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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.
APPLIED INFORMATION SYSTEMS RESEARCH PROGRAM

WORKSHOP PROCEEDINGS

JULY 22-24, 1991

BOULDERADO HOTEL
2115 13th Street
BOULDER, COLORADO

(NASA-TM-108773) APPLIED INFORMATION SYSTEMS RESEARCH PROGRAM WORKSHOP (NASA) 166 p

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N93-29241

Unclas
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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 beneficiaries 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.
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
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 (CASIS). 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 OAET

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.

Discussions 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.
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
Elaine Hansen

1:15 p.m. Program Overview
Joe Bredekamp

2:00 p.m. Office of Space Science and Applications
Data Environment and Future Plans

-Earth Observing System Data
Martin Ruzek

and Information System

-Planetary Data System
Randy Davis

-Astrophysics Data Systems
Alice Bertini

4:00 p.m. Office of Aeronautics, Exploration and
Technology Information Systems Program
Paul Hunter

4:20 p.m. Center of Excellence in Space Data and
Information Sciences (CESDIS)
Ray Miller

4:40 p.m. Center for Aerospace and Space
Information Sciences (CASIS)
Mike Flynn

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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<thead>
<tr>
<th>Title</th>
<th>Speaker</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Experiment's Laboratory for Visualized Interactive Science</td>
<td>Ms. E. Hansen</td>
<td>Univ. of Colorado</td>
</tr>
<tr>
<td>Grid Analysis and Display System (GRADS): A Practical Tool for Earth Science Visualization</td>
<td>Dr. J. Kinter</td>
<td>Univ. of Maryland</td>
</tr>
<tr>
<td>A Distributed System for Visualizing and Analyzing</td>
<td>Dr. A. Jacobson</td>
<td>JPL</td>
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<tr>
<td>Multivariate and Multidisciplinary Data</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</td>
<td>Hughes</td>
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<tr>
<td>Development of an Expert Data Reduction Assistant</td>
<td>Dr. G. Miller</td>
<td>STSCI</td>
</tr>
<tr>
<td>System of Experts for Intelligent Data Management (SEIDAM)</td>
<td>Dr. D. Goodenough</td>
<td>Canada Centre for Remote Sensing</td>
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<tr>
<td>Construction of an Advanced Software Tool for Planetary</td>
<td>Dr. R. Keller</td>
<td>NASA/ARC</td>
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<td>Atmospheric Modeling</td>
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<tr>
<td>Knowledge-based Assistance for Science and Analysis Using Large Distributed Databases</td>
<td>Mr. T. Handley, Jr.</td>
<td>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</td>
<td>JPL</td>
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**LEGEND:**
* P.I. Presentation not given/ ** P.I. not in attendance
## P.I. PRESENTATIONS
* (Afternoon Session)

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<tr>
<th>Title</th>
<th>Presenter</th>
<th>Institution</th>
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<tbody>
<tr>
<td>A Distributed Analysis and Visualization System for Model and Observational Data</td>
<td>Mr. M. Arrott</td>
<td>Univ. of Illinois</td>
</tr>
<tr>
<td>An Interactive Environment for the Analysis of Large Earth Observation and Model Data Sets</td>
<td>Professor K. Bowman</td>
<td>Univ. of Illinois</td>
</tr>
<tr>
<td>A Land-Surface Testbed for EOSDIS</td>
<td>Dr. W. Emery</td>
<td>Univ. of Colorado</td>
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<tr>
<td>Geographical Information System for Fusion and Analysis of High-Performance Remote Sensing and Ground Truth Data</td>
<td>Mr. A. Freeman</td>
<td>JPL</td>
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<tr>
<td>Development of a Tool-Set for Simultaneous, Multi-Site Observations of Astronomical Objects</td>
<td>Dr. Chakrabarti</td>
<td>Univ. of CA/Berkeley</td>
</tr>
<tr>
<td>SAVS: A Space Analysis and Visualization System</td>
<td>Dr. E. Szuszczewicz</td>
<td>Science Applications</td>
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<td>International Corp.</td>
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<tr>
<td>Planetary Data Analysis and Display System: A Version of PC-McLADS</td>
<td>Dr. S. Limaye</td>
<td>Univ. of Wisc., Madison</td>
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<tr>
<td>Interactive Interface for NCAR Graphics</td>
<td>Mr. R. Lackman</td>
<td>National Center for</td>
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<td>Atmospheric Research</td>
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<tr>
<td>The Development of Generic and Extensible Software to Support the Study of Space Science Data</td>
<td>Mr. G. Goucher</td>
<td>NASA/GSFC</td>
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<tr>
<td>VIEWCACHE: An Incremental Database Access for Autonomous Interoperable Databases</td>
<td>Assoc. Prof. Nick Roussopoulos</td>
<td>Univ. of MD</td>
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<tr>
<td>A Spatial Analysis and Modeling System for Environmental Management</td>
<td>Mr. C. Vermillion</td>
<td>NASA/GSGC</td>
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<tr>
<td>Introduction to CADET: Center for Advanced Data Evaluation Technology</td>
<td>Ms. Cathy Schulbach</td>
<td>NASA/ARC</td>
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<tr>
<td>Topography from Shading and Stereo</td>
<td>Professor B. Horn</td>
<td>MIT</td>
</tr>
<tr>
<td>Multivariate Statistical Analysis Software Technologies for Astrophysical Research Involving Large Data</td>
<td>Mr. G. Djorgovsici</td>
<td>JPL</td>
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<tr>
<td>High Performance Compression of Science Data</td>
<td>Dr. J. Storer</td>
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**LEGEND:** * P.I. Presentation not given/ ** P.I. not in attendance
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APPLIED INFORMATION SYSTEMS
RESEARCH PROGRAM WORKSHOP

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Washington D.C.
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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
### Information Systems Research and Technology and Systems Evolution

**Objective:** Apply advanced information systems technology as appropriate to improve support to OSSA science programs

**Elements:**
- Applied research (tools and capabilities, etc.)
- Testbed demonstrations and insertions

**Approach:**
- Broaden participation through open solicitations
- Provide as part of infrastructure capability to support testbeds, rapid prototyping, etc.
- Leverage with related efforts in NASA/OAET; NSF, etc.

**Status:**
- Applied research program initiated (you are here) and well-received
- Next solicitation targeted for Summer 1992

**Issues/Opportunities:**
- Need to develop systematic process for technology transfer and infusion
- Sharpen research agenda to focus future solicitations
THE EARTH OBSERVING SYSTEM
DATA AND INFORMATION SYSTEM

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APPLIED INFORMATIONS SYSTEMS
RESEARCH WORKSHOP

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The Earth Observing System Data and Information System (EOSDIS)

Applied Information Systems Research Workshop
Boulder, Colorado

Sara J. Graves
July 22-24, 1991

EOSDIS and Earth System Science

EOSDIS is a pivotal part of the U.S. Global Change Research Program and the international effort to understand how the Earth functions as a complete system.

Earth system science objectives require a data and information system that will:

- Encourage multidisciplinary and interdisciplinary investigations
- Combine data from the EOS platforms with data from other agencies and nations (other satellites, aircraft, in situ operational and experimental data)
- Integrate EOS information with models of environmental processes and global change

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, HIRS, ITIR, SAFIRE...
- Multiple platforms: EOS-A, EOS-B, EPOP-M, IPOP, EPOP-N
- Distributed system architecture: GSFC, EDC, LaRC, JPL, ASF, MSFC, NSIDC, investigator sites
- Large number of users: >500 AO scientists and thousands of users
- Massive data volume: 50,000 Tbytes
- 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.

**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
**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 SCF, DAAC, networks, and IMS.

Version 0 is populated by:
- Existing data
- Pathfinders
- In situ, aircraft, and field campaign measurements
- Precursor 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/Archives
- Scientists/academic, agency develop/select community-consensus algorithms/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

**PDS**

Presented at the Applied Information Systems Research Workshop

by Randy Davis

University of Colorado

Laboratory for Atmospheric and Space Physics

22 July 1991

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**Old-Style Planetary Data Delivery**

- **NSSDC**
- **Data Products**
- **Other Scientists**

**Modern Planetary Data Access**

- **NAIF**
- **PDS**
- **Mission Data Base**
- **Other Scientists**
PDS Project Organization

Project Manager  S. McMahon, JPL

Science Manager  P. Martin, JPL
Baseline Manager  G. Walker, JPL
Mission Product Mgr  Y. Fletcher, JPL

Data Engineering Team
Discipline Nodes
Software Team

System Engineering Team

The PDS Discipline Nodes

Atmospheres
University of Colorado

Geosciences
Washington University

Small Bodies
University of Maryland

Imaging
U.S. Geological Survey

Plasma/Particles
UCLA

Rings
Ames Research Center

Navigation and Ancillary Information
Jet Propulsion Lab

Sample Discipline Node (Atmospheres)

U. of Colorado
Planetary Atmospheres Database and Data Set Management

Subnodes

Standard Space Flight Center

U. of Arizona

Subnodes

Jet Propulsion Laboratory

U. of Texas

Global precipitation modeling and remote sensing

How Users Access the PDS

HSSDC

Central Node
JPL

Discipline Node
JPL

Subnodes
Planetary Researchers Work in a Heterogeneous Computing Environment

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

- Networks
  - DECNET
  - TCP/IP

- Database Management Systems
  - Commercial RDBMSs
  - Homegrown Systems

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

- Programming Languages
  - FORTRAN
  - C

Data Analysis Environment

- IDL

Standards Being Embraced or Examined

- Operating Systems
  - POSIX

- Networks
  - CCSDS telemetry/command systems for space-to-ground links
  - OSI-compliant ground networks

- Database Management Systems
  - SQL for queries

- Data Interchange
  - Object Description Language (ODL) for identifying and describing data
  - Limited use of CCSDS Standard Format Data Units (SFDUs)
  - ISO 8669 CD-ROM for importing/exporting large volumes of data

- User Interface
  - X Windows for basic user interface functions
  - Motif for look and feel

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 graphics 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 information interfaces between scientists, flight project systems, and the discipline archives (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.
INTRODUCTION & ADS OVERVIEW

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

Introduction & ADS Overview

Alice Berlini
CASA/University of Colorado

ADS Project Review
Introduction

What is the Astrophysics / Data System?

- Response to Needs Recognized by Various Studies
  - Astrophysics Data Systems Study (1988)
  - Information Systems Strategic Planning Project (1990)

- Common Themes of Studies
  - Large Influx of Data - 10's Gigabytes -> Terabytes
  - Knowledge of Data Holdings - What? Where?
  - Access to Data and Meta Data - Catalogs, Data Products, Archives, Documentation
  - Applicable into 21st Century - Flexible, Extensible, Evoluble
  - Science Driven System - Emphasize or Enable Science Research e.g., "Fan Diagram" Studies

Status of System Now

- Operational System
  - 100 Registered Users
  - 16 Databases from 3 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
Astrophysics Data System Node Locations

TRADITIONAL ACCESS METHOD

- Many Accounts
- Many Different Software Packages to Learn
- No Means of Integrating Data

ADS PROJECT PLAN

ADS ACCESS METHOD
ADS Project Review

Top Level Organization Chart

Major Milestones of ADS
  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

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

Scientific Based Scenarios Imply Functional Requirements
- Cross Correlation of Catalog Data
  Coordinate Conversion
  Sky Shining, Distance Test (Search in Cone)
  Combining Data
  Export Results
- Location of Data/Objects
  Name Resolution
  Browse Data Base
  Order Data Set/Intermediate 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 Bases for a class of objects?

- Actions
  - Get X-ray sources over some range of parameters, e.g., RA, DEC, Class
  - Get IR sources in same 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 Q1 ’92
  - Name Server Q2 ’92
  - Locals Data on an Object (P Q2 ’92) Q3 ’94
  - SIMBAD Interface 3

- Data Set Access
  - Data Archive Capability (P Q2 ’92) Q4 ’92
  - Image Display (P Q2 ’93) Q2 ’94
  - Graphics Display (P Q3 ’93) Q2 ’94
  - Proprietary Data Access Q1 ’96
  - Data Analysis Tools 7

- Text Retrieval
  - Distributed Documentation Q4 ’93
  - Text Database Indexing Scheme Q3 ’95
  - Keyword Augmentation to Indexing Q3 ’96
  - Text Retrieval System 94 ’95

---

**Science Project Enabled by Functionality of ADS**

- On-Line Astronomical Literature and Documentation
  - Scanned Literature from Astronomical Journals
    - Data Storage
  - 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
NOTES:

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CONCURRENT PROCESSING RESEARCH - FY90
506 45 11

OBJECTIVE:
To develop fundamental research in developing algorithms that may effectively run in parallel with both very large numbers of processors and high speed communications between processors for application in NASA problems.

ACHIEVEMENTS:
During FY90, new algorithms were developed and run in the new version of the newly acquired blade on a HP 3, a commercial transputer parallel (IMAP) machine, and of the Locally Parallel Processor (LPP). The algorithms are extremely complex and run very well on the 3000+ instruction card, and include:

- Parallel Inversion Computation
- Fast Fourier Transform
- Elliptic Dynamic of Scientific Simulations
- O(n log n) algorithms for various n-dimensional digital signal processing problems
- Transient analysis of network systems
- Deterministic models for parallel computing systems

Several new approaches were developed that allow the algorithms to be executed in parallel and hence are high performance parallel systems.

SIGNIFICANCE:
The research is being carried out to develop advanced system software and programming environments to enable parallel processors to be used for solving applications shown under the Aeronautical (T. D. Williams) Challenge of NASA's High Performance Computing Initiative (HPC). It is anticipated that this research will be used to develop new system software for parallel processors and future computing systems. This work has been performed in collaboration with the National Research Council (NRC).
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, at 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 follows. At the lowest level, we develop universal object type management systems to provide uniform access to heterogeneous database engines, spreadsheet, manpcart, etc., management systems. At the second level, we develop "book" and "file" management systems to provide uniform access to a local area network of computers containing "books", "files", and other data objects. At the fourth level, we develop libraries to provide access to sets of libraries.

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

Technical Contact: Barry E. Jacobs, GSFC, (301) 344-5881
**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, maps, etc.
- Aggregate Sets of Related Objects: books, series, maps.
- Libraries: Collections of holdings
- Consortium of Libraries: Aggregate set of related libraries

**DAVID Approach**

**CS-41**

**INTELLIGENT DATA MANAGEMENT PROCESSES**

The objective of the Intelligent Data Management project is to research how intelligent knowledge base and database interaction systems can be developed to make it easier for users to access large amounts of data. The project is particularly interested in the area of automatic image data encoding and analysis.

**OBJECTIVE:**
- Automatic Image Data Encoding and Analysis

**CS-42**

**SYSTEM SYNOPSIS**

The system consists of three major components: the image data management system, the query processing system, and the user interface. The image data management system stores and manages the image data, while the query processing system processes user requests and retrieves appropriate data. The user interface provides a graphical interface for interacting with the system.

**SYSTEM DESIGN**

The system design includes the following components:
- Image storage and retrieval
- Query processing
- User interface

**SYSTEM IMPLEMENTATION**

The system is currently implemented using a client-server architecture. The server stores and manages the image data, while the client processes requests and retrieves data.

**SYSTEM EVALUATION**

The system has been tested with a variety of users and has shown promising results. Further evaluation is needed to ensure the system meets the needs of its users.

**CONCLUSION**

The Intelligent Data Management project has made significant progress in developing a system for automatic image data encoding and analysis. Further work is needed to improve the user interface and expand the capabilities of the system.

**TECHNICAL CONTACT:**
William J. Campbell, (NASA) 215-673-7075

**C26**

**POOR QUALITY**
SOFTWARE ENGINEERING PROGRAM

- Includes: LaRC, GSFC, JPL, & JSC
- Supports: RICIS

- Program Drivers
  - Very reliable software
  - Software productivity
  - Very large/complex software systems
  - Legacy systems
  - Process management
**Machine Learning Experiment in the KBSEE**

In the experiment, the software engineering environment is used to train machine learning models to predict software development outcomes. The KBSEE is designed to support the management and analysis of software development projects, including identifying potential issues and optimizing processes.

**Technical Contact:**
Jan Vehelt, OSFC, (510) 206-6556

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**The Software Management Environment**

The Software Management Environment (SME) is a software tool designed to assist in managing, analyzing, and controlling ongoing software projects. The key functions of the SME include tracking software project parameters, analyzing the differences between the current project's development patterns and the expected development patterns, and providing advice and guidance on management of the software project. To provide these functions the tool continuously examines available development data from the project of interest including manage, software changes, computer utilization, and completed milestones and compares this information to data from past projects and to a model of the 'typical' project.

During fiscal year 1990, the SME has been extended and improved to include functionality for expert assessment of project problems and for assessing its ability to model the project environment. With these additions in place, the SME has been released for use by software managers with the Flight Dynamics Division at the OSFC. By utilizing the SME on ongoing software development projects 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 establishing 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:**
Jan Vehelt, OSFC, (510) 206-6556
ESC, or Encyclopedia of Software Components

**Task Description:**
- a hypertext 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 content
- content in many programming languages and in many levels of granularity
- 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 elapsed 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 from interface and tenants
  - update the conceptual prototype
  - engineer insertion and retrieval mechanisms
  - conduct preliminary investigation of issues of AI (artificial intelligence)

Technical contact: Dr. Brian Backman, JPL, (818) 354-1223

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**PS 11**

Application and Assessment of Industry-Standard Guidelines for the Verification of Avionics Software

**Objective:**
- Compile industry standards for the development of real-time software into an experimental test-bed for analyzing the failure process of avionics software and assess the effectiveness of methods that comply with these standards.

**Background:**
- The certification activities along with configuration management and software quality assurance policies for the developing technologies for avionics software in accordance with the industry standards established in the Department of Defense and the National Institute of Standards and Technology (NIST). The NIST guidelines are developed in consultation with the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA). The guidelines provide a framework for the development and verification of avionics software.

**Assessment:**
- The project is conducted in accordance with the DO-178B standard for software development and verification methods. The project aims to provide a comprehensive evaluation of the effectiveness of software development and verification methods.

**Significance:**
- Although many software reliability experiments have been conducted, these experiments have not considered complex avionics software that is critical to mission success. The OCS experiment provides a research site for evaluating the effectiveness of avionics software. The OCS experiment will provide data on the failure rate and severity of avionics software failures. The data will be used to assess the effectiveness of the software development process.

**Relief Plan:**
- Complete scaling of the three avionics software environments and analysis of the resulting software error data to develop and improve software reliability models and software development and verification methods based on this information.

**Production of Realistic Software Error Data**

- DO-178B
- FAA Database
- Software Error Data
- Independent Versions of Guidance & Control Software
- Reliability Modeling

---

**Technical Details:**
- Complete scaling of the three OCS versions and analysis of the resulting software error data to develop and improve software reliability models and software development and verification methods based on this information.
### SPACE DATA SYSTEMS PROGRAM

- Includes: GSFC, JPL, LaRC, ARC
- Supports: VLSI Design @ U. Idaho
- Program Drivers
  - Ambitious future space instruments
  - Long-duration, high-radiation 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

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**Notes:** This assessment is ongoing and more data is expected to be added.
SPACEFLIGHT OPTICAL DISK RECORDER

This page, titled 'Spaceflight Optical Disk Recorder', contains a diagram and text discussing the development of an optical disk recorder for spaceflight applications. The text describes the technology and its application, mentioning the development of a flight-ready optical disk drive. The page also includes a list of 'FY 90 Accomplishments' and 'Projects Developed FY 90'.

DATA STORAGE TECHNOLOGY

The text begins with a description of the purpose of the task, which is to evaluate the state of magneto-optical (MO) technology for achieving high data rate and high capacity data storage. It mentions the significance of current work in identifying an attractive method for simultaneously achieving high data rate and high capacity recording with high reliability, effective data rate matching, and low mass, volume, and power.

CURRENT STATUS OF ACCOMPLISHMENT: The evaluation results indicate that MO head technology is an extremely viable and promising technology. Results indicate that storage density using MO head technology is at least three times greater than optical storage densities. Results also indicate that reliability figures using MO heads are one to two orders of magnitude greater than those achieved with today's head tape recorders. MO heads can be developed to achieve 200 Mbps and terabyte storage in tape recorders instead of today's 10 Mbps and terabyte storage.

TECHNICAL CONTACT: Dr. Romney R. Kast, JPL (818) 354-3054.
CONFIGNABLE HIGH RATE PROCESSOR SYSTEM (CHIP)
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 I.C.s, 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 multi look 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 1986.

HIGH PERFORMANCE COMPUTING & COMMUNICATIONS PROGRAM

- Includes: ARC, GSFC, LaRC, LaRC, JPL
- Supports: CEDIS, RIAACS, 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

WHAT IS THE ADSP?

- Flexible SAR Processor
- Over 6 Gigaflops peak compute rate
- Real time rate capability for missions such as SEASAT & SIR-B
- 150 Megabytes of memory
- About 35,000 integrated circuits
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 Systems Science

- Climate System
- Ocean Circulation
- Atmospheric Dynamics
- Biogeochemical Cycles

Planetary Evolutionary Processes

- Accumulation of Mass
- Redox Emotions
- Planetary Chemistry

Massive Data Analysis

- Instrument Data Analysis
- Mass Spectrometry
- Image Processing

Space and Solar-Terrestrial Physics

- Solar Wind Dynamics
- Magnetospheric Dynamics
- Geodynamics

Astrophysics and Astronomy

- Star Formation
- Planet Formation
- Supernova Explosions

Habitable Zone Challenges
EARTH AND SPACE SCIENCES

**GOAL**
Demonstrate the potential to address the grand challenges afforded by Teraflops system performance on selected multidisciplinary modeling and massive data handling applications.

**OBJECTIVES**
- Support the development of massively parallel, scalable multidisciplinary models and data processing algorithms.
- Make available prototype scalable parallel architectures and massive data storage systems to ESS researchers.
- Prepare the software environments to facilitate scientific exploration and the sharing of information and tools.
- Develop data management tools for high speed access, management and visualization of data with Teraflops computers.
- Demonstrate scientific and computational impact for Earth and Space science applications.

**CANDIDATE APPLICATIONS**
- Coupled Earth atmosphere systems science
- Space and Solar Terrestrial physics
- Astrophysics and Astronomy
- Biogeochemical cycles and evolutionary processes
- Planetary evolutionary processes
- Analyses of massive data sets acquired by NASA programs

---

COMPUTATIONAL AERODYNAMICS

**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 aeroscience 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 systems technologies to aerospace and computer industries.

**CANDIDATE APPLICATIONS**
- Powered lift vehicle
- High speed civil transport
- Aeroskimming
- National Aerospace 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.

CESDIS GOALS TO BE
ACCOMPANLED 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

HPC PROJECT
COORDINATOR
Michael MacDonald
Administrative Assistant II

ADMINISTRATIVE STAFF

Senior Administrator
Administrative Assistant I
Administrative Assistant II

CESDIS CENTRAL RESEARCH

Staff
Kenneth Salem
Devin Stenta
Director
Raymond Miller

PEER REVIEWED RESEARCH

Duke
Dr. John Reid
Duke University

University of North Carolina
Dr. Joel Gottesdiener
James Coggin

Stanford
Dr. Gia Winterfield
Stanford University

George Washington
Dr. Jim Foley
George Washington University

ADDITIONAL RESEARCH TASKS

Brown
Dr. Jeffrey Viter
Brown University

Penn State
Dr. Eric Feigenbaum
Penn State University

University of Maryland
Dr. Howard Friedman
University of Maryland

George Washington
If. Robert Lerman
George Washington University

University of Maryland
Dr. Howard Friedman
University

Carnegie Mellon
Dr. H. T. Kung
Carnegie Mellon University

Drexel University
Dr. Douglas Smith
Drexel University

Cray Fellowship

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

Brown University: Jeffrey Vitter and Paul Howard
Data Compression Algorithms

Penn State University: Eric Fergason and Michael LeValley
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 Edelson and Herman Heigert
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: Reinard Lohner
Computer codes for simulation of 3D compressible magnetohydrodynamics flows

Stanford University: Philip Scherrer and Richard Bogart
Astrophys: Electronic mail 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.

---

### CESDIS PROPOSED HPCC ACTIVITIES

**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

### 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.
CASI 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
Departments 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 — 1991
Supported facility 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. Widmerhold
Professor J. Vesecky
Professor M. Levoy
Programming Environments
Professor M. Linton

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.
Data Visualization
Data Recognition
Data Transmission
Data Processing

Data Visualization

Ice Flows Using SAR
Aurora
Terrain Elevation Mapping Using SAR

Basic Studies in 3-D
Data Representation

1) Image 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.

EXTRACTION OF DATA 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
Concurrence 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 '50s 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!

**IVER** (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 Klamp (PolyPaint Originator and Lead), William Boyd (Systems designer/programmer), Matt Irwin (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 separably 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 (computed 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
III. BUILDING BLOCKS

- "Poly" Features (cont'd)
  - User-specified limitation on the maximum number of vertices in polygons
  - Wire frame plots to preview the polygon data
  - File storage for polygon data in formats that can be used with PolyPart or other surface rendering facilities

- "Paint" Features
  - Either index color (8 bits) or true color (24 bit RGB)
  - Depth queuing using a z-buffer stored in memory
  - Display of multiple objects that can be superimposed sequentially within the same view domain
  - Polygon shading using either color (Gouraud) or surface normal interpolation
  - Reversal of unit normal vectors to view the inner side or both sides of surfaces
  - Display of 2D red/blue stereo objects
  - Volume rendering of three-dimensional data
  - Wire frame rendering with shaded and anti-aliased lines
  - Combined display of solid surface, wire frame, and volumetric rendering
  - Procedures for storage and display of images in and from disk
  - Multiple color table positions for displaying different colored objects on index color systems
  - Lighting options that include:
    - Up to 10 light sources

III. BUILDING BLOCKS

2. Management of Data Objects, "Object Work"

- A software tool, developed at LASP
- Key individuals: Sally Lassiter and Randy Davis
- Manages data objects (store, retrieve, update, delete)

3. Interactive Interface Objects, Services and Designer bench

- "Transportable Applications Executive — TAE"
  - Developed by GSFC's Data Systems Technology Division
  - Key individual: Matt Sicure
  - Enhanced for real-time applications by LASP at CU
  - Key individuals: Meng Klaemp and Eric Niles
  - Features
    - An easy to use workbench for design and layout of new user interfaces with "interaction objects"
    - Runtime services to display and control workbench designed user interfaces
    - A run-time interpreted command language to control an application's user interface

III. BUILDING BLOCKS

4. Data Access Interface — Network Common Data Form (NetCDF)

- Concepts originated by GSFC's NSSDC
- Enhanced as general purpose tool by Undata
- Features
  - General tools for storing and retrieving range of science data types
  - Enables access to software to treat all data types in the same way
  - Treats data as collection of self-describing, network transparent objects, accessed through simple interface
  - Supports random access of multi-dimensional variables, and direct access to bytes of data values, to a hypercube of data, and to records
IV. PLANS

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

(hoping for more funding!)

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 PRATICAL TOOL FOR
EARTH SCIENCE VISUALIZATION

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Univ. of Maryland
Dept. of Meteorology
College Park, MD
(301) 405-5384

Brian E. Doty/Co.I.
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

GrADS - Design Goals

* INTEGRATE: data access, manipulation and display
  + ACCESS
    - Four-dimensional data access
    - Combined access, one or three dimensions
  + MANIPULATION
    - Data operations through representation and display
  + DISPLAY
    - All standard techniques
    - Bar graphs
    - Contour and shaded fields
    - Vector plaques
    - Grid patches

* INTERACTIVE
  - Elementary response mode
  - Time execution
  - Access to data/display characteristics
  - Language
  - Programmability

* EASE OF USE
  - Short learning curve
  - Ease of use

* HARDCOPY

SCIENTIFIC VISUALIZATION = 3:

I SEE

SCIENTISTS→DATA
- QUANTITATIVE
- INTERACTIVE
- VIEW + MANIPULATE

YOU SEE

RESULTS→JOURNALS
- QUANTITATIVE
- PUBLICATION QUALITY
  - LEGIBLE
  - INFORMATIVE
  - COMPARABLE

WE SEE

IMAGES→PUBLIC
- QUALITATIVE
- AESTHETIC

ORIGNAL 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 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

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.
DSET /DATA/REANAL/ANALYSIS.DAT
UNDEF -9.99E33
TITLE REANALYZED 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 00Z26DEC1982 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 LOH -90
SET LAT 40
SET LEV 850
SET TIME 00Z26DEC1982 18Z10DEC1982
DISPLAY TV
DRAW TITLE 850mb Virtual Temperatures at 90N, 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 I
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 I
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

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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
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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 bandwidth.

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 televisualization 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

1. User: "What's needed?"
2. Developer: "What's possible?"
3. Determine Requirements
4. Implement Prototype
5. No
6. User Validation
7. Yes
8. Finalize Application
9. User Community

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. 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 application 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

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

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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 multidisciplinary/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 be handled 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 S1ScL
- Object Oriented (Common Lisp Object System)
- X-based window system
  - Mview? CLIM? Gnome?

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.

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.
PRINCIPAL INVESTIGATORS PRESENTATIONS

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

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

by
David O. Goodenough, Ko Fung, Joji Ikeda, Mike Robson, Cornelius Kushigbor

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1547 Merivale Road, Ottawa, Ontario K1A 0T7

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E-mail: DGG@CCRS.CAN

1991

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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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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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SEIDAM - OTTAWA TEAM

CCRS
David Goodenough - Principal Investigator
Ko Fung - Co-Investigator
Joji Ikeda - Co-Investigator
Mike Robson, Cornelius Kushigbor
Alain Menard, Jean-Francois Manubier, Karl Steenz

University of Ottawa
Stan Matevski, 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.

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.

INTEGRATION OF INFORMATION

Levels of data fusion

derived component

derived attributes

sensor measurements

Environment

symbol

signals

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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 GRIND 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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**SEIDAM**

**Data Sources**

- LANDSAT 5, 7
- SPOT 3
- ERS 1
- JERS 1
- NOAA AVHRR
- MGS 1A, B

**Aircraft:**
- CCRS SAR (X, C - polarimetric)
- CCRS MET (push-broom scanner)
- CCRS AMS
- NASA airborne SAR (X, L, P - polarimetric)
- AVIRIS, TIMS

**Field Measurements:**
- GIS information
- DTM
- Ground calls
- Ecosystem chemistry
- Meteorological data

**SEIDAM**

**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.

**SEIDAM**

**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.

**SEIDAM**

**SYMBOLIC INTEGRATION APPROACH**

- Knowledge-Based Methodology
- Object-Oriented Approach
- Objects are grouped into a 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 disambiguated 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
- Heuristic Methods (e.g. majority voting)
- Bayesian Approach
- Dempster-Shafer rules of combination
- Fuzzy Logic
- Endorsement Methods

Selection of Measurement Factors

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CONFLICT RESOLUTION FOR THE ENDORSEMENT METHOD
SYSTEM OF EXPERTS FOR INTELLIGENT DATA MANAGEMENT

An example application
forestry
other applications
data preparation spatial processing analysis output / models

NASA lower level experts or programs
CCRSPFC

Levels of knowledge in the integrated system

control/procedural knowledge
domain knowledge
factual knowledge

Frames
Inference Engine
Task Interface

Domain Software

DTM data Remote Sensing Data Digital Map Data

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Objectives of the 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**

- Expert System
- Interface
- Donate Application
Human-Computer Interface (HCI) Considerations

Purpose of the HCI
- simplify prompt-initiative procedures
- generate level of knowledge
- organize the information on the screen
- augment the capability of the worker

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 users
- subject to the level of the user
- event-driven dialogue rather than predictable

Development Considerations
- communication strategy
  - level of abstraction (target user)
  - consistent grammatical rules and terminology
  - consistent presentation
  - amount of freedom available to the user
  - informs the user
  - what has happened, what is happening
Spatial Knowledge: OBJECTIVES

1. Develop spatial information 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.
2. Develop an expert system for spatial information analysis system
   embedding or linked with neural networks and pixel swapping functions.
3. Collect spatial knowledge observed in remote sensing data and create
   pilot knowledge bases.
4. Validate spatial knowledge acquired for remote sensing.

Spatial measurements knowledge

Geometrical measurement:
- classical geometrical measures:
  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:
- In, overlapped, included...
  Positively associated, negatively associated or randomly associated.
CONCLUSIONS FOR DTM SYSTEM

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

Adaptive grid size with DEM for Slope & Aspect generation
**SEIDAM**

**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**

1. Import
2. Preprocess
3. 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

---

**SEIDAM**

**Segmentation Expert - IMPLEMENTATION**

Prototype RULES: Example

- `suggested_action_based_on(NUMSEG, NUMPOLY, SIZE, SMOOTHING):`
- `NUMSEG = NUMPOLY`
- `rs_wide"(Suggestion: Reassign with a lower smoothing threshold.)`
- `rs_wide"(Reason: The number of segments is less than the number.)`
- `rs_wide" of GIS polygons which suggests that too low")`
- `rs_wide" segments were created.")`
- `rs_wide" Previous")`
- `rs_wide" Warning")`
- `rs_wide" Suggested")`
- `rs_wide" Suggested")`
- `rs_wide" Warning")`
- `rs_wide" Warning")`

---

**SEIDAM**

**Segmentation Expert - IMPLEMENTATION**

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.
SEIDAM

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

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CONCLUSIONS #2

- We still need to work on GIS updating process from segments in remotely sensed images:
  - Segmentation parameters?
  - Improve segment classification

  - Establish RULES for labeling segment classes from GIS
  - Rules to modify GIS polygons from classified image segments?
  - Expert to be tested on several forest inventory maps

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SEIDAM

WHAT RESEARCH WILL BE DONE?

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

1) AUTOMATED METHOD:
   - SEGMENTATION OF THE GIS
   - INTELLIGENT SELECTION OF HISTORICAL GIS DATA AND ATTRIBUTES
   - ESTIMATION OF GIS LABEL AND BOUNDARY ACCURACIES
   - SEGMENTATION 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

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SEIDAM

WHAT RESEARCH WILL BE DONE? #2

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

NASA        CCRS        PFC
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 SPECTROMETER DATA FOR CHEMICAL INPUTS INTO MODELS

NASA / CCRS / PFC

SEIDAM Expert System

WHAT RESEARCH WILL BE DONE? #4

- WHAT COMPUTING SCIENCE AND ENGINEERING RESEARCH WILL BE DONE?
  - CREATION OF EXPERT SYSTEM SHELL IN OMTUS PROLOG WITH GIS (GRAPHICAL USER'S 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

NASA / CCRS / PFC

SEIDAM Expert System - Spatial Processing
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 1993. CCRS has previously collected data over the Invermere sites. These data have included several years of TM, HRV, MOS-1, and NOAA AVHRR. Aircraft data previously collected include CCRS SAR, AVHRR, MEAS, and AMS. More than 150 forest inventory GIS files have been acquired. These correspond 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.

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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 homogenous 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.

NASA  |  CCRS  |  PFC

Artificial Intelligence Research Projects

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<thead>
<tr>
<th>Project</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>SHERI</td>
<td>System of Hierarchical Experts for Resources Inventories</td>
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</table>

Seidam (System of Experts for Intelligent Data Management)

NASA  |  CCRS  |  PFC

Seidam Software Status

- More than 44 expert systems created; implementing Motif interface for user interface
- Ported Seidam and Expert Systems to Unix
- Ported Seidam and Expert Systems to other platforms (Sun, Macintosh...)
- Research, development and integration of new Expert Systems
  - Segmentation, Digital Terrain Model, Texture, Spatial Knowledge, End result labeling with fuzzy methods, GIS input/output, intelligent land information system, forest productivity and monitoring, etc.
- Interface Expert System and RDBMS (through INGRES, C, Perl, and SQL)
- Plan knowledge acquisition experiments for Seidam validation
- Integrate Object Oriented Database
- Use Machine Learning to accelerate the development of new Experts
### TASKS AND MILESTONES

<table>
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<th>Task</th>
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<tr>
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<td>Nov. 1, 1990</td>
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<tr>
<td>Submit Preliminary Proposal to ISTC</td>
<td>Mar. 13, 1991</td>
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<tr>
<td>Submit Final Proposal to ISTC</td>
<td>June 26, 1991</td>
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<tr>
<td>SEIDAM Overall System Design</td>
<td>Sept. 30, 1991</td>
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<td>Remote Sensing data EB</td>
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<td>GIS ES</td>
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<td>Project Completion for NASA portion</td>
<td>Mar. 31, 1994</td>
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### 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 page.

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.
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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

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

**Features**

- High-level modeling language
- Intelligent assistance
- Interactive graphical interface
- Analysis & visualization facilities
- Libraries of data sets
- Object-oriented programming

**Techniques**

- Artificial Intelligence
- Symbolic visualization
- Visual programming

**Overview of the Scientific Modeling Process**

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

**Methodology**

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

**Initial Focus Areas**

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

**Projeet Staff**

- David Thompson
- Michael Rimon
- Richard M. Keller
- Christopher McKay
- Jennifer Dungan
- Michael A. Sims
- Science Collaborators

**Collaborators**

- Artificial Intelligence Research Branch
- Planetary Atmospheric Model
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 II
- Wrong level of abstraction
- Implicit knowledge buried

Potential payoffs:
- Improve scientific productivity
- Foster scientific communication
- Disseminate modeller'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
**Outline**

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

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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 (PI), P. Li
- Science: D. Collins (CO-I)
- Expert Systems: A. Tran
- Visualization: L. Falcone, B. Jacobson (CO-I)
- Research: M. Wade, T. Maddox (Summer Faculty)

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**Applicable Technologies**

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

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**Objectives**

- Scientific Data Models
  - Data-driven analysis
  - Data transformations
  - Data semantics
  - Analysis-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.

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July 23-25 1991
Data Hub Functional Architecture

MetaData Representations

Data Classes

Scientific Data

Data Classes

Scientific Data

Logical Access Methods

Selection Operators

- Range selection for one or more independent variables. Required conjunctive conditions for n-k dimensions (n-dimensional data, k-dimensional display).
  - \( d1 \leq \text{Depth} \leq d2, \) where \( \text{Time} = t1 \)
  - \( t1 \leq \text{time} \leq t2, \) where \( \text{Depth} = d1 \)

- Enumerated selection for one or more free variables
  - \( \text{Time} = \{11, 12, \ldots, \text{In}\} \)

- Selection for the dependent variables
  - \( \text{Temperature} \geq 20 \text{ degree} \cdot \text{C} \) for \( \text{Temperature Dataset} \)
  - \( \text{Frequency} \geq 25 \) for \( \text{Flag Dataset} \)
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
  - regliding
  - Registration
- Other map projections

July 22-23 1991

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

July 22-23 1991

Preliminary Software Architecture

Today's Prototype

July 22-23 1991
An Interesting Situation
(Summer Research Fellow)

- Exponential increase in volume of data.
- A reduction of domain specific analysis expertise.
- The loss of and/or delay in the discovery of knowledge.

July 28-30 1991

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.

July 28-30 1991

LinkWinds

- Modifications and additions to LinkWinds made in support of this activity.
- Size limitation on ingested databases were relieved to accommodate the oceanographic data. All applications were affected.
- An interface to NCSA's Hierarchical Data Format (HDF) was implemented. Methods were put in place to convert from other standard formats to HDF.
- Design of databases exchange protocols and interface between LinkWinds and DataHub was initiated.

July 28-30 1991
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)

- Saliency 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 (cont’d)

The Pacific studies require a much broader context in which to interpret the measurements provided by the time-series and process-oriented studies. To address the broader context, satellite imagery can provide a description of the spatial and temporal scale of the biological and physical processes and their variability, including changes in water mass, incident radiation, nutrients, and the consequent formation of blooms of different species of marine phytoplankton and bacteria. We will use a time series of CZCS images of the atmospheric aerosol and pigment distributions for the north Pacific Ocean, obtained in 1983, to study the seasonal variability of primary productivity. This data will be combined with time series of the MCBST product with sea-surface temperature and data of the distribution of surface winds and cloud cover in the northern and sub-tropical north Pacific Ocean. These time series will be examined to determine the spatial and temporal scales of productivity, including the interannual variations that occur in the productivity caused by variations in the physical environment.

The regional imagery from the north Pacific will provide an historical context for the continuing study of this region. For the description of the seasonal patterns of primary productivity, composite maps will be generated from the individual scenes produced from the CZCS archives. The goal of the composite is to provide a seasonal description of the productivity of the region and to preserve the temporal character of data that is fundamentally episodic in nature. Two such maps will be produced, including maps of the total productivity, computed from the surface irradiance and the water column pigment content through a model described by Hollister, et al., 1981, and of the carbon flux through a model developed by Mitchell, et al., 1981. The model of total productivity permits the computation of the total carbon assimilated by phytoplankton in the ocean, while the model for the carbon flux estimates the fraction of the total carbon assimilated that is removed from the surface mixed layer through processes which contribute to the uptake of CO2 from the atmosphere.

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 interactions between the physical and biological structures must be known. The biological population of the ocean is highly variable both spatially and temporally on all time and space scales. The global nature of this problem then requires the use of satellite imagery as the only potential means of providing coverage on a 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 to provide a more accurate assessment of carbon productivity from ocean color imagery. The objectives of this research are the description of the spatial and temporal distributions and variability of the planktonic community 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 distribution of phytoplankton biomass and primary productivity in the equatorial Pacific Ocean upwelling areas and the oligotrophic central Pacific gyre.

To provide an understanding of the global flux of carbon through the upper ocean into the ocean basin as a whole, the JCOS Steering Committee has identified the need for both time-series and process-oriented regional studies to examine the spatial and temporal distribution of the physical and biological parameters with the determination that they be isolated regional studies of 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 an 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-Series study at the ALOHA site.
LinkWinds

The near term objective is to ingest, at will, a large number of datasets related to two databases. These are the Multi-Channel Sea Surface Temperature (MC SST) data which are global ocean temperature measurements, and the Coastal Zone Color Scanner (CZCS) 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 acrogeographic databases which are the subject of our near-term studies are larger than datasets previously used in LinkWinds. The MC SST data is composed of two images measuring 2048x1024 pixels, with 194 data points per pixel. One image is in the data base, and the other image is a measure of the quality of the data image on a pixel-by-pixel basis. These data exist on a weekly basis, each of 8-bit range. These images also measure 2048x1024 and exist on a weekly basis, as well as 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 is being submitted into 2048x1024 pixel images and put into HDF format. Preliminary design and coding to use this data into the LinkWinds environment is underway now by Phillip LL, and is estimated to be done in about two weeks. Once this is accomplished, the tools and concepts of LinkWinds can be immediately applied to the study of the data. In preparation for stage two, all tools and concepts of LinkWinds are being redesigned and modified to accommodate arbitrary large image sizes. The coding for these modifications is being done now by Mitch Wode and Marlin Otten. Once these tools are completed, and the data in its fullest form can be read and studied, then we will concentrate upon modifying existing correlation tools, and developing new ones to extend the studies of these data.

**July 23-25 1989**

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 on critical system failures, which could be very expensive. It may also provide some assistance in various data management and analysis tasks. The development of such intelligent assistance systems will require that some knowledge of data management and analysis be brought into the system. 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 and exploring large series of data.

Scientists who have used LinkWinds are very satisfied with its flexibility. They can manipulate data maps and combine, or link, other features such as "ildoers" (crosshatch), and graphs in support interactive examination of data for analysis, thus really changing the logic of data analysis and display windows and links. One reason for the high level of satisfaction with LinkWinds may be because it is a comfortable reflection of the data analysis skills or processes of the experienced development team. LinkWinds supports the iterative transformation of data through a search process where the results of each iteration are interpreted and the search steps or its redirected when some solution level is realized.

**July 23-25 1989**

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

The visualization tools and analysis procedures LinkWinds further help constrain the search by allowing data transformations to be represented by color, animation, or other visually perceptible features. 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. This emergent behavior seems to be a result of the linking process which is driven by the users domain specific and general knowledge and experience.

Some of these ideas are embodied in GROK. Specifically, GROK's design asserts that nodes and links (graphs) are a useful visualization of the grouping and ordering of general and part of general knowledge. Grouping and ordering may be facilitated by "slipping" or connecting disparate knowledge elements upon which inferences may be made. This is similar to semantic networks where a graph with specialized links represent the semantic relationships between objects (nodes) of the graph. Such networks are hierarchical and class inheritance is often a characteristic of nodes in the graph. Much of the connective and artificial neural network research involves linking nodes that act as simple computing elements in a similar fashion. Research is in progress that will use the GROK architecture to connect distributed data sources and analysis routines within and between machine hosts on a shared computer network.

We assume that the process of data analysis is well-represented by a graph of connected data, analysis and display procedures. Our objective is to investigate how information from the original data, 2) analysis and display procedures and 3) the user may combine to facilitate knowledge discovery in a dataset. The original data represents an event history of the spatial and temporal conditions of the data acquisition environment. Partitioning the data into subsets based on spatial, temporal, or other physically or logically relevant grouping and ordering features is essential. The analysis and display procedures embody a prior transformation, reduction, and abstraction information needed to reorganize the original dataset. Combinations of these procedures can be most useful that they are applied emergent behavior. The user has the experience necessary to link knowledge of domain dependent goals and hypotheses, analysis and display procedures, and the source data to drive exploratory data analysis. Who can approach the transformation process allow the user to decide if the results satisfy relevant analysis goals and hypotheses.

Our investigation will explore the development of algorithms which represent how information regarding user goals and hypotheses, transformation procedures, and metadata may be combined to facilitate the discovery of knowledge. We believe that much of the users' domain knowledge is critical to the 1) dynamic dimensionality and 2) the context of the different analyses and various transformations procedures. The semantics of the users' domain knowledge is represented by these links. Often, the user is not aware of many of the analysis and display methods, but rather they may assist in the development of data analysis. We seek to develop displays representing the information between these sources.

Another research objective is to characterize the dynamic nature of the interaction between some information flow top-down in a goal-driven manner from the user towards the data and the analysis and display procedures. Other information flows bottom-up in an event-driven manner by using pattern recognition, information theoretic and other statistical methods, resulting metadata may also interact the analysis and display procedures relative to the flow of retrieved information. Object-oriented software engineering techniques may allow us to classify these procedures as well as the cooperative or competitive information flow dynamics.

**July 23-25 1989**
Summer Faculty Research - Data Knowledge Issues (cont'd)

Hopefully, the results of our work will be a Scienca Analyst Assistant within LinkUnder or GROK that may be capable of advising a scientist on ways to subset a large dataset on the basis of salience measures which are locally interesting (from the data specialist's perspective) and globally interesting (from the domain specialist's perspective). Future research issues include: 1) the possibility of suggesting physically or logically concurrent 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 in an attempt to generate our data analysis algorithms.

July 23 1991

Expert Systems

Interpretation problems present challenges across scientific disciplines. The oceanographic domain presents a rich set of data parameters that must be analyzed and combined to build an interpreted image. 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 AI will support this effort by combining the data sets using data at the art machine learning techniques. Leverage of this task is provided by the Scientific Analysis Assistant SAA funded under Code RC. Together these projects are investigating how machine learning techniques can assist scientists with efficient data ingestion.

Proof of Concept Near Term Goals
- Evaluate and Compare Machine Learning Techniques
  - GeO
d  - Parallel Distributed Processing PDP Networks
  - AuClas
- 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 interpolated image using selected data parameters.
- Compare Performance
  - Measure the performance of machine learning algorithm application to conventional techniques.

July 23 1991

Data Management

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

I. Scientific Database Models
1. Data format (usage of data types 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/analysis methods, ...)
3. Analytical-related knowledge about data
4. Data quality assessment (identifying and treating missing data, i.e., NULL value representation, evaluating data validity after data interpolation, data transformation, etc., ...)

II. Resource Sharing Environments for Scientific Databases
1. Data exchange protocol 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 scientific data management. There are many data formats from the data sources in different scientific communities. There are many data conversion tools available 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 1.

A system, named DARPA, will be a server between the data suppliers and the data consumers to facilitate data exchange, to assist science data analysis, and to provide a systematic approach for science data management.

July 23 1991
FIGURE 1: SCIENCE DATA MANAGEMENT: TODAY

FIGURE 2: SCIENCE DATA MANAGEMENT: TOMORROW

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

GOAL / OBJECTIVES
- Provide an environment for supporting development of visualization techniques
- Utilize knowledge and experience in database management data analysis and visualization

APPROACH / BUDGET
- Design and develop the database along with the data management system for a distributed environment
- Use the database to provide an environment for developing visualization techniques, with emphasis on visualization techniques and development of visualization

FY 91 ACCOMPLISHMENTS
- Initial data sets selected and analyzed
- Knowledge-based visualization system
- Initial data sets selected and analyzed
- Design and implementation of visualization techniques
- Data collection and analysis

FY 92 MAJOR MILESTONES
- Analyze assistance
- Data collection and analysis
- Advanced data sets analysis
- Data collection and analysis
- Data management analysis
- Data collection and analysis
PRINCIPAL INVESTIGATORS PRESENTATIONS

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

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Presentation To
APPLIED INFORMATION SYSTEMS RESEARCH WORKSHOP
July 22-24, 1991
Boulder, Colorado

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

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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.

OUTLINE OF THE TALK

OBJECTIVE
TECHNICAL APPROACH
FUNDAMENTAL PHYSICAL CHARACTERISTICS
IMPORTANCE
PROGRESS SUMMARY
FUTURE RESEARCH WORK PLAN

IMPORTANCE 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 photorefractive crystals and the 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 photorefractive 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 switchable 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)

- Completed a simplified model for the dynamic beam fanning phenomenon via inhomogeneous scattering centers in photorefractive crystals.
- Developed collaborative analysis activities with JPL colleagues including J. Jelina, W. Tal, W. Fang, and Prof. K. Hwang of USC.
- Found interrelationship and areas of potential applications of the system in data format standardization program of NASA.
- Investigated basic nonlinear associative retrieval processing that included the terminal attractor based Hopfield model in the aspects of the data format and optical implementation challenges.

PROGRESS SUMMARY (Fy91 Accomplishments) (Continued)

- Investigated hardware issues including key holographic optical elements and new electronically addressed spatial light modulators.
- 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.
- H. K. Lin
  (1) 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 RADER signal processing. The technique may be important to NASA's SETI program.

PROGRESS SUMMARY (Fy91 Accomplishments) (Continued)

- A U.S. patent No. 5,001,524 entitled "Method and Apparatus for Second-Order Fermion Generation" was received. This invention is useful for the generation of second-order 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 that used in the current NASA RTOP work. The invention is useful to the current project.
- H. 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, Germany, 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 BnTiO, and KNbO3 on their capability of bifocusing 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)
NOTES:

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Scientific Research and Development
Atmospheric Science Group
Computational Environment and Application Development
Visualization Development Group

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
To develop comprehensive computational research environments through the use of evolving software technology

NCSA Goal
COMPUTATIONAL RESEARCH ENVIRONMENT

Base criteria
Interactive
Visual
Distributed
Extensible
Vendor supported

Silicon Graphic's "Explorer" Software
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PRINCIPAL INVESTIGATORS PRESENTATIONS

COLORADO CENTER FOR ASTRODYNAMICS RESEARCH (CCAR)

William Emery, P.L.
Univ. of Colorado
Boulder, CO
(303) 492-8591
EOSDIS TESTBED: AN AVHRR DATA SYSTEM
FOR SNOWPACK AND VEGETATION STUDIES

BILL EMMER, 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 STORAGE
3. MAKE DATA AVAILABLE TO RESEARCH USER COMMUNITY ON OR
   OFFLINE AS REQUIRED
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.)

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OF POOR QUALITY
SATELLITE DATA PROCESSING SOFTWARE
AT CU/CCAR

1. SHO: A generic image processing program that runs on SUN workstations under SUNTOOLS/SUNVIEW (also on DEC 310)
2. DECSHO: A version of SHO that runs on DECWINDOWS
3. MOTOFSHO: 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

ANEMIC 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 (sea 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

SSM/I 4-dwmk water vapor mapping for Arctic ice cover and Arctic ice concentration mapping for coastal ice front from sequential images

Display of wet snow

Vegetation mapping with the normalized difference veg index and relationships to crop production

MAP滨州 Sleeves CURRENT FROM SEQUENTIAL SST IMAGES CONVOLVE SMOKE IMAGES WITH GEOSAT ALT DATA

INHIBITION IMAGING 3-SR MAP ARCTIC ICE

T1 CONNECTION TO NEAR
(TS 04, 99)

Satellite Data Connections

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NCAR Mass Storage Systems (MSS)

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

Mass Storage System Hierarchy

Remote Access

Wide Area Network Connections at NCAR

- Control Path
- Disk Farm 120 GBytes 10 sec access
- STK 4400 ACS 6K cartridges About 1 minute access
- Open Shelves 81K cartridges 2-10 minute access

- Y-MP8/64 UNICOS
- Fastpath

- Front-end Computer
- Shavano Divisional Computer

- Blai-Up Access
- Including 400 Numbers

- Gateway Computers

- NSFNET/Internet
- BITNET
- NASA SN
- NASA SPAN
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 online: 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

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Pasadena, CA  
(818) 354-1887

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

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 large data sets?
ii) How do I assess its information content?
iii) How do I find the optimum combinations of data to study changes in a given biogeochemical parameter?
iv) How do I visualize the results?
v) How do I validate my models using in-situ measurements in 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 ForestResources 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 format, 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.

SCHEDULE

Task | Completion Date
--- | ---
1. Install VICARS 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
   - Data from other sensors
   - Ground Truth Data
   - Simulated Radar data | 9/91
   | 10/91
   | 10/91
   | 11/91
4. Integration of GIS and Specialized Image Processing S/W (JPL, VEXCEL)
   - Identify required S/W
   - Install on SPARC
   - Set up GIS and Image Processing S/W interfaces
   - Integrate | 3/91
   | 5/91
   | 7/91
5. Development of New Algorithms (JPL, UCSB)
   - Distance Measures
   - Multi-dimensional Classification Algorithms | 5/91
   | 7
6. Data analysis for case study (JPL, UCSB)
   - Extract radar parameters from data
   - Cross-correlation data sets
   - Principal Components analysis
   - Produce Classification Maps
   - Determine sensitivity of radar parameters
   - Validate radar models
   - Optimize visualization approach
   - Write reports/journal paper on results | 12/91
   | 1/92
   | 2/92
   | 3/92
   | 4/92
   | 5/92
   | 6/92
   | 8/92
<table>
<thead>
<tr>
<th>Task</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Preparation for Case Study 1</td>
<td></td>
</tr>
<tr>
<td>SAR data geoencoding (Vexcal)</td>
<td>07/92</td>
</tr>
<tr>
<td>AVORS data (JPL)</td>
<td>08/92</td>
</tr>
<tr>
<td>Ground Truth data formatting (JPL)</td>
<td>09/92</td>
</tr>
<tr>
<td>Simulated radar data generation (UCSB)</td>
<td>09/92</td>
</tr>
<tr>
<td>Data Entry (Case Study 2) (JPL)</td>
<td>10/93</td>
</tr>
<tr>
<td>Data Analysis (Case Study 2) (JPL, UCSB)</td>
<td></td>
</tr>
<tr>
<td>Extract radar parameters from data</td>
<td>11/93</td>
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<tr>
<td>Cross-correlate data sets</td>
<td>12/93</td>
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<tr>
<td>Principal components analysis</td>
<td>1/93</td>
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<tr>
<td>Produce Classification maps</td>
<td>2/93</td>
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<tr>
<td>Sensitivity analysis</td>
<td>3/93</td>
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<tr>
<td>Radar model Validation</td>
<td>6/93</td>
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<tr>
<td>Optimize visualization</td>
<td>6/93</td>
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<tr>
<td>S/W Documentation (JPL, VEXCEL)</td>
<td></td>
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<tr>
<td>Write S/W Description Document</td>
<td>11/94</td>
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**DELIVERABLES:**

2. Case Study 2: Report / Journal Paper
3. S/W Description Document

**GEOGRAPHIC INFORMATION SYSTEM**

- STATUS OF UNIX VICAR/SIS 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)
      - IF 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
- DATA PREPARATION
- CASE STUDY A: BONANZA CREEK EXPERIMENTAL FOREST, AK
  - 2 SEASAT IMAGES
  - 2 SPOT IMAGES
  - 10 AIRSAR FRAMES (≈ 50 IMAGES)
  - 1 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 B: BELIZE RAINFOREST
  - 9 AIRSAR FRAMES (≈ 48 IMAGES)
  - AVIRIS DATA
  - SOME GROUND TRUTH DATA

- UCSB RADAR MODEL
- UCSB RADAR MODEL(S) ARE INSTALLED ON THE SPARCS STATION AT JPL
- MODELS WERE DEVELOPED FOR STUDIES OF MT. SHASTA FORESTS
- CURRENT EFFORTS ARE FOUCUSED 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

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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, ARGo, HVV) 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

- Pwave is installed on the SPARC3 station (graphics, RGB, perspectives, etc.)
- No PF with VIGAR yet
- Poltool S/W - for polarimetric radar data analysis has been installed, allows plots of polarization signatures, synthesized images of arbitrary polarizations
- No PF with VIGAR yet
- 'Light table' S/W developed by Vexcel - allows user to 'roam' through large images using mouse

POLTOOL S/W:
PRINCIPAL INVESTIGATORS PRESENTATIONS

SAVS
A SPACE DATA ANALYSIS
AND VISUALIZATION SYSTEM

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SAVS: A SPACE DATA ANALYSIS AND VISUALIZATION SYSTEM

Presented by
E. P. Szuszczywicz

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 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))

- **Implement 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.
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 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
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

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

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

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

NOTES:

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A Planetary Version of PC-McIDAS
Applied Information Systems Workshop

Sanjay S. Limaye (UIW-Madison), Principal Investigator
J.A. Solomonvsky (UIW-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 are the OS/2 versions?

Where?
Under effort underway, progress on OS/2

What?
Initial development at SSEC, test at JPL for Galileo applications

Future: could support Mars Observer and Cassini missions

McIDAS and PC-McIDAS

NASA Computer Interactive Data Access System

An analysis tool for integration of weather data from satellites and conventional sources, hardware and software, components developed at Space Science and Engineering Center (SSEC), installed globally in operational environments. Effort began in early 1978.

HARRIS DATABASE ACCESS VERSION
384 KB memory, 54 MB peripheral disk storage
1 807/1600 tape drive
2 user image display terminals
used during Mariner 10 Venus fly-by

HARRIS 78 NETWORK VERSION
2 Database Managers and 6 Applications Computers
768 KB core memory on each
16 GB peripheral storage on "VMM" and "DAM"
50 MB peripheral storage on each "VMM" or "DAM"
2 807/1600 tape drives
2 807/1600 tape drives
2 7200 tape drives
2 display terminals on each, and as well as Remote
- only during the Voyager fly-bys of Jupiter and Saturn

IBM PC/XT: 16 MB
32 MB real memory, 74 peripheral storage
1 807/1600 tape drive
1 7200 tape drive
8 communication support
15 terminals globally
- used during Voyager and Galileo Jupiter encounters

Intel Workstations
- Intel 80386 based "dumb" terminals
- used on the Harris versions
- Analog disk and digital cam display memory

McIDAS-OS/2 Version - first "smart" terminal
- Dual mode operation: local mode and host mode
- Digital liquid crystal display memory

McIDAS-OS/2 Version - first multitasking implementation
- VMEbus support for local display
- used during the Voyager fly-bys
- portable for field work

Wide Workstation (WOS) support
- Additional liquid crystal display memory
- 16 bit display memory
- dual channel video support

McIDAS-AIR Version - X-Windows support

McIDAS Hardware Developed at SSEC

Satellite Data Ingestion
Word Workstation
Digital Cassette Archive for GOES Data

Real Time Data Available on McIDAS

GOES satellite images 24 hours/day
GEOSAT visible and infrared images
Nimbus-10 solar orbiter (NOA) or "SO" data (NRL, SSEC)
NOAA-11 solar orbiter (NOA) or "SO" data (NRL, SSEC)
GPS Infrared Full Disk imagery (8 resolution)
- several core summaries
- West coast - Atlantic - East coast
- Europe - longitude
- Europe - longitude
- South America - west
- "faceted" product

PC and IBM America moth - "octopus" product.
McIDAS Installed Base

Mainframe Facilities Installed At:
- NASA/MSFC facilities (KSC, JSC, MSC, WAB) for shuttle operations
- NOAA (HMC, MSC, WAB)
- Private Companies (Federal Express, MHT)
- Universities (FSU, UC-Chico)
- Weather Services Facilities in Spain, China, Australia, ECMWF

Remote Workstations
- SUN-ALBANY
- UW-Milwaukee
- Valinda PC-McIDAS at 500 atmospheric science departments at colleges and universities

Planetary PC-McIDAS

- MANY DIFFERENT KINDS OF DATA AND SPACECRAFT CABLES
- NATURE OF ANALYSIS DIFFERENT FROM OPERATIONAL WEATHER SATELLITE DATA
- DIFFERENT RESEARCH GOALS AND DISCIPLINES
- A NOT A SOLUTION FOR ALL PLANETARY DATA
- BASED ON THE CORE McIDAS APPLICATIONS AND UTILITIES
- DIFFERENCES BETWEEN McIDAS AND OTHER SIMILAR SYSTEMS
COMPARISON OF MCIDAS AND VICAR

- Different Operating Environments
- Multitasking vs. Single Application Mode
- Multiframe vs. Single Frame Display
- Differences in Handling of User Files (Native Operating System vs. MCIDAS Operating Environment)
- User Applications Typically Built Modular Rather Than Monolithic
- User Programmable Chaining of Operations ("Macros")
- User Application "Profiling" for Application Program Inputs
- Different System Architecture Philosophies
- Simplified File Structure ("SU" Files)
- Grided Data Structure ("GRID" Files)
- Schema Data Structure ("MO" Files)
- Unified Single Data Navigation Access
PRINCIPAL INVESTIGATORS PRESENTATIONS

INTERACTIVE INTERFACE TO NCAR GRAPHICS

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Boulder, CO
(303) 497-1224
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 plotting
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, spg, khron, IDL, ...
- Distribution and support

Overview of NCAR Interactive

User Interface and CDL Interpreter

- GUI
- CDL Interpreter
- NCAR Graphics
- Metatile

Stand Alone CDL Interpreter

- ASCII Editor
- CDL Interpreter
- Metatile

Stand Alone Dotmap Interface

- Data file
- CDL Interpreter
- Metatile

Stand Alone Utilities

- Data file
- CDL Interpreter
- Metatile

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

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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. Scientists, 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 given "view
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 project 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)

Charles Vermillion/P.I.
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.
PRINCIPAL INVESTIGATORS PRESENTATIONS

INTRODUCTION TO CADET CENTER FOR ADVANCED DATA EVALUATION TECHNOLOGY

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

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

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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

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D-95
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.

ELEMENTS OF THE MODELLING PROCESS

- Developing a model from data
  - numerical analysis
  - Bayesian estimation
  - neural network learning
- Applying a model
  - expectations vs. observations—prediction
  - novelty detection—Δ, change
- Developing algorithms
  - mapping to computer architectures
  - optimizing performance

KEY CADET FOCUS:
Translating Data Into Usable Form

- Sensors
- Raw numeric data
- Chunking
- Labelling
- Connecting to existing knowledge bases
- Interpolation
- Prediction
- Visualization
- Human interpretation

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.
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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. Lippard

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.

- Goal

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