then requires the use of satellite imagery as the only remote technique of providing coverage on temporal and spatial scales that are appropriate to the assessment of carbon flux into the ocean.

The goal of this research is to increase our understanding of the sources of variability in the sea and the primary productivity of that community. To achieve these objectives, remotely sensed data of the spatial and temporal distributions of pigment concentration, temperature and incident irradiance at the surface are used to provide a description of the seasonal variability of the water column primary productivity in the north Pacific Ocean and to explore the spatial and temporal distributions of phytoplankton biomass and primary productivity in the equatorial Pacific Ocean upwelling area and in the oligotrophic central Pacific gyre.

To provide an understanding of the global flux of carbon through the upper ocean into the ocean basin-wide, the JGOFS Steering Committee has identified the need for both time-series and process-oriented regional studies to examine the spatial and temporal distribution of physical and biological parameters with determination that live and have initiated regional studies in these processes. A regional study has been defined to describe the role of the north Pacific Ocean in the global flux of carbon. The equatorial Pacific has been selected for the intensive process-oriented study upwelling processes in this region, and a time-series study of the oligotrophic central Pacific gyre has been initiated with the Hawaii Ocean Time-Serie study at the ALOHA site.

Science (cont'd)

This task will address the issue of the assessment of pigment concentration, and of the radiance leaving the sea surface, as mediated by pigment concentration, for the determination of the fundamental physical and biological description of the data fields have been insufficient in the past to describe the development of these fields in space and time. The statistical description provided by the use of AI technology will provide the technical ability to predict the development of these fields through the use of these techniques to assess the impact of each of the parameters in the development of the pigment fields in space and time.

With the development of properly interpreted and extrapolated fields, estimates of the net and total primary productivity will permit an assessment of the carbon flux in the equatorial Pacific Ocean. These concepts will be extended to provide an assessment of the net flux of carbon from the atmosphere into the ocean on an annual basis. Our preliminary estimates of this quantity are 3.2 Gt CO₂ per year based on estimates of the water leaving radiance and a representation of water leaving radiances and carbon flux based on work by Mitchell, et al., 1991. These estimates will be refined through a better estimate of the pigment concentration and thus of the water leaving radiance.
LinkWinds

The near-term objective is to ingest, at will, a large number of datasets related to two disciplines. These are the Multi-Channel Sea Surface Temperature (MCST) data which are global ocean temperature measurements, and the coastal zone color scanner (CICSS) data which measure ocean biomass. Once these data are ingested into LinkWinds, its tools can be used to study the correlations between ocean temperature and biomass.

The oceanographic datasets which are the subject of our near-term studies are larger than datasets previously used in LinkWinds. The MCST data is composed of one image measuring 365x1024 pixels, with 16 data elements per pixel. These data exist on a weekly basis. The CICSS data is composed of images in three sizes, each of 8-bit data. These images also measure 365x1024 and exist on a weekly basis, as well as a monthly composite form.

For ingestion, all data has been transformed to the Hierarchical Data Format (HDF) developed at the National Center for Supercomputing Applications (NCSA) at the University of Illinois. LinkWinds will be modified to read this standard data format.

Because of the large size of these datasets, the ingestion process is taking place in two stages. For stage one, the data are being submitted into 365x1024 pixel images and put into HDF format. Preliminary design and coding to store this data into the LinkWinds environment is underway now by Phillip Li, and is estimated to be done in about two weeks. Once this is accomplished, the tools and controls of LinkWinds can be immediately applied to the study of the data. In preparation for stage two, all tests and controls of LinkWinds are being redesigned and modified to accommodate arbitrary large image sizes. The coding for these modifications is being done now by Mitta. Concurrently, we are making modifications to allow the user to read arbitrary HDF files which will be developed in a collaboration with Phillip Li, Mitta, and Martin Orton. Once these tools are completed, and the data in its fullest form can be read and studied, then we will concentrate upon modifying existing correlational tools, and developing new ones to extend the analysis of these data.

July 25-31 1985

Summer Faculty Research - Data Knowledge Issues

One result of an exponential increase in volume of data and a reduction of domain specific analysis expertise is a loss or delay in the discovery of knowledge. Such delays or losses could mean performance degradation or critical system failure, which could be very costly or may be prohibitive to some existence in various data management and analysis tasks. The development of such intelligent assistant systems will require that some knowledge of data management and analysis be made available to it. How should this knowledge be represented in a form that may be used by a machine?

An exploratory data analysis system, LinkWinds, has been developed at the Jet Propulsion Laboratory (JPL) at the California Institute of Technology to help scientists from various disciplines discover new knowledge from data. LinkWinds allows its user to select data sources and link them with various transformation procedures that analyze or display data. LinkWinds is one of at least two other efforts at JPL (Graphical Representation of Knowledge (GROK) and the Science Analysis Assistant (SAA) whose objectives are to reduce the difficulty of managing or exploring large databases.

Scientists who have used LinkWinds are very satisfied with its facility. They can manipulate color maps and combine, or link, other features such as "slices", crosshatch, and graphs in support interactive manipulation of data for visualization, that easily changing the topology of data. But there is a need for high-level satisfaction with LinkWinds may be because it is a comfortable reflection of the data analysis skills or processes of its experienced development team. LinkWinds supports the iterated transformation of data through a search process where the results of each iteration are interpreted and the search steps or process is redirected when some sufficient level is reached.

July 25-31 1985

Summer Faculty Research - Data Knowledge Issues (cont'd)

abstraction information needed to reconfigure the original dataset. Combinations of these procedures can be most useful when they are domain- and application-specific. This work is built on the base of spatial, temporal, or other physical or logically relevant grouping and ordering features to be essential. The analysis and display procedures embody a priority transformation, reduction, and reconstruction.

Integration information needed to reconfigure the original dataset. Combinations of these procedures can be most useful when they are domain- and application-specific. This work is built on the base of spatial, temporal, or other physical or logically relevant grouping and ordering features to be essential. The analysis and display procedures embody a priority transformation, reduction, and reconstruction.

July 25-31 1985
Summer Faculty Research - Data Knowledge Issues (cont'd)

Hopefully, the results of our work will be a Science Analyst Assistant within LinkWin or GROK that may be capable of advising a scientist on ways to subset the large datasets on the basis of salience measures which are locally interesting (from a data perspective) and globally interesting (from the domain specialist's perspective). Future research issues include 1) the possibility of suggesting physically or logically coherent data exploration paths of interest to the user, 2) experimental trials to determine if our algorithms faithfully represent user preferences and goals, and 3) the application of machine learning techniques to an attempt to generate our data analysis algorithms.

July 30 1991

JPL

Expert Systems (cont'd)

Interpretation problems present challenges across scientific disciplines. The oceanographic domain presents a rich set of data parameters that must be clustered and combined to build an interpretable model. The time required to construct the interpretation is inhibited by the computational resources needed to find a comprehensive correlation over the entire set. Artificial Intelligence will support this effort by combining the data sets using state-of-the-art machine learning techniques. Leverage of this effort is provided by the Scientific Analysis Assistant 2.4.4 funded under Code RC. Together these projects are investigating how machine learning techniques can assist scientists with sufficient data ingestion.

Proof of Concept Near Term Goals
- Evaluate and Compare Machine Learning Techniques
  - GROK
  - Parallel Distributed Processing PDP Networks
  - AutoClass
- Apply Selected Technique and Test Performance
  - Apply the selected machine learning algorithm to two thirds of the data set and test the algorithm performance on the remaining one third of data.

Solution Long Term Goals
- Apply Proven Technique
- Produce the interpretable model using selected data parameters.
- Compare Performance
  - Measure the performance of machine learning algorithm application to conventional techniques.

July 30 1991

JPL

Data Management

Currently available database technology is largely designed for business data processing applications, and seems inadequate for scientific applications. This R&D is addressing the following issues in scientific data management:

I. Scientific Database Models
1. Data format (usage of best-data embedded in dataset headers, data conversion that preserves data validity, data formats for different analysis methods, ...)
2. Data semantics (meaning of data values, relationship between datasets, discipline-dependent data access/query methods, ...)
3. Analyze-related knowledge about data
4. Data quality assessment (identifying and treating missing data, i.e., NULL value representation, validation, data validity after data interpretation, data transformation, etc., ...)

II. Resource Sharing Environmen for Science Databases
1. Data exchange protocols to facilitate data ingestion and data visualization
2. Data extraction and storage of extracted data
3. Tracking, logging, and synchronization of data access activities

Figure 1 depicts today's world of science data management. There are many data formats from the data sources in different science communities. There are many data conversion lossy, some to convert from the suppliers' formats to the data formats desired by the data consumers. One of the objectives of the ongoing project is to build a resource sharing environment depicted in Figure 2. A system, named Darp, will be a server between the data suppliers and the data consumer to facilitate data exchanges, to assist science data analysis, and to provide a systematic approach for science data management.

July 26 1991

JPL
PRINCIPAL INVESTIGATORS PRESENTATIONS

MULTI-CHANNEL HOLOGRAPHIC BIRFURCATIVE NEURAL NETWORK SYSTEM
FOR REAL-TIME ADAPTIVE EOS DATA ANALYSIS

Hua-Kuang Liu/P.I.
Jet Propulsion Laboratory
Pasadena, CA
(818) 354-8935

J. Diep/Co.I.
K. Huang/Co.I.
NOTES:

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MULTI-CHANNEL HOLOGRAPHIC BIFURCATIVE NEURAL NETWORK SYSTEM FOR REAL-TIME ADAPTIVE EOS DATA ANALYSIS

Hua-Kuang Liu
Jet Propulsion Laboratory
Pasadena, Ca. 91109

OBJECTIVE

To research and develop a novel optical bifurcating neuromorphic pattern recognition system for making optical data array comparisons and to evaluate the use of the system for EOS data classification, reduction, analysis and other applications.

IMPORTANT OF THE WORK

The bifurcating optical data and pattern recognition and classification system is based on the theory of the nonlinear wave scattering and interaction in photoreactive crystals and nonlinear neuromorphic interconnection and activation. Theoretical understanding of the system is important to nonlinear science and technology.

The system combines advanced spatial light modulator technology with holographic and photoreactive material and devices. These elements function together to allow massively parallel processing at the speed of light. Experimental results of the system can lead to inventions important for technology breakthrough.

The multi-channel version of the system allows the input of data simultaneously from many different sensor sources and thus offers sensor analysis and fusion capability with high capacity and throughput. The system has important potential applications include parallel database search, image and signal understanding and analysis, natural language processing, in addition to real-time multi-channel adaptive EOS data analysis.
TECHNICAL APPROACH

- The face-space holographic interconnection and optical parallel processing
capabilities with multi-channel input capacity.
- The multi-channel input is realizable by holographic optical elements (HOE) and
high-speed addressable SLM's.
- Photorefractive crystals will be used for the formation of the bifurcating decision
making process.
- Input data are applied via optical spatial light modulators into the optical system.
- Output are naturally classified into multiple channels of pairs of branches.
- Separately controlled or integrated and organized decisions of the out information
can be made based on the output.

PROGRESS SUMMARY (FY91 Accomplishments)

1. Completed a simplified model for the dynamic beam fanning phenomenon via
inhomogeneous scattering centers in photorefractive crystals.

2. Developed collaborative analysis activities with JPL colleagues including J. Gilmore, W. Tal,
W. Fang, and Prof. K. Hwang of USC.

3. Found interrelationship and areas of potential applications of the system in data format
standardization program of NASA.

4. Investigated basic neuromorphic associative retrieval processing that include the terminal
attractor based Hopfield model in the aspects of the data format and optical implementation
challenges.

PROGRESS SUMMARY (FY91 Accomplishments)

(Continued)

5. Investigated hardware issues including key holographic optical elements and new
electronically addressable spatial light modulators.

6. Recent theoretical and experimental results on the spatial and spectral effects on noise
fanning for photorefractive bifurcating process was submitted for publication at the OSA
annual meeting in Nov. 1991.

J. K. Lin
(7) Presented an invited talk on nonlinear photorefractive optical processing at the Electrical
Engineering Department of the City College of New York on June 24, 1991. He also
discussed the projects on the new wavelet theory and its optical implementations with the
researchers led by Prof. Y. Li at CCNY. They explored the wavelet RADAR signal
processing. The technique may be important to NASA's SETI program.

PROGRESS SUMMARY (FY91 Accomplishments)

(Continued)

8. A U.S. patent No. 5,005,954 entitled "Method and Apparatus for Second-Stage Forward
Generation" was received. This invention is useful for the generation of mixed net
interconnection matrices in real time and is important for future optical computer networking
applications. The photorefractive crystal used in the patent was the same as the one used in
the current NASA RTOP work. The invention is useful to the current project.

J. K. Lin
(9) Attended the Gordon Research Conference in the week of June 16, 1991 at the Plymouth
College, Plymouth, NH. He presented a talk on the topic of self-amplification in optical
pattern recognition. The talk was well received by about 100 invited experts in the field of
holography and information processing from various countries including Japan, France, Israel,
Canada, German, USSR, China, Sweden, and USA. Many interesting and important
techniques were discussed in a very informal atmosphere.
FUTURE RESEARCH WORK PLAN (FY92 Major Milestones)

(1) Experiment with the photorefractive crystals including BaTiO₃ and KNbO₃ on their capabilities of bidirectional diffraction via the studies of beam polarization, incidence angle of the input beam, crystal orientation, and spatial light modulator characteristics.

(2) Investigate the analogy between the neuromorphic processing and the nonlinear dynamic wave coupling phenomenon in the photorefractive crystals for gaining a deeper understanding of the fundamental building block of the system.

(3) Investigate the data format requirement and the output utilization algorithm of a multichannel system for the preparation of the design of an application-oriented architecture design.
APPLIED INFORMATION SYSTEMS
RESEARCH PROGRAM WORKSHOP

PRINCIPAL INVESTIGATORS PRESENTATIONS
(P. M. SESSION)
PRINCIPAL INVESTIGATORS PRESENTATIONS

NATIONAL CENTER FOR SUPERCOMPUTER APPLICATIONS

Matthew Arrott/P.I.
NCSA
University of Illinois
Urbana, IL
(217) 244-6833
Prototype

*Investigate the issues and mechanics for possible integration of atmospheric data across scales and use of modeling and observational data*

Divide and conquer

*Storm (supported by NCSA and NSF)*
*Regional (supported by NASA)*
*Global*
*Ocean*

Computational Application Model

*Data Generation*
*Observation*
*Modelling*
*Analysis*
*Inspection*

Develop

*Integration of successful prototype efforts into a series of robust applications*
NASA MEETING

NCSA GOAL
NCSA TEAM
PROJECT STRATEGY
COMPUTATIONAL RESEARCH ENVIRONMENT

To develop comprehensive computational research environments through the use of evolving software technology.
Computational Research Environment

Base criteria
Interactive
Visual
Distributed
Extensible
Vendor supported

Silicon Graphics' "Explorer" Software
PRINCIPAL INVESTIGATORS PRESENTATIONS

COLORADO CENTER FOR ASTRODYNAMICS RESEARCH (CCAR)

William Emery, P.I.
Univ. of Colorado
Boulder, CO
(303) 492-8591

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EOSDIS TESTBED: AN AVHRR DATA SYSTEM FOR SNOWPACK AND VEGETATION STUDIES

BILL EMMERY, JEFF DOZIER, AND PAUL ROTAR

OBJECTIVE: TO PROVIDE AN END-TO-END DATA SYSTEM FOR THE COLLECTION, PROCESSING AND ANALYSIS OF AVHRR DATA FOR TWO SPECIFIC DISCIPLINES

1. COLLECT AND PROCESS AVHRR IMAGERY OF THE WESTERN U.S. AT CUCCAR
2. STORE PROCESSED DATA AT NCAR ON MASS STORE
3. MAKE DATA AVAILABLE TO RESEARCH USER COMMUNITY ON OR OFFLINE AS ACQUIRED
4. DEVELOP USER COMMUNITY INTERESTED IN AVHRR APPLICATIONS IN SNOW COVER AND VEGETATION
5. DEVELOP APPLICATIONS SOFTWARE ON MACS AND UNIX FOR THIS USER COMMUNITY; DISTRIBUTE SOFTWARE TO USERS (I.E. IMAGE PROCESSING, IMAGE NAVIGATION, IMAGE CALIBRATION, ETC.)

ORIGINAL PAGE IS OF POOR QUALITY
SATellite DATA PROCESSING SOFTWARE
AT CU/CCAR

IMAGES PROCESSING SOFTWARE
1. SHO: A generic image processing program that runs on SUN workstations under SUNTOOLS/SUNVIEW (also on DEC VT100)
2. DEC-SHO: A version of SHO that runs on DECwindows
3. MOTIFS-HO: A version of SHO that runs on any X11 workstation
4. Image: A similar image processing program that runs on the MACINTOSH-II family of computers

AIRBORNE DATA COLLECTION AND HANDLING
a. Antenna Operation (scheduling, tracking, ingest, archival)
   b. Image Navigation and IR Calibration
   c. TOYS profiles (ITPP or 3)
   d. Applications (skin SST, SST motion, ice edge and concentration, ice motion, vegetation, cloud top temperature, cloud height, 3D perspective, etc.)

OTHER SATellite DATA HANDLING
a. SSM/I (Ice and water vapor), LANDSAT & SPOT (3D mapping), SAR (Ice mapping)

CU/CCAR SATellite DATA ANALYSIS ACTIVITIES
- Snow and water vapor mapping for Arctic regions
- Arctic ice and snow changes
- Remote sensing of wetlands

VARIATION SATELLITE STREAMS:
- CURRENT FROM SEQUENTIAL
- LANDSAT AND MODIS DATA
--artificial ice concentration

SATELLITE DATA CONNECTIONS
- Connection to COLOREADO STATE U (for GOES data)
- Connection to NOAA ORGANIZATION
- Connection to U OF WASHINGTON FOR AVHRR

ORIGINAL PAGE IS OF POOR QUALITY
NCAR Mass Storage Systems (MSS)

105,000 tape cartridges in use
Total data stored 19 TBytes
Over 722,000 files
Average file length 26.3 MB
< two-minute delivery

Mass Storage System Hierarchy

- MSS Controller and Directory
- Disk Farm 120 GBBytes 10 sec access
- STK 4400 ACS 6K cartridges About 1 minute access
- Open Shelves 81K cartridges 2-10 minute access

Y-MP8/64 UNICOS

Remote Access

Front-end Computer
Shavano
Divisional Computers

Blair-Up Access
Including 25,400 Numbers

MASnet
Gateway Computers

NSFNET/Internet
BITNET
NASA SN
NASA SPAN

Wide Area Network Connections at NCAR
As of this date, there are 499 days of data starting on March 3, 1989 – July 18, 1991. The first images consisted only of channels 1 and 2. Now all channels are being archived.

Current Number Of Images
Images on line: 1,200
Size of image: 1 Megabyte
Storage Size: 1.2 Gbytes

Monthly Number Of Images
Images processed per month: 120/mth
Processed Data Size: 120 Megabytes/mth

Daily Number Of Images
Images Processed Per Day: 4/day
Size of image: 1 Megabyte
Storage size: 4 Megabytes/day
Channels 1, 2, 3, 4, 5

Image Projection
Images at End Of Project: 4,200
Image Storage Size: 4.2 Gbytes
PRINCIPAL INVESTIGATORS PRESENTATIONS

GEOGRAPHIC INFORMATION SYSTEM FOR FUSION AND ANALYSIS OF HIGH-RESOLUTION REMOTE SENSING AND GROUND TRUTH DATA

Anthony Freeman/P.I.
Jet Propulsion Laboratory
Pasadena, CA
(818) 354-1887

Pascale Dubois/Co.I.
Franz Leberl/Co.I.
L. Norikane/Co.I.
JoBea Way/Co.I.
SCIENTIFIC OBJECTIVES

Confronted with the potentially massive volumes of data from remote sensing instruments and ground data collection for this site, the applications scientist might ask the following questions:

i) How do I manipulate such a large data set?

ii) How do I assess its information content?

iii) How do I find the optimum combinations of data to study changes in a given biogeophysical parameter?

iv) How do I visualize the results?

v) How do I validate my models relating in-situ measurements to the remotely sensed data?

vi) What scientific generalizations can be made from this study, even though there are only two case studies?

vii) What important issues emerge which would impact EOS DIS and Forest/Forest Resources research with highly multi-dimensional data?

viii) To what extent do the GIS and Image Processing systems, both of which were designed to work with scientific data in raster form, and which are essentially state-of-the-art, show significant weaknesses in handling large volumes of high-resolution data? This is a practical issue of great importance to the remote sensing community.

JPL

SCIENTIFIC OBJECTIVES

GEOGRAPHIC INFORMATION SYSTEM FOR FUSION AND ANALYSIS OF HIGH-RESOLUTION REMOTE SENSING AND GROUND TRUTH DATA

A. Freeman, J. Way and L. Norikane (JPL)

F. Leberl (Vexcel Corp.)

F. Davis and Y. Wang (UCSB)

JPL

SCHEDULE

Task: Completion Date

1. Install VICAR/GRIS on SPARC Workstation (JPL): 9/91

2. Data Preparation:
   - Identify SEASAT, LANDSAT Spot scenes (JPL): 9/91
   - Generate simulated radar data for models (UCSB): 9/91

3. Data Entry into GIS Databases (JPL)
   - SAR data: 9/91
   - Data from other sensors: 9/91
   - Ground Truth Data: 9/91
   - Simulated Radar data: 9/91

4. Integration of GIS and Specialized Image Processing S/W (JPL/VEXCEL)
   - Identify required S/W: 3/91
   - Install on SPARCS: 3/91
   - Set up GIS and Image Processing S/W interface: 3/91

5. Development of New Algorithms (JPL/UCSB)
   - Distance Measures: 5/91
   - Multi-dimensional Classification Algorithms: 7

6. Data analysis for case study (JPL/UCSB)
   - Extract radar parameters from data: 12/91
   - Cross-correlate data sets: 1/92
   - Principal Components analysis: 2/92
   - Produce Classification Maps: 3/92
   - Determine sensitivity of radar parameters: 4/92
   - Validate radar models: 5/92
   - Optimize visualization approach: 6/92
   - Write reports/journal paper on results: 8/92
### SCHEDULE (CONT.)

<table>
<thead>
<tr>
<th>Task</th>
<th>Completion Date</th>
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<tbody>
<tr>
<td>7. Data Preparation for Case Study II</td>
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<tr>
<td>SAR data Geocoding (Vexcel)</td>
<td>07/92</td>
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<tr>
<td>AVHRR data (JPL)</td>
<td>08/92</td>
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<tr>
<td>Ground Truth data formatting (JPL)</td>
<td>09/92</td>
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<tr>
<td>Simulated radar data generation (UCSB)</td>
<td>08/92</td>
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<tr>
<td>8. Data Entry (Case Study II) (JPL)</td>
<td>10/92</td>
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<td>9. Data Analysis (Case Study II) (JPL, UCSB)</td>
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<tr>
<td>Extract radar parameters from data</td>
<td>11/92</td>
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<tr>
<td>Cross-correlate data sets</td>
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<td>Produce Classification maps</td>
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<td>Sensitivity analysis</td>
<td>3/93</td>
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<td>Radar Model Validation</td>
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<td>Optimize visualization</td>
<td>09/93</td>
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<td>Report/journal paper</td>
<td>10/94</td>
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<tr>
<td>10. S/W Documentation (JPL, VEXCEL)</td>
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<tr>
<td>Write S/W Description Document</td>
<td>11/94</td>
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### GEOGRAPHIC INFORMATION SYSTEM

**STATUS OF UNIX VICAR/BIS S/W:**

- **STARTING POINT WAS A SET OF UNIX VICAR Routines TRANSLATED BY ARIZONA STATE UNIVERSITY**
- **CURRENTLY HAVE 45 VICAR APPLICATIONS PROGRAMS RUNNING**
- **8 OF THEM ARE IBIS Routines (NEED ~30 IBIS Routines IN TOTAL)**
- **CURRENT CAPABILITIES:**
  - **CAN READ RADAR IMAGE DATA INTO THE VICAR FORMAT**
  - **CAN SET UP - IMAGE FILES (RASTER)**
    - GRAPHICS FILES (VECTOR)
    - V F FILES (TABULAR)
  - **PERFORM IMAGE ROTATION, STRETCHING**
  - **IMAGE RUBBER-SHEETING (FOR REGISTRATION)**
  - **DRAW POLYGONS ON DISPLAY AND CONVERT TO IMAGE FILES**
  - **FILL POLYGONS WITH DATA ATTRIBUTES**

### DELIVERABLES:

1. Case Study II: Report/Journal Paper
2. Case Study II: Report/Journal Paper
3. S/W Description Document
**JPL**

**GEOGRAPHIC INFORMATION SYSTEM**

- **DATA PREPARATION**
  - CASE STUDY 1: BONANZA CREEK EXPERIMENTAL FOREST, AK
    - 2 SEASAT IMAGES
    - 2 SPOT IMAGES
    - 10 AIRSAR FRAMES (~45 IMAGES)
    - DIGITAL ELEVATION MODEL (USGS)
    - GROUND TRUTH SURVEY DATA
    - AERIAL PHOTOS
    - FURTHER AIRSAR DATA (5/91), GROUND TRUTH DATA AND ERS-1 SAR DATA WILL BE RECEIVED IN NEAR FUTURE
  - CASE STUDY 2: BELIZE RAIN FOREST
    - 9 AIRSAR FRAMES (~45 IMAGES)
    - AVIRIS DATA
    - SOME GROUND TRUTH DATA

---

**JPL**

**GEOGRAPHIC INFORMATION SYSTEM**

- UCSB RADAR MODEL
  - UCSB RADAR MODEL(S) ARE INSTALLED ON THE SPARC STATION AT JPL
  - MODELS WERE DEVELOPED FOR STUDIES OF MT. SHASTA FORESTS
  - CURRENT EFFORTS ARE FOCUSED ON:
    - ENSURING THAT THE CONTINUOUS AND DISCRETE FOREST CANOPY MODELS AGREE IN THE LIMIT
    - ADAPTING THE MODEL FOR THE TYPE OF TREES FOUND IN ALASKA
    - GENERATING SIMULATED RADAR MEASUREMENTS FROM BONANZA CREEK GROUND TRUTH DATA
    - SIMULATED RADAR MEASUREMENTS FROM THE MODEL WILL BE USED TO FILL POLYGONS IN THE GIS TO GENERATE SIMULATED IMAGES

---

**ORIGINAL PAGE IS OF POOR QUALITY**
CLASSIFICATION ALGORITHMS (FOR RADAR DATA)

- First step is the reduction of polarimetric radar image data to five basic quantities for each frequency (HH, HV, VV, ARGHHVV) and (HHVV)
- This gives 15 'channels' for each radar image set
- Then use linear discriminant analysis to come up with a supervised classification of the image
- Approach was tested on an AIRSAR image of an agricultural test site in the Netherlands with 15 different classes of target

VISUALIZATION S/W AND ANALYSIS TOOLS

- PVWAVE is installed on the SPARC STATION (graphics, RGB, perspectives, etc.)
- No VP with VCSAR yet
- POLTOOL S/W - For polarimetric radar data analysis has been installed, allows plots of polarization signatures, synthesized images of arbitrary polarizations
- No VP with VCSAR yet
- 'Light Table' S/W developed by VEXCEL - Allows user to 'roam' through large images using mouse

GEORADIOGRAPHIC INFORMATION SYSTEM

- POLTOOL S/W:
PRINCIPAL INVESTIGATORS PRESENTATIONS

SAVS
A SPACE DATA ANALYSIS
AND VISUALIZATION SYSTEM

Edward Szuszczewicz/P.I.
SAIC
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Charles C. Goodrich/Co.I.
Alan Mankofsky/Co.I.
NOTES:
SAVS
A SPACE DATA ANALYSIS AND VISUALIZATION SYSTEM

Presented by
E. P. Szuszkiewicz

Laboratory for Atmospheric and Space Science Applications International Corporation
McLean, VA

Applied Information Systems Workshop
July 22-24, 1991

CONTRIBUTING ORGANIZATIONS

SAIC
Laboratory for Atmospheric and Space Science

STARDENT
Computer Inc.

UNIVERSITY OF MD
Department of Physics and Astronomy

SAVS: A DATA ACQUISITION, MANIPULATION, ANALYSIS AND VISUALIZATION SYSTEM

MAJOR COMPONENTS:

INNOVATIVE VISUALIZATION SOFTWARE (AVS)

ADVANCED DATABASE TECHNIQUES (DAVID)

SET OF MATHEMATICAL, STATISTICAL, ANALYTICAL AND IMAGE PROCESSING TOOLS

STRONGLY DEVELOPED SENSE OF THE SCIENTIFIC REQUIREMENTS
### The NASA Vision for the Coming Decade

**The Vision:** This vision includes a comprehensive attempt to understand the flow of energy into and through the geospace environment, with the goal that "quantitative study of the geospace environment, created by the interplay of solar and terrestrial processes, will be progressing toward a full-scale predictive stage" (from OSSA's Strategy Document (1989)).

**Implementation:** Coordinated multi-spacecraft missions (e.g., ISTP) to collect "in situ" plasma and field measurements throughout the magnetosphere, the ionosphere and the interplanetary medium.

- Requires imaging of the thermosphere, the ionosphere and the Sun, and coordinated ground-based magnetometer, ionosonde, radar, and photometric observations
- Requires interactive database handling and visualization and analysis techniques
**STATEMENT OF THE PROBLEM**

Increased focus on large-scale system phenomena

The cross-disciplinary nature of many investigations

Higher data rates and projections of increased volumes of data

Enhanced measurement capabilities (need for cross-correlation of global images with "in situ" and ground-based observations)

Increasing number of large-scale 3-D numerical models available as analytical tools for data synthesis and interpretation

---

**INTERACTIVE FEATURES INCORPORATED**

Interactive data analysis and graphics environment

Ability to cross-disciplinary boundaries with ease and understanding

Ability to "compress" data into a visually-organized form optimized for analysis and interpretation

Easy-to-use mathematical, statistical and image processing tools

Tools to obtain data sets from remote archives

Access to empirical and numerical model results to correlate with the data and assist in data analysis and interpretation

An integrated user-friendly system they can afford

---

**SAMPLE PLANNED APPLICATION**

Comparison of boundary conditions (BC) values for Sept. 22 - Sept. 30, 20XX

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<th>Time (days)</th>
<th>BC Value</th>
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<td>500.0</td>
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</table>
**Visualization:** 1-, 2- AND 3-DIMENSIONAL DISPLAYS, ALONG WITH ANIMATION, COMPRESSION, WARPING AND SLICING

**Analytical Tools:** GENERIC MATHEMATICAL AND STATISTICAL TECHNIQUES ALONG WITH THE ABILITY TO USE LARGE-SCALE MODELS FOR INTERACTIVE INTERPRETATION OF LARGE-VOLUME DATA SETS

**Platform:** IMPLEMENTED ON SUN AND DEC UNIX WORKSTATIONS AND ON THE STARDENT GRAPHICS SUPERCOMPUTER

**Immediate Application:** SOLAR, HELIOSPHERIC, MAGNETOSPHERIC, IONOSPHERIC AND THERMOSPHERIC PHYSICS, WITH EXTENSIONS TO A BROADER RANGE OF PLANETARY, INTERPLANETARY AND ASTROPHYSICAL ENVIRONMENTS

**THE VISUALIZATION SYSTEM (AVS)**

AVS IS DESIGNED FOR A DISTRIBUTED NETWORK ENVIRONMENT...SINGLE SYSTEM OR A NETWORK OF SYSTEMS

COMPLETE IMAGE DISPLAY CAPABILITIES:
- REAL-TIME PAN AND ZOOM
- ROTATION AND TRANSFORMATION
- FLIPBOOK ANIMATION
- SUPPORT FOR 8-BIT, 24-BIT AND FLOATING POINT IMAGES

IMAGE FILTERS INCLUDE:
- LOOK-UP TABLE OPERATIONS
  - PSEUDO-COLORING, HISTOGRAM BALANCING, DATA RESIZING
  - INTERPOLATION, CROPPING AND SAMPLING

PROVIDES A VARIETY OF TOOLS FOR RENDERING VOLUME DATA; A REAL-TIME ISO-SURFACE GENERATOR; ETC.

**PROJECTED CAPABILITIES**

**Start customization of the AVS Interface**

Address the porting issues

Adapt AVS to NASA applications of 1-, 2-, and 3-D displays

Implement basic mathematical and statistical functions

Support locally-resident NASA data sets

Begin remote data handling capabilities

Implement relevant large-scale numerical models
PRINCIPAL INVESTIGATORS PRESENTATIONS

A PLANETARY VERSION OF PC-McIDAS

Sanjay S. Limaye/P.I.
Univ. of Wisconsin-Madison
Madison, WI
(608) 262-9541

Mike Martin/Co.I.
R. S. Saunders/Co.I.
L. A. Sromovsky/Co.I.
APPLIED INFORMATION SYSTEMS
RESEARCH WORKSHOP

NOTES:

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A Planetary Version of PC-McIDAS
Applied Information Systems Workshop

Sanjay S. Limaye (UW-Madison), Principal Investigator
J.A. Solomonov (UW-Madison), R.S. Saunders (JPL), Mike Martin (JPL), Co-Investigators

WHAT IS PC-McIDAS?
- A compact system for analysis of atmospheric imaging data

WHY A PLANETARY VERSION?
- The nature and volume of the planetary data and uniqueness

_ WHAT_ - UNIX and OS/2 VERSIONS
- UNDER EFFORT UNDERWAY, PROGRESS ON OS/2

- INITIAL DEVELOPMENT AT SSEC, TESTING AT JPL FOR MACELLAR APPLICATIONS
- FUTURE: COULD SUPPORT WAP OBSERVER AND CASSINI MISSIONS

McIDAS and PC-McIDAS

DATA COMPUTER INTERACTIVE DATA ACCESS SYSTEM
AN ANALYSIS TOOL FOR INTEGRATION OF WEATHER DATA FROM SATELLITES AND CONVENTIONAL SOURCES
RADIATION AND SOFTWARE COMPONENTS DEVELOPED AT SPACE SCIENCE AND ENGINEERING CENTER (SSEC)
INSTALLED GLOBALLY IN OPERATIONAL ENVIRONMENTS, EFFORT BEGAN IN EARLY 1978'S

- HARRIS DATABASE ACCESS VERSION
  - 384 k memory, 40 Mo Peripheral Disk Storage
  - 1 807/1600 line tape drive
  - 2 user image display terminals
  - used during Mariner 10 Venus Flyby

- HARRIS 2E NETWORK VERSION
  - 2 Database Manager and 4 Applications Computers
  - 768 k core memory on each
  - 50 Mo peripheral storage on "Main" and "Main" drive
  - 1 Mo peripheral storage on each "run" or "client"
  - 2 807/1600 line tape drives
  - 1 101/1200 line tape drive
  - 1 - 1" display terminal on each (as well as Remote)
  - used during Voyager I flyby of Jupiter and Saturn

- IBM MPS *"60
  - Memory, 32 Mo real memory, 7 Mo peripheral storage
  - 2 1200 line tape drives
  - 1 1440 tape drive
  - communication support
  - 15 terminals globally
  - used during Voyagers and Mariner 10/11 encounters

McIDAS Workstations

- INTEL 8086 based "dumb" terminal
  - used on the Harris versions
  - Analog disk and digital cam display memory

- McIDAS III-UGS Version - First "smart" terminal
  - Dual mode operation: local mode and host mode
  - Digital cam display memory

- McIDAS-OS/2 Version - First multi-threaded implementation
  - EGA/HDGA support for local display
  - Used during the Voyager Jupiter encounter
  - portable for field work

Wide Area Workstation (WAW) support
- Additional image display memory
- 16 M display memory
- dual channel video support

McIDAS AIR Version - A-Windows support

McIDAS Hardware Developed at SSEC

SATELLITE DATA INGESTION
- WORK SPACE WORKSTATION
- DIGITAL CASSETTE ARCHIVE FOR G0ES DATA

Real Time Data Available on McIDAS

G0ES satellite images 24 hours/day
METEOSAT visible and infrared images
MODIS-10 polar orbiting AVHRR (MOD, ERS, SSMI)
NOAA-15 polar orbiting AVHRR (AVHRR, ERS, SSMI)
GMS/Infrared full disc images - 1 resolution
Irexat color images
- Specialized data
- Hi-Res Earthsight
- Images, and Meteosat data
- G0ES/1-9 images

SNMC and MODERR Americas West - at "present" resolution
Archived Data available on McIDAS

Continuous WARS digital imagery data going back to 1977, some to 1976
Harbor 10 images of Venus
Voyager 1 and 2 images of Jupiter, Saturn (Digital Tape)
Voyager 2 images of Uranus and Neptune (Digital Tape)

McIDAS Installed Base

MAINFRAME FACILITIES INSTALLED AT:
- NASA/MSFC facilities (AFGL, SSC, JSC, MSFC, NASA) for Shuttle operations
- NOAA (NMC, MSFC, WAO)
- Private Companies (Federal Express, NPI)
- Universities (FSU, UC-Chico)
- Weather Services facilities in Spain, China, Australia, COMSAT

REMOTE WORKSTATIONS
- San-Diego
- UW-Madison
- University PC McIDAS at 700 atmospheric science departments at colleges and universities

PLANETARY PC-MCIDAS

- MANY DIFFERENT KINGS OF DATA AND SPACECRAFT GABIES
- NATURE OF ANALYSES DIFFERENT FROM OPERATIONAL WEATHER SATELLITE DATA
- DIFFERENT RESEARCH GOALS AND DISCIPLINES
- NOT A SOLUTION FOR ALL PLANETARY DATA
- BUILT ON THE CORE McIDAS APPLICATIONS AND UTILITIES
- DIFFERENCES BETWEEN McIDAS AND OTHER SIMILAR SYSTEMS

ENHANCEMENTS/MODIFICATIONS

- BRIDGE TO SPACELAB KERNELES FOR PLANETARY NAVIGATION
- DIRECT SUPPORT OF CD-ROM DATABASE
- IMPROVED PROTOTYPE PRODUCT DEPLOYMENT REPORTING
- NEW APPLICATIONS FOR GEOLOGIC DATA ANALYSIS FROM PLANETARY IMAGES
- MULTISENSOR COMPOSITES AND ANIMATIONS
- DOCUMENTATION OF PLANETARY PROGRAMS/ALGORITHMS
- USER GUIDE
<table>
<thead>
<tr>
<th>COMPARISON OF MCIDAS AND VICAR</th>
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<tbody>
<tr>
<td>• DIFFERENT OPERATING ENVIRONMENTS</td>
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<td>• MULTITASKING VS. SINGLE APPLICATION MODE</td>
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<td>• MASSFRAME VS. SINGLE FRAME DISPLAY</td>
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<td>• DIFFERENCES IN HANDLING OF USER FILES (NATIVE OPERATING SYSTEM VS. MCIDAS OPERATING ENVIRONMENT)</td>
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<td>• USER APPLICATIONS TYPICALLY BUILT MODULAR RATHER THAN MONOLITHIC</td>
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<td>• USER PROGRAMMABLE CHAINING OF OPERATIONS (&quot;MACROS&quot;)</td>
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<tr>
<td>• USER APPLICATION &quot;PROVEN&quot; FOR APPLICATION PROGRAM INPUTS</td>
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<tr>
<td>• DIFFERENT SYSTEM ARCHITECTURE PHILOSOPHIES</td>
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<tr>
<td>• SIMPLIFIED FILE STRUCTURE (&quot;LU&quot; FILES)</td>
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<tr>
<td>• GRIDDED DATA STRUCTURE (&quot;GRID&quot; FILES)</td>
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<td>• SCHEMA DATA STRUCTURE (&quot;MO&quot; FILES)</td>
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<td>• UNIFIED SINGLE DATA NAVIGATION ACCESS</td>
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</tbody>
</table>
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INTERACTIVE INTERFACE TO NCAR GRAPHICS

Robert Lackman, P.I.
NCAR
Boulder, CO
(303) 497-1224
NOTES:

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Interactive Interface to NCAR Graphics

Bob Lackman
Scientific Visualization Group

NCAR Graphics Features

- Standards conforming
  - ANSI C and FORTRAN 77
  - GKS and CGM
- Portable
  - UNIX and VMS
- Scientifically oriented
- International distribution
  - University, government, and industry
  - Since 1971
  - Approximately 1500 sites
- Evolving
  - UNIX Version 3.1.1

NCAR Graphics Current State

- Features
- Components
- Interface

NCAR Graphics Components

- Test drivers for all utilities
- Over two dozen high-level utilities
- An intermediate interface library (SPPS)
- NCAR GKS-0A (Optional)
- Fortran and C translators (Optional)
- Miscellaneous tools and utilities
- Documentation
NCAR Graphics Utilities

- Contouring
  - Regular and irregular grids
  - Various quality levels
- Maps
  - Outlines or filled
  - Ten popular transformations

NCAR Graphics Utilities (continued)

- X-Y plotting
- Surfaces and isosurfaces
- Streamlines and velocity vectors
- Histograms
- Stroked-character generators
- Others

NCAR Graphics Programmatic Interface

User application programs
NCAR Graphics utilities
  X-Y graphing
  Contouring
  Maps
  Etc.
  SPPS library
  GKS (NCAR or other)
  CGM

NCAR Graphics

NASA Proposal Enhancement

An Interactive Interface
A Typical Application

GUI

X Toolkit

Text-based UI

NCAR Graphics

Design Considerations

- Ease of use
- Portability
- Enhanced functionality
- Standards
- Interoperability
  Module compatibility with AVS, xfd, khoros, ILA, ...
- Distribution and support

Overview of NCAR Interactive

User Interface and CDL Interpreter

GUI

CDL Interpreter

NCAR Thinner

Metatile

Stand Alone CDL Interpreter

ASCI Editor

CDL Interpreter

NCAR Utilities

Stand Alone Postman Interface

Postman Driver

Data file

CDL = Command Description Language
PRINCIPAL INVESTIGATORS PRESENTATIONS

VIEWCACHE: AN INCREMENTAL DATABASE ACCESS METHOD FOR AUTONOMOUS INTEROPERABLE DATABASES

Nick Roussopoulos/P.I.
Univ. of MD
College Park, MD

Timoleon Sellis/Co.I.
VIEWCACHE: AN INCREMENTAL DATABASE ACCESS METHOD FOR AUTONOMOUS INTEROPERABLE DATABASES

Principal Investigator:
Nick Roussopoulos

Co-Principal Investigator:
Timoleon Sellis

Department of Computer Science
and
Institute for Advanced Computer Studies
University of Maryland
College Park, MD 20742

July 5, 1991

Submitted to the First Workshop of the Applied Information Systems Research Program
Boulder, Colorado
July 22-24, 1991
PROJECT SUMMARY

The objective of this work is to illustrate the concept of incremental access to distributed databases. An experimental database management system, ADMS, which has been developed at the University of Maryland, in College Park, uses VIEWCACHE, a novel database access method based on incremental search. VIEWCACHE is a pointer-based access method that provides a uniform interface for accessing distributed databases and catalogues. The compactness of the pointer structures formed during database browsing and the incremental access method allow the user to search and do inter-database cross-referencing with no actual data movement between database sites. Once the search is complete, the set of collected pointers pointing to the desired data are dereferenced.

One of the most attractive features of VIEWCACHE is its versatility in providing External Multi Gateway Access to commercial database servers, such as INGRES, ORACLE, and SYBASE, supporting existing and independently maintained databases. We have designed and implemented a Client-Server Database Management System Architecture which utilizes powerful workstations for managing inter-database queries and cached data. The workstation environment provides the "glue" for interoperating otherwise foreign environments. Gateway database access methods are enhanced by the incremental techniques of VIEWCACHE for caching local subsets of useful data.

VIEWCACHE is especially suited for distributed scientific databases maintained on commercial database systems. Scientist, who search such large catalogued databases, cannot write complete queries because search is defined during browsing. Current computer and database technology allows a user only to browse a single database at a time. It is, however, extremely useful to be able to browse and correlate data sets from multiple data servers. During browsing, there is no need to move data from one database to the next to compare and do cross-referencing; instead, VIEWCACHE creates a working set of pointers to the data sets or records that are candidates for the final retrieval. The working set is continuously refined until the user finds the exact data sets he needs. Furthermore, VIEWCACHE allows the creation of mixed breed views from several data sets and caching of them onto the users workstations. Such new data sets provide value added to the exiting data.

Another feature that ADMS supports is spatial search on image data sets. This capability is not offered by commercial DBMS but it was absolutely necessary for searching for objects in a giver "view
field." Spatial search is based on R+-trees, an established access method. The indexing technique we are planning to support, provides for very efficient search over large databases of spatial objects.

The concept of VIEWCACHE has been demonstrated with the various traditional database benchmarks (like the Wisconsin benchmark); we propose to investigate and develop extensions to ADMS to make our system suitable for accessing very large space data sets. Clearly, NASA's huge numbers of distributed data sets collected from space and ground stations cannot be supported by existing distributed commercial distributed database systems because they require unnecessary and bulky data movements. VIEWCACHE, on the other hand, provides an inexpensive processing without interrupting the independence of existing and autonomous databases.
TECHNICAL OBJECTIVES

Our objective is to illustrate the potential of the incremental access of VIEWCACHE in a real NASA environment of distributed databases, in particular on a collection of Astrophysics databases. The compactness of the VIEWCACHE pointer structures formed during database browsing and the incremental access method allow the user to search and do inter-database cross-referencing with no actual data movement between database sites. Once the search is complete, the set of collected pointers pointing to the desired data are cached. This will provide a uniform user interface to a large number of databases using the VIEWCACHE concept, and the Client-Server Architecture. We will also examine ways to interface VIEWCACHE with the DAVID system and its library-based access methods for providing access to Heterogeneous and Distributed Databases.

In more detail, the following technical objectives will be sought during the next three years:

(1) An extension of the physical pointer structure of VIEWCACHE to a logical one. This will permit VIEWCACHE to do inter-machine pointer referencing across a communication network (Local or Wide Area Networks). Access of heterogeneous DBMSs will be done by gateway software based on the SQL language.

(2) Investigate features and characteristics of various Client-Server DBMS architectures and measure their performance under a wide variety of key parameters, including speed of the storage media, speed of the CPUs, network transfer rates.

(3) Incorporate a spatial access methods and accordingly extend the SQL query language to include spatial search and operators which deal with imagery databases.

(4) Design and develop a user interface and the appropriate tools to facilitate handling and distribution of data sets and documents. The Astrophysics environment will be the first to target this interface. Other environments will also be investigated and appropriate tailoring of the interface will be attempted.

(5) Investigate ways to interface VIEWCACHE with DAVID, the Distributed Heterogeneous Database System developed at Goddard.

Work on this projects has already started on the items 1, 2, and 3 from above. We have been experimenting with Oracle DBMS on the subject of logical pointers. We have also developed simulation
packages for evaluating alternative Client-Server Architectures for DBMSs. Experiments are currently being conducted with very large simulation runs.
PRINCIPAL INVESTIGATORS PRESENTATIONS

SPATIAL ANALYSIS AND MODELING SYSTEMS (SAMS)

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Univ. of Chicago
Chicago, IL

Paul Chan/Co.I.
John Hill/Co.I.
Robert Jaske/Co.I.
Gilbert Rochon/Co.I.
Fran Stetina/Co.I.
The objective of this project is to develop a uniform environmental data gathering and distribution system to support a) emergency management for environmental disasters, and b) the calibration and validation of remotely sensed data. Initial activities will be to select a data test site and to demonstrate multi-discipline applications using simulated or satellite data in a non real-time mode.

The investigators have arranged collaboration with the CERL Laboratory of the Corps of Engineer (COE) in integrating its Geographic Information System (GIS), the Geographic Resources Analysis Support System (GRASS), into SAMS. CERL will also provide hydrological models (HEC-I and II) to be integrated into SAMS. The collaboration with the Federal Emergency Management Agency (FEMA) will allow this project to tap into FEMA's resources in GIS and emergency management tools.

We choose to use rainfall and flooding as the testbeds for the SAMS concept because of the abundance of data and the availability of models. We will integrate into SAMS (in a UNIX, GRASS and X-Windows environment) capability to display and process GOES data and analyze GOES generated rain-rate maps. GRASS is compatible with the majority of the data to be input to the selected hydrologic model (i.e. topography, land-use, soils, rainfall, stream gauge, etc.). The choice of the data test site has been narrowed down to West Virginia or Galveston, Tx, based on the availability of test data.

The expected results in six months are:

a) Design concept of SAMS,
b) Demonstration of a pilot module, and
c) Project implementation plan based on the pilot demonstration.
INTRODUCTION TO CADET CENTER FOR ADVANCED DATA EVALUATION TECHNOLOGY

Cathy Schulbach/P.I.
NASA Ames Research Center
Moffet Field, CA

C. Jorgensen/Co.I.
INTRODUCTION TO CADET
Center for Advanced Data Evaluation Technology

Cathy Schulbach /c_schulbach
7/25/91

OUTLINE

- INTRODUCTION
- GOAL
- CADET OVERVIEW
- OBJECTIVES
- APPROACH
- KEY CADET FOCUS
- FUTURE MILESTONES

TECHNOLOGY PROBLEM

approx. 1% of EOS sensor data can be transmitted

HUMAN PROBLEM

DATA COLLECTION

DATA UNDERSTANDING
IMPLICATIONS

- The "BRUTE FORCE" method of trying to collect, save, and analyze "everything" is intractable and may not produce the best science.
- Smarter and more automated approaches are required.

GOAL

- DEVELOP AND DEMONSTRATE IMPROVED METHODS OF HANDLING LARGE SCIENTIFIC DATA FLOWS RESULTING FROM CURRENT AND PLANNED NASA MISSIONS.
  - Real-time
  - On-board

OBJECTIVES

- Integrate existing work in neural networks, photonics, parallel processing, and dependable systems.
- Develop, test, and evaluate new concepts for model-capturing and novelty detection mechanisms (e.g. neural net learning).
- Implement advanced data analysis technology using advanced processors (e.g. optical processors, IWARP, ES-KIT).
Approach

- Focus on common problems of importance to major NASA missions (e.g. MTPE, MFPE).
- Demonstrate technology advancements first with ground-based systems and then move to on-board, real-time platforms.
- Capitalize on existing capabilities and programs: Ames Advanced Data Systems and Software Test Facility (includes DARPA testbed) and the High Performance Computing and Communication Program.
- Coordinate with NASA and non-NASA agencies.

Key Cadet Focus:
Translating Data Into Usable Form

- Sensors → Raw Numerical Data → Chunking → Labeling → Visualizing → Human Interpretation
- Connecting to existing knowledge bases: prediction, interpolation, novelty detection, change

Future Milestones

FY92
- Use the Failure Environment Analysis Tool (FEAT) to model a sensor system.
- Demonstrate the use of sensor overlays to display earth science data.
- Demonstrate the ability of a neural network front end to automatically capture underlying regularities in a real-world sample of spectrographic sensor data.

FY93
- Develop parallel code implementing a novelty filter to redirect a data recording device to dynamically respond to changes in measured, earth science phenomena.

FY94
- Validate the above concepts on the Ames Advanced Data Systems and Software Test Facility.
APPLIED INFORMATION SYSTEMS 
RESEARCH PROGRAM WORKSHOP 

PROGRAM PRESENTATIONS
FLIGHT PROJECTS OFFICE
INFORMATION SYSTEMS TESTBED
(FIST)

Patricia Liggett
Jet Propulsion Laboratory
Pasadena, CA
(818) 357-4619
Flight Projects Office
Information Systems Testbed
(FIST)

P. Liggart

- Goal

- FIST reduces risk by providing support for:
  - Requirements Clarification
  - Design Validation
  - Design Evolution

To perform technology evaluation and prototyping of information systems to support SFOC and JPL flight projects in order to reduce risk in the development of operational data systems for such projects.
Criteria

- Applied research and development using commercially available products and systems.
- Results of prototypes and evaluations are reported in the FIST Quarterly Report and presented during demonstrations.
- FIST guidelines are provided by SFOC compatibility requirements.

Quarterly Reports

- FIST Quarterly and SFOC Prototype Interim Reports are available through:
  FPSO Library
  Mail Stop T-1607
  Jet Propulsion Laboratory
  4800 Oak Grove Drive
  Pasadena, California 91109

SYSTEM BUILDING BLOCKS

- Open Systems Architecture
- Server/Client Model
- Iterative Design and Development
- Commercial and Public Products

OPEN SYSTEMS ARCHITECTURE

- Limited Constraints
- Well Defined Interfaces
- Data Format Agreement
- Soft Serve versus Hard Freeze
SERVER/CLIENT MODEL

- Limited and Well Defined Interdependence
- Loosely Coupled
- Services Provided to Requesting Client
- Role Reversal

ITERATIVE DESIGN AND DEVELOPMENT

- Provides Users with Early View of System
- Adaptive to Changing Technology and Requirements