The Third Annual NASA Science Internet User Working Group Conference

Edited by
Brian S. Lev
Hughes STX Corporation
Lanham, Maryland

J. Patrick Gary
NASA Goddard Space Flight Center
Greenbelt, Maryland

Proceedings of a conference sponsored by the National Aeronautics and Space Administration and held in Greenbelt, Maryland March 30–April 3, 1992
Acknowledgements

We gratefully thank all the people who contributed to the success of the third annual NSIUWG Conference: the NSI user community, invited speakers and exhibitors, and project staff. In particular, we thank Anthony Villasenor, NSI Program Manager, and Christine Falsetti, NSI Project Manager, for their sponsorship of the conference, and Chairperson Dr. Ron Zwickl and the Subgroup Chairpersons for their excellent leadership. Thanks also to Lenore Jackson for her conference logistics planning and to those at Goddard Space Flight Center who contributed to the production of these proceedings.

Brian Lev
J. Patrick Gary
Editors
# TABLE OF CONTENTS

I. Conference Agenda ................................................................. 1

II. Meeting Summaries ............................................................... 11

   NSI User Working Group Conference Overview ....................... 13
   NSIUWG Organization Subgroup Summary ................................. 15
   Networking Subgroup Summary ............................................... 16
   User Services Subgroup Summary ........................................... 17

III. Presentation Material .......................................................... 19

   A. Opening Plenary ............................................................... 21
       NSI Program Update ....................................................... 23
       NSI Project Update ....................................................... 35
       NSI Planning Office Status Report ................................... 53
       NSI Engineering Status Report ....................................... 63
       NSI User Support Objectives and Recent Accomplishments ..... 67
       NSI Security Update ..................................................... 73

   B. NSI User Projects Plenary ................................................ 79
       UARS Project Update ..................................................... 81
       Galileo: The Second Earth Encounter ................................ 93

   C. Network Information/User Services Plenary ......................... 123
       Internet Information Servers ......................................... 125
       X.500 White Pages Service ............................................ 141

   D. Network Communications Technology Plenary ..................... 173
       Internet Forecast ........................................................ 175
       NASA & NREN ........................................................... 187

   E. Network Applications Technology Plenary ........................ 207
       Distributed Visualization .............................................. 209
       TAE Plus ............................................................... 231
<table>
<thead>
<tr>
<th>Section</th>
<th>Presentation Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.</td>
<td>User Services and Applications Subgroup Presentations</td>
<td>257</td>
</tr>
<tr>
<td></td>
<td>User Services Planning In the Internet</td>
<td>259</td>
</tr>
<tr>
<td></td>
<td>The Internet Cruise</td>
<td>277</td>
</tr>
<tr>
<td></td>
<td>Requirements Processing Update</td>
<td>279</td>
</tr>
<tr>
<td></td>
<td>The NSI NIC Help Desk</td>
<td>293</td>
</tr>
<tr>
<td></td>
<td>NSI NIC Services/Future Possibilities</td>
<td>303</td>
</tr>
<tr>
<td></td>
<td>CRUSH: The NSI Data Compression Utility</td>
<td>305</td>
</tr>
<tr>
<td>G.</td>
<td>Networking Subgroup Presentations</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>The Program Support Communications Network</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>DECnet Phase V Update</td>
<td>319</td>
</tr>
<tr>
<td></td>
<td>NASA DECnet/OSI Phase V Activities</td>
<td>329</td>
</tr>
<tr>
<td></td>
<td>NSI Technical Update</td>
<td>347</td>
</tr>
<tr>
<td></td>
<td>NASA's DECdns Nameserver</td>
<td>373</td>
</tr>
<tr>
<td>H.</td>
<td>Tutorials</td>
<td>375</td>
</tr>
<tr>
<td></td>
<td>NSI Online Network Aide (NONA)</td>
<td>377</td>
</tr>
<tr>
<td></td>
<td>X.500 and QUIPU</td>
<td>385</td>
</tr>
<tr>
<td></td>
<td>VMS System Security</td>
<td>403</td>
</tr>
<tr>
<td></td>
<td>UNIX System Security</td>
<td>425</td>
</tr>
<tr>
<td></td>
<td>Electronic Mail</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td>Technical Introduction to TCP/IP</td>
<td>483</td>
</tr>
</tbody>
</table>

IV. Exhibit Summaries .......... 485
I. Conference Agenda
Third Annual NSIUWG Conference
NSI Networking in the Nineties
March 30 - April 3, 1992

Schedule of Events
(Subject to change)

MONDAY, March 30
5:00 - 7:00 Registration and No-Host Reception
7:00 - 8:30 Executive Planning Meeting

TUESDAY, March 31
Opening Plenary
8:30 - 8:45 Opening Session
   R. Zwickl/NOAA-ERL
8:45 - 9:15 NSI Program Update
   A. Villasenor/NASA HQ
9:15 - 9:45 NSI Project Update
   C. Falsetti/ARC
9:45 - 10:00 BREAK
10:00 - 12:00 NSI Panel: Highlights, Status of Previous Findings, Current Issues
   John Martin, SNP/Sterling
   Milo Medin, NSI Engineering/ARC
   J. Patrick Gary, NSI User Services & Applications/GSFC
   Ron Tencati, NSI Security/Hughes STX
12:00 - 1:30 LUNCH
1:30 - 2:30 Plenary: Subgroup Agenda Review
2:30 - 5:30 Subgroup Meetings
   • Networking
   • User Services/Applications
   • NSIUWG Organization
5:30 - 6:00 Executive Committee Meeting

Exhibit Area open from 10:00 to 5:00
NSI Networking in the Nineties

SCHEDULE OF EVENTS

WEDNESDAY, April 1

8:30 - 8:45  Subgroup Update (in plenary)

Science Networking Keynotes

8:45 - 9:30  UARS Project
             D. DeVito/GSFC

9:30 - 10:15  MARS Observer Project

10:15 - 10:45  BREAK

Network Information / User Services Plenary

10:45 - 11:30  Internet Information Servers
               Joyce Reynolds/ISI

11:30 - 12:15  X.500 White Page Service
               Peter Yee/ARC

12:15 - 1:30  LUNCH (No Host)

1:30 - 2:00  Possible Plenary Session

Subgroup Meetings

2:30 - 5:00  Parallel Subgroup Meetings
             • Networking
             • User Services/Applications
             • NSIUWG Organization

3:00-3:15  (Break)

7:00 - 10:00  GROUP DINNER (No Host)

Exhibit Area open from 8:00 to 5:00
NSI Networking in the Nineties

SCHEDULE OF EVENTS

Thursday, April 2

8:30 - 8:45   Subgroup Update (in plenary)

Network Communications Technology Plenary

8:45 - 9:30   Internet Forecast
              Vinto Cerf/CNRI

9:30 - 10:15  NASA NREN
              Milo Medin/ARC

10:15 - 10:45 BREAK

Network Applications Technology Plenary

10:45 - 11:30 Distributed Visualization
         Horace Mitchell/GSFC

11:30 - 12:15 TAE
              Marti Szczer/GSFC

12:15 - 12:30 Overview of Tutorials and Demos

12:30 - 2:00  LUNCH (No Host)

2:00 - 5:00   Exhibits (in parallel with tutorials) Tutorials (in parallel with exhibits)

EOS DAAC NCDC & PLDS
NCCS Visualization
NSI NOC & NIC
NSSDC Master Directory
TAE
TGV
X.500 White Pages

On-Line Info Servers (NONA, Archie, etc.)
NIC staff

Host Security (VMS & UNIX)
Ron Tencati/Hughes STX

Introduction to TCP/IP
John McMahon/TGV, Inc.

Exhibit Area open from 8:00 to 5:00
NSI Networking in the Nineties

SCHEDULE OF EVENTS

Friday, April 3

Closing Plenary

8:30 - 12:00  Subgroup Summaries
              • NSIUWG Organization
                Linda Porter/MSFC

              • User Services/Applications
                Neil Cline/JPL

              • NSIUWG Organization
                Ron Zwickl/NOAA-ERL

12:00        Adjourn

1:30          Tour of GSFC

Exhibit Area open from 8:00 to 12:00
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00</td>
<td>Registration</td>
<td>Registration</td>
<td>Continental Breakfast</td>
<td>Continental Breakfast</td>
<td>Continental Breakfast</td>
</tr>
<tr>
<td>8:30</td>
<td>Opening Plenary</td>
<td>NSI User Project Plenary</td>
<td>Network Communications Technology Plenary</td>
<td>Closing Plenary</td>
<td>Closing Plenary</td>
</tr>
<tr>
<td></td>
<td>- Welcome</td>
<td>- NSI Program Updates</td>
<td>- Network Information User Services Plenary</td>
<td>- Subgroup Summaries</td>
<td>- Subgroup Summaries</td>
</tr>
<tr>
<td></td>
<td>- NSI Project Updates</td>
<td></td>
<td>- Network Applications Technology Plenary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td>Lunch (no host)</td>
<td>Lunch (no host)</td>
<td>Lunch (no host)</td>
<td>Lunch (no host)</td>
<td>Lunch (no host)</td>
</tr>
<tr>
<td>1:30</td>
<td>Parallel Subgroup Meetings &amp; Exhibits</td>
<td>Parallel Subgroup Meetings &amp; Exhibits</td>
<td>Parallel Subgroup Meetings &amp; Exhibits</td>
<td>Parallel Tutorials &amp; Exhibits</td>
<td>Parallel Tutorials &amp; Exhibits</td>
</tr>
<tr>
<td>5:00</td>
<td>Registration &amp; Reception (No Host)</td>
<td></td>
<td></td>
<td>Group Dinner (No Host)</td>
<td></td>
</tr>
<tr>
<td>7:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tour of GSFC</td>
</tr>
</tbody>
</table>

Note: Exhibits will remain open until 2:00 p.m.
## PLENARY SESSIONS OF THE THIRD ANNUAL NSIUWG

<table>
<thead>
<tr>
<th>Time</th>
<th>Tuesday, March 31</th>
<th>Wednesday, April 1</th>
<th>Thursday, April 2</th>
<th>Friday, April 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30</td>
<td><strong>Opening Plenary</strong></td>
<td><strong>NSI User Projects</strong></td>
<td><strong>Network Communications Technology</strong></td>
<td><strong>Closing Plenary</strong></td>
</tr>
<tr>
<td></td>
<td>・ Welcome</td>
<td>・ UARS</td>
<td>・ Internet Forecast</td>
<td>・ Networking Subgroup</td>
</tr>
<tr>
<td></td>
<td>〜<em>Ron Zwickl /NOAA-ERL</em></td>
<td>〜<em>Danny Devito/GSFC</em></td>
<td>〜<em>Vinton Cerf/CNRI</em></td>
<td>〜<em>Linda Porter/MSFC</em></td>
</tr>
<tr>
<td></td>
<td>・ NSI Program Updates</td>
<td>・ Mars Observer</td>
<td>・ NASA NREN</td>
<td>・ User Services/</td>
</tr>
<tr>
<td></td>
<td>〜<em>Tony Villasenor/ NASA HQ</em></td>
<td></td>
<td>〜<em>Milo Medin/ARC</em></td>
<td>Applications Subgroup</td>
</tr>
<tr>
<td></td>
<td>・ NSI Project Update and Overview</td>
<td></td>
<td></td>
<td>〜<em>Neil Cline/JPL</em></td>
</tr>
<tr>
<td></td>
<td>〜<em>Christine Falsetti/ARC</em></td>
<td></td>
<td></td>
<td>・ NSIUWG Organization</td>
</tr>
<tr>
<td></td>
<td>〜<em>Milo Medin/ARC</em></td>
<td></td>
<td></td>
<td>Subgroup</td>
</tr>
<tr>
<td></td>
<td>〜<em>John Martin/Sterling</em></td>
<td></td>
<td></td>
<td>〜<em>Ron Zwickl/NOAA-ERL</em></td>
</tr>
<tr>
<td></td>
<td>〜<em>Pat Gary/GSFC</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>〜<em>Ron Tencati/Hughes STX</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:15</td>
<td>Lunch (No Host)</td>
<td>Lunch (No Host)</td>
<td>Lunch (No Host)</td>
<td></td>
</tr>
<tr>
<td>1:30</td>
<td><strong>Plenary Session</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>・ Subgroup Agenda Review</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## PARALLEL SUBGROUP MEETINGS OF THE THIRD ANNUAL NSIUWG

### Room A

**2:30 Networking**  
*Tentative Agenda:*  
- NSI network update (technical status report)  
- network architecture  
- protocol summaries  
- protocol encapsulation update  
- network management tools used by the NOC  
- NSI futures  
- Frame relay?  
- XTP?  
- OSPF "type of service" routing?  
- other futures

**Information/User Services**  
*Tentative Agenda:*  
- Welcome  
- NSIUWG Direction  
- User Services on the Internet  
- Internet Cruise  
- NSI NIC Organization and Functions

**NSIUWG Organization**  
*Tentative Agenda:*  
- NSIUWG direction  
- Other TBD

**Break**  
3:00-3:15

**5:00 Networking**  
*Tentative Agenda:*  
- DECnet and OSI in the NSI  
- What has NASA/NSI done since last meeting?  
- NSI and the HEP-SPAN DECnet Coordination Group  
- Implementation of Phase V/OSI in ESnet-DECnet  
- DECdns naming plans and current implementation  
- NSI plans for support of CLNP  
- Question & Answer

**User Services/Applications**  
*Tentative Agenda:*  
- Summary of Tuesday's Discussion  
- NSI NIC Help Desk: What It Does; How It Can Help You  
- Procedures for Providing Network Connectivity  
- Open Discussion  
- NSI NIC Possibilities  
- Info Tools on the Internet  
- User Concerns  
- Feedback on Subgroup

**Applications**  
*Tentative Agenda:*  
- Crush  
- Scientific Visualization

### Room B

**Room C**

#### Wednesday, April 15, 1992

**Networking**  
*Tentative Agenda:*  
- DECnet and OSI in the NSI  
- What has NASA/NSI done since last meeting?  
- NSI and the HEP-SPAN DECnet Coordination Group  
- Implementation of Phase V/OSI in ESnet-DECnet  
- DECdns naming plans and current implementation  
- NSI plans for support of CLNP  
- Question & Answer

**User Services/Applications**  
*Tentative Agenda:*  
- Summary of Tuesday's Discussion  
- NSI NIC Help Desk: What It Does; How It Can Help You  
- Procedures for Providing Network Connectivity  
- Open Discussion  
- NSI NIC Possibilities  
- Info Tools on the Internet  
- User Concerns  
- Feedback on Subgroup

**Applications**  
*Tentative Agenda:*  
- Crush  
- Scientific Visualization
# TUTORIAL SESSIONS OF THE THIRD ANNUAL NSIUWG

<table>
<thead>
<tr>
<th>Room A</th>
<th>Room B</th>
<th>Room C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1:30</strong>&lt;br&gt;<strong>Using X.500 Services</strong>&lt;br&gt;<em>Peter Yee/ARC</em>&lt;br&gt;• X.500 Directory Services Overview&lt;br&gt;• Applications for White Pages&lt;br&gt;• Use of X.500 in NASA&lt;br&gt;• Directory User Agent Software&lt;br&gt;• Future of X.500 in NASA</td>
<td><strong>Introduction to TCP/IP</strong>&lt;br&gt;<em>John McMahon/TGV</em>&lt;br&gt;To Be Announced</td>
<td><strong>Security, Emphasizing VMS</strong>&lt;br&gt;<em>Ron Tencall/Hughes STX</em>&lt;br&gt;• Vulnerabilities&lt;br&gt;• Current Hacker Threats&lt;br&gt;• Configuration Parameters&lt;br&gt;• Object-Level Security Methods&lt;br&gt;• Audit Trails and Tools&lt;br&gt;• Incident Handling and Reporting</td>
</tr>
<tr>
<td><strong>3:00</strong>&lt;br&gt;<strong>Break</strong></td>
<td><strong>Break</strong></td>
<td><strong>Break</strong></td>
</tr>
<tr>
<td><strong>3:30</strong>&lt;br&gt;<strong>Using NSI NIC Services</strong>&lt;br&gt;<em>David Stern/Hughes STX&lt;br&gt;Brian Lev/Hughes STX</em>&lt;br&gt;• Finding Email Addresses on Different Networks&lt;br&gt;• NONA, an Online Networking into Source&lt;br&gt;• NSI File Cabinet, an FTP/DECnet Site&lt;br&gt;• NSI_DB, an Online DECnet Node Info Source</td>
<td><strong>Introduction to TCP/IP</strong>&lt;br&gt;<em>John McMahon/TGV</em>&lt;br&gt;(Repeat of Above)</td>
<td><strong>Security, Emphasizing UNIX</strong>&lt;br&gt;<em>Eugene Schultz/Lawrence Livermore National Labs</em>&lt;br&gt;• Overview&lt;br&gt;• Password Management&lt;br&gt;• File Protection&lt;br&gt;• System Configuration&lt;br&gt;• Vulnerabilities&lt;br&gt;• Recommended Strategies</td>
</tr>
<tr>
<td><strong>5:00</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
II. Meeting Summaries
NSI User Working Group Conference Overview

On March 30 through April 3 approximately 130 NSI users attended the Third Annual NASA Science Internet (NSI) Users Working Group (NSIUWG) Conference at the Marriott Hotel in Greenbelt, Maryland to learn more about NSI, hear from projects which use NSI, and receive updates about new networking technologies and services. The NSIUWG Conference was sponsored by the NSI User Support Office, which is managed by the GSFC Science Network Office/Code 930.6, and was coordinated by Lenore Jackson of the NSI USO.

The plenary sessions gave listeners the opportunity to hear from a variety of invited speakers. These included NSI project management, scientists and NSI user project managers whose projects and applications effectively use NSI, and notable citizens of the larger Internet community, such as Joyce Reynolds of the University of Southern California Information Sciences Institute, Dr. Vinton Cerf of the Center for National Research Initiatives, and Laura Kelleher of Merit Network, Inc. User subgroups were Networking, chaired by Linda Porter of Marshall Space Flight Center, User Services & Applications, chaired by Dr. Neal Cline of the Jet Propulsion Lab, and NSIUWG Organization, chaired by Dr. Ron Zwickl of the National Oceanographic and Atmospheric Administration. One afternoon offered well-attended tutorials covering the implementation and use of X.500 services, an introduction to TCP/IP, using NSI Network Information Center services, and network-oriented security for both VMS and UNIX operating systems. Several NASA projects also held demonstrations in the Exhibit Area which was interconnected with the NSI at 1.5 Mbps throughout the week.

The NSIUWG Organization Subgroup proposed a number of changes for next year's meeting. For example, because the users wanted the sense of the conference to be understood less as a working group and more as an information exchange, the name next year will change to the NSI Users Forum. This reflects the evolving nature of the conference as a forum for dialog among network users, NSI project personnel, and representatives of various online resources. The Organization Subgroup having completed its job, planning for next year's meeting will begin with only the Networking and User Services subgroups, although others will be added as emerging interests demand. An updated mailing list and improved means of announcing the annual meeting were also recommended.
Some of the elements of the conference which users suggested not be changed were convening annually in March, rotating to sites alternately on the East and West Coasts, retaining the subgroups as an integral part of the meeting, and including presentations by speakers from outside NSI and even outside NASA.

The USO wishes to thank all of the presenters, tutorial instructors, exhibitors, and NSI user attendees who participated in making this NSIUWG Conference a success. The project and all its users thank Dr. Ron Zwickl, Conference Chair, and Linda Porter, Network Subgroup Chair, for their years of service. Both are stepping down this year.

**Plenary Presenters:**

Mr. Jeffrey Burgan, Sterling (NSI)
Dr. Vinton Cerf, CNRI
Dr. Theodore Clarke, JPL (Galileo)
Mr. Daniel DeVito, GSFC (UARS)
Ms. Christine Falsetti, ARC (NSI)
Mr. J. Patrick Gary, GSFC (NSI)
Mr. John Martin, Sterling (NSI)
Dr. Horace Mitchell, GSFC (NCCS)
Ms. Joyce Reynolds, ISI
Ms. Marti Szczur, GSFC (TAE)
Mr. Ron Tencati, Hughes STX (NSI)
Mr. Anthony Villasenor, NASA HQ (NSI)
Mr. Peter Yee, ARC (ISODE)
Dr. Ron Zwickl, NOAA/ERL

**Subgroup Presenters:**

Dr. Randy Barth, Hughes STX (NSI)
Mr. Jeffrey Burgan, Sterling (NSI)
Mr. Todd Butler, RMS/GSFC
Mr. Phil DeMar, FNAL/DOE
Mr. J. Patrick Gary, GSFC (NSI)
Ms. Laura Kelleher, Merit
Mr. Brian Lev, Hughes STX (NSI)
Mr. John Martin, Sterling (NSI)
Dr. Alan McConnell, Pixel Analysis/GSFC
Mr. John McMahon, TGV
NSIUWG
Organization Subgroup

Findings:

1. Name needs to be changed to NSI Users Forum

2. Continue annual meeting, retain March time frame

3. Meeting site will vary
   - Retain East/West rotation
   - Can hold meetings at other sites

4. Subgroups are a necessary part of annual meeting format
   - Do not want a seminar format
   - New Subgroups will be formed as needed
   - Currently two subgroups: Networking, User Services

5. Need updated, more complete mailing list
   - Announce annual meeting

6. Continue to have presentations from outside of NSI

7. Support National Meetings
   - Could have lower level of support, such as local dial-up

8. Regional User meetings be held during National Meetings
NSIUWG Network Subgroup Meeting Summary
March 31- April 1, 1992
Linda Porter/ Subgroup Chairman

Anywhere from 20 to 50 people attended the network subgroup during the two afternoon meeting days. During the two days, various speakers provided much technical information on NSI. Discussions were limited to questions and answers. No formal findings were established, however several requests were made:

Day 1:

- One or more postscript maps of the network with IP addresses and DECnet addresses should be made available. The "network" in this case is the NSI backbone and directly connected NSI sites over
  a) Proteon or DEC h/w
  b) encapsulated (logical DECnet connectivity only)

  The idea is to be able to look at a map and visually trace one's way through the network under either TCP/IP or DECnet. These maps should be made available on the NSINIC and kept up-to-date.

- Ability to traceroute DEC paths through NSI (similar to ESnet/DECnet capability) The current problems (lack of support) with the NSI provided Proteon routers is understood, however it was noted that in a few months Proteon would be supporting both a nonprivileged access mode and SNMP MIB for DECnet functions. Both tools would be invaluable to the network community, and NSI is requested to keep the community apprised of new developments.

Day 2:

- There is a mail exploder for DECnet to OSI transition set up for DECnet PV/OSI information. The address is

  DECNET-OSI-TRANSITION@NSIPO.NASA.GOV

  to be placed on this list, send a request to the address:

  DECNET-OSI-TRANSITION-REQUEST@NSIPO.NASA.GOV

- A request was made to create a Usenet News Group for NSI DECnet to OSI information.

- Some significant issues were raised with the DECnet VMS/OSI product scheduled for release in the summer timeframe. The VMS product will not fully support full (hierarchical, DECdns) names at first customer ship (FCS). Primary concern is lack of support for RMS. SET HOST and MAIL however, will be supported. Users were asked to make their concerns known to their local Digital offices, if they felt this was a problem in implementing the product as a result. Also, mail can be sent to SEGREST@DC101.DCO.DEC.COM (Robert Segrest, DEC Network Strategic Coordinator for DOE/NASA).
NSIUWG '92
User Services Subgroup
(A) Follow-up On Last Year's Meeting

• Network Requirements Processing
  - no customer problems reported
  - further improvements in planning and processing reported

• User Help Desk
  - implemented by USO as outlined last year
  - network support problem at JSC noted last year appears to have been solved

NSIUWG '92
User Services Subgroup
(A) Follow-up On Last Year's Meeting
(Continued)

• The NSI NIC
  - operational as advertised last year
  - menu-driven system (NONA) demonstrated
  - user requirements still needed
  - USENET feed being provided as needed; demand for USENET newsgroup not established
  - X.500 involvement by NSI demonstrated

• Conference Support
  - plans and schedule for FY 92 shown
  - formal process for authorization established
NSIUWG '92
User Services Subgroup
(B) Findings

(1) NSI User Services need to be advertised in
media read by NASA scientists.

(2) E-mail distribution services need to be made
available to NSI customers.

(3) There is considerable user demand for
on-line availability of network maps, statistics,
and performance information.

(4) E-mail user comments, concerns, etc... should
be solicited prior to the next NSIUWG

(5) X.500 pilot support should be continued

(6) User Support Office and Planning Office has
assembled exceptionally dedicated & talented
teams; NASA should make sure they are
maintained
III. Presentation Material
A. Opening Plenary
NSI Program Update
Information Systems: an Integrated Approach

... for Today's Research Environment!
NSI Acceptable Use Guidelines

SUMMARY:
NSI supports all NASA science flight missions, discipline research programs, and collaborating scientists at NASA Centers and elsewhere.

NSI is not to be used for private gain or profit.

SPECIFIC USES:
1) Use of NSI must be in support of official NASA programs; all user requests for NSI connectivity must be validated and supported by cognizant OSSA Discipline Chiefs.
2) Use of NSI to support coordination and administrative execution of OSSA research grants is permissible;
3) Use of NSI to support NASA research, related training, and associated technical activities at non-profit institutions of research and education is acceptable.
4) Use of NSI for commercial or intellectual gain by for-profit organizations is not acceptable, unless those organizations are using NSI to satisfy specific NASA contract or grant requirements.
5) Use of NSI for research or education at for-profit institutions will be reviewed on a case-by-case basis to ensure consistency with OSSA programs; lack of program approval will result in disconnection.
6) Use of NSI to gain unauthorized use of resources attached to NSI will result in disconnection and legal prosecution. NSI will make every attempt to implement precautions to safeguard against unauthorized use of NASA computers, databases, and other attached federal resources.

NSI Grades of Service

BASIC SERVICE
- Required connectivity to data archives, computational facilities, and collaborators worldwide; up to 56kbpas
- Reliable communications monitored continuously (24 x 7), including automatic fault detection procedures initiated within minutes of occurrence.
- Full interoperability with science and research communities via NSFnet, ESnet, and other INTERNET networks in the U.S. and abroad; also interoperable with the evolving NREN.
- Broad spectrum of network applications including electronic mail, file transfer, remote log-on, etc.
- User consultation and technical assistance through NSI "Help Desk" and network documentation.

All the above, plus:
- Dedicated private circuits between specific facilities.
- Very high performance service, T1 or greater, to end users.
- Non-standard installations and applications requiring specially engineered solutions and equipment.
- Large influx of requirements for new circuits needed for operational use within two years of current budget cycle.

NSI - NASA Science Internet
PRIORITY SCHEMA (2/20/92)

INFRASTRUCTURE

0* Provide a high quality, reliable, 24 hour per day by 7 days a week, open access network connecting all current OSSA science missions, investigators, their data archives and computational resources. Includes basic network services such as e-mail, file transfer, remote logon, Internet & Inter-Center access, security management, and basic science conference support as approved by the ISMB, etc.

MISSION SPECIFIC RESOURCES

1 Current active missions and campaigns where data is now being acquired and used for science analysis; e.g., UARS, GALILEO, KAQ, etc.

2 Near-term missions, campaigns, & research projects which will require NSI services in 6 months (circuit order time), e.g., EOS, ISTD, Balloons, etc.

3 OSSA infrastructure or science projects with management visibility: key science conferences, JOVE, Eastern Bloc access, coordination with PSCH, ICCN, NSF, GAET/ARREN, etc.

4 Long-term missions & projects: Antarctica, AXAF, etc.

5 Generic network services for space science community not directly traceable to specific project or discipline requirements: DECnet Phase V planning, performance measurement, requirements management, security, industry (IETF) collaboration, etc.

6 NSI technology enhancements, such as network applications, software/hardware upgrades, NSIUG technical forum, OSI transition planning, satellite-ground interoperation, AppleTalk encapsulation, packet radio applications, etc. In general, items that improve NSI robustness.

7 Science conferences with supplemental funding, support for external activities such as NIST testbed, etc. Items that do not effect "NSI success" as perceived by OSSA Divisions.

*0 = highest priority

NSI - NASA Science Internet

Projected Requirements Growth

Projected Requirements (with EOS)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Infrastructure</th>
<th>New Mission</th>
<th>Specific Users</th>
<th>Guideline Funding Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>1,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>93</td>
<td>2,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>94</td>
<td>3,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>95</td>
<td>4,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

NSI - NASA Science Internet
National Network Hierarchy

NSFNET

Regional Network

Corporate Net  NASA Center  Campus Net

Local Area Net  Building Net  Office Net  Value Added Network

USERS
(electronic mail, file transfer, logon, etc.)

INTERNET COMMUNITY

IAB = Oversees the engineering of the Internet

INTERNET ACTIVITIES BOARD

NSI-ENG

INTERNET ENGINEERING TASK FORCE

COMMERCIAL NETWORK & CARRIER SERVICES

AT&T, MCI, SPRINT, Regional BOC's,
IBM, DEC, Apple, Proteon, Cisco, Wellfleet,
PSI, ANS, Educom, etc.
FNC Organization

Chairman - Dr. Charles Brownstein/NSF

GSA      DARPA  NASA      NSF
DOD      NIST    HHS      DOE
USGS     DCA     NOAA     OMB
NTIA     DE      OSTP

WORKING GROUPS

RESEARCH & DEVELOPMENT
ENGINEERING & OPERATIONS
POLICY
SECURITY
EDUCATION

FNC WORKING GROUP CHAIRS

<table>
<thead>
<tr>
<th>Chairperson</th>
<th>Working Group</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Wolff</td>
<td>All Groups</td>
<td>FNC Exec Director</td>
</tr>
<tr>
<td>John Cavallini</td>
<td>Policy</td>
<td>FNC/DOE</td>
</tr>
<tr>
<td>Tony Villasenor</td>
<td>Eng &amp; Ops</td>
<td>FNC/NASA</td>
</tr>
<tr>
<td>Paul Mockapetris</td>
<td>R &amp; D</td>
<td>FNC/DARPA</td>
</tr>
<tr>
<td>TBD</td>
<td>Security</td>
<td>FNC/NIST</td>
</tr>
<tr>
<td>TBD</td>
<td>Education</td>
<td>FNC/DE</td>
</tr>
</tbody>
</table>

NSI - NASA Science Internet
MEMBERS

INITIAL MEMBERSHIP OF THE EOWG WOULD CONSIST OF BUT NOT BE LIMITED TO THE FOLLOWING, BECAUSE OF THEIR STRONG VESTED INTEREST IN THE ENGINEERING AND OPERATION OF THE INTERNET:

Tony Villasenor, NASA - Chairman
Steve Wolff, NSF - Vice Chairman
John Cavallini, DOE - Vice Chairman
Bill Bostwick, U.S./CCIRN
Paul Mockapetris, DARPA
TBD, FARNET
TBD, IAB

Note: Operations managers of key federal networks may be included as members. The EOWG will provide delegates to CCIRN meetings.

Federal Internetwork Exchange ("FIX")

An Example

[Diagram showing network connections with MPR (Multi-Protocol Router) nodes and labels for backbone and regional links.]

MPR = MULTI-PROTOCOL ROUTER
CCIRN

COORDINATING COMMITTEE FOR INTERCONTINENTAL RESEARCH NETWORKING

The purpose of the CCIRN is to agree and progress a set of activities to achieve inter-operable networking services between participating entities (currently North America and Europe) to support open research and scholarly pursuit. Policy, management, and technical issues will be examined, based on agreed requirements. More precisely, the committee aims to:

a. stimulate cooperative intercontinental research by promoting enhanced interoperable networking services, specifically
   - promoting the evolution of an open, international research network in line with official policies on the use of international standards,
   - coordinating and facilitating effective use of the international networks to enhance the quality of research and scholarship.

b. optimize use of resources and to coordinate international connections of the networks represented on the CCIRN

c. coordinate development of international network management techniques

d. exchange results of networking research and development

International Technical Coordination

CURRENT ACTIVITIES
- inter-continental link coordination and planning
- global domain name system
- uniform network statistics and monitoring
- global registration
- global routing
- national character sets
- coordination among network control centers
- CLNS Introduction
- mapping
- electronic mail interoperability & reliability

FUTURE TOPICS
- international X.400 with X.500 directory services
- international voice/video teleconferencing
- resource accessibility; authorization; control
- resource control: costing and accounting
- relevant national policy concerns

NSI - NASA Science Internet
OAST-OSSA NREN Relationships

EVOLUTION INTO THE NREN
NSI Project Update
The NASA Science Internet - NASA's Worldwide Science Communications Network

NSIUWG 1992

Christine M. Falselli
NASA Science Internet Office
Information and Communications Systems Division
AMES RESEARCH CENTER

Outline

I. Background

II. Current Services and Architecture

III. Future Directions
The NASA Science Internet

Recognizing that science communications networking is an integral element of successful science, the NASA Science Internet Office was established in 1988 to provide communications to NASA's entire science community. NSI absorbed U.S. SPAN and NSN when the program was formally established.

The NSI provides computer networking services, management and operations support, and technical assistance to authorized users throughout NASA centers and research institutions worldwide.

NSI's goal is to provide a high-speed communications network that connects all space scientists, providing ready access to data and information stored anywhere in the world.
Value-Added Services

Science Network Planning
- Systems Planning - MOU development
- Requirements management and validation
- Tracking and Status Reporting
- Conference Management

Engineering
- Network architecture configuration
- Custom design & documentation
- Network service acquisition and testing
- Development & Implementation of Security measures and tools

Network Operation
- 7-day, 24-hr. Network Operation
- Network Monitoring and Trouble Shooting
- Problem Management: reporting, alerting
- Equipment Installs, Upgrades, and Maintenance

User Support Services & Applications Development
- Coordinate Integration of OSSA Information Systems
- Network Information Center
- White/Yellow Pages directory services
- User Help Desk
- NSI User Working Group

Community Served by NSI

NSI PROVIDES SERVICE TO:

OSSA DISCIPLINES AND FLIGHT PROJECTS:
- OFS of Space Science and Applications
- SB Life Sciences
- SE Earth Sciences
- SL Solar System Exploration
- SM Flight Systems
- SN Microgravity
- SP Administration & Resource Management
- SS Space Physics
- SZ Astrophysics

Intercenter Coordinating Committee for Science Networking:
- JPL
- GSFC
- ARC
- LeRC
- LaRC

UNEP GRID
United Nations Environmental Programme
Global Research Information Facility
NSI Support of NASA Science

Life Sciences Division
- Space Life Sciences 1-4
- Cosmos
- Spacelab J

Solar System Exploration
- Voyager
- Magellan
- Galileo
- Ulysses
- Mars Observer
- CRAF/Cassini
- Pioneer

Earth Science and Applications
- Crustal Dynamics
- Upper Atmospheric Research (UARS)
- Ocean Topography (TOPEX)
- Earth Observing System (EOS)
- WETNET

Astrophysics
- Explorer Program
- Scout Program
- Supernova
- Cosmic Background Explorer
- Gamma Ray Observatory
- Hubble Space Telescope

Microgravity Science
- Materials Science Lab
- International Microgravity

Space Physics
- Dynamics Explorer
- International Cometary Explorer
- Solar Maximum Mission
- International Solar Terrestrial Physics
- Rockets and Balloons

Planning Process

"Working Together"

Contact Science Discipline

Understand and Participate in
Information Systems Planning Process
and Requirements Development

Identify and Conceptualize
Communications Architecture

Draft and Sign Discipline MOU

Transfer to Production
Manage Requirements
throughout operation

CMFalsel1 9

CMFalsel1 10

40
Outline

I. Background

II. Current Services and Architecture

III. Future Directions

NSI OSSA Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Division</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code S</td>
<td>Office of Space Science &amp; Applications</td>
<td>148</td>
</tr>
<tr>
<td>Code SB</td>
<td>Life Sciences Division</td>
<td>21</td>
</tr>
<tr>
<td>Code SE</td>
<td>Earth Science &amp; Applications Division</td>
<td>886</td>
</tr>
<tr>
<td>Code SL</td>
<td>Solar System Exploration Division</td>
<td>260</td>
</tr>
<tr>
<td>Code SM</td>
<td>Flight Systems Division</td>
<td>8</td>
</tr>
<tr>
<td>Code SN</td>
<td>Microgravity Science &amp; Applications Division</td>
<td>4</td>
</tr>
<tr>
<td>Code SP</td>
<td>Administration and Resource Mgmt Division</td>
<td>0</td>
</tr>
<tr>
<td>Code SS</td>
<td>Space Physics Division</td>
<td>158</td>
</tr>
<tr>
<td>Code SZ</td>
<td>Astrophysics Division</td>
<td>82</td>
</tr>
</tbody>
</table>

TOTAL number of OSSA requirements: 1567
NSI Acceptable Use Guidelines

SUMMARY:
NSI supports all NASA science flight missions, discipline research programs, and collaborating scientists at affiliated research institutions.

NSI is not to be used for gain or profit by non-NASA organizations engaged in non-NASA business.

SPECIFIC:
1) Use of NSI must be in support of official NASA programs; all user requests for NSI connectivity must be validated (and possibly funded) by cognizant OSSA Discipline Chiefs.

2) Use of NSI to support coordination and administrative execution of OSSA research grants is permissible;

3) Use of NSI to support NASA research, related training, and associated technical activities at non-profit institutions of research and education is acceptable.

4) Use of NSI for commercial or intellectual gain by for-profit organizations is not acceptable, unless those organizations are using NSI to satisfy specific NASA contract or grant requirements.

5) Use of NSI for research or education at for-profit institutions will be reviewed on a case-by-case basis to ensure consistency with OSSA programs; lack of program approval will result in disconnection.

6) Use of NSI to gain unauthorized use of resources attached to NSI will result in disconnection and legal prosecution. NSI will make every attempt to implement precautions to safeguard against unauthorized use of NASA computers, databases, and other attached federal resources.

** Requirement must be prioritized by the Division within NSI's ability to implement; excess requirements are delayed or funded separately.

Process to Prioritize OSSA requirements...

Identification and Initial Prioritization of OSSA Requirements

- NSI Requirements Based Budget Proposed
  - ISMB Interdisciplinary Priority Cutoff
    - SE
    - SZ
    - SS
    - SL
    - S,SP
    - SB,SN,SM

** Final Review

NSI Implementation

OSSA connectivity!
Priority Schema as of 2/20/92

INFRASTRUCTURE
0* Provide a high quality, reliable, 24 hour per day by 7 days a week, open access network connecting all current OSSA science missions, investigators, their data archives and computational resources. Includes basic network services such as e-mail, file transfer, remote logon, Internet & Inter-Center access, security management, and basic science conference support as approved by the ISMB, etc.

MISSION SPECIFIC RESOURCES
1 Current active missions and campaigns where data is now being acquired and used for science analysis; e.g., UARS, GALILEO, KAO, etc.
2 Near-term missions, campaigns, & research projects which will require NSI services in 6 months (circum order time), e.g., EOS, ISTP, Balloons, etc.
3 OSSA infrastructure or science projects with management visibility: key science conferences, JOVE, Eastern Bloc access, coordination with PSCN, ICCN, NSF, OAET/NREN, etc.
4 Long-term missions & projects: Antarctica, AXAF, etc.
5 Generic network services for space science community not directly traceable to specific project or discipline requirements: DECnet Phase V planning, performance measurement, requirements management, security, industry (IETF) collaboration, etc.
6 NSI technology enhancements, such as network applications, software/hardware upgrades, NSIUWG technical forum, OSI transition planning, satellite-ground interoperability, AppleTalk encapsulation, packet radio applications, etc. In general, items that improve NSI robustness.
7 Science conferences with supplemental funding, support for external activities such as NIST testbed, etc. Items that do not effect "PSI success" as perceived by OSSA Divisions.

*0 = highest priority

NASA Science Internet
NSI Traffic Growth

<table>
<thead>
<tr>
<th></th>
<th>Bytes/day</th>
<th>Packets/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 1991</td>
<td>8 Billion</td>
<td>38 Million</td>
</tr>
<tr>
<td>March 1992</td>
<td>20 Billion</td>
<td>110 Million</td>
</tr>
</tbody>
</table>

Note:
Average traffic increased 250%.
Average packet size - 200 bytes

NSI - NASA Science Internet
NSI Today

CONNECTIVITY
-10000 hosts & 25000 researchers worldwide - In FY91, NSI implemented an additional 205 requirements to 60 sites; by end FY92, NSI will satisfy 233 requirements to 58 new sites, thereby reaching approximately 25000 hosts and 60000 researchers worldwide.
Access to most U.S. universities & labs
Access to ~3 million users via the Internet
Most major countries in Europe & Asia

SERVICE
High reliability - NSI-NOC provides continuous 24x7 monitoring for >125 nodes; 90% of faults fixed within 30 minutes, 97% of all 'trouble tickets' detected by NSI-NOC before user knew problem existed
High performance - NSI continually upgrades bandwidths while optimizing and tuning the network performance.
Strong user support & interaction at all levels - Established strong ties with OSSA Divisions to review, justify, prioritize & track requirements. Ongoing user assistance provided by User Support Office through the NIC (24 hour online service, prime shift phone coverage, end-user documentation)
Proven technical expertise & leadership in networking - NSI provides proactive leadership in several Federal and International Networking coordination efforts such as the FNC, FEPRG, IETF, CCIRN, etc.

INTEROPERABILITY
Between TCP/IP and DECnet science networks
With universities on the Internet, NREN, Regional & Campus networks
With commercial networks: Sprint, Omnet, PSI, ANS, etc.
With key universities and research facilities in Europe, Asia, S.America, Australia, New Zealand
NSI'S RELATIONSHIP TO NASCOM

EOS Observatories

TDRSS

Space Station Freedom Attached Payloads

TDRSS Ground Terminal White Sands

NASCOM "Mission Critical"

International Partner Operations Center (IPOC)

EOS Operations Center GSFC (EOC-GSFC)

Instrument Support Terminal (IST)

Instrument Control Facility (ICF)

Information Mgmt Services (IMS) Coordination

Distributed Active Archive Center (DAAC)

System Management Center (SMC)

"Mission Essential"

NASA Science Internet "Mission Success"

Affiliated Data Center (ADC)

Science Computer Facilities (SCF)

Users

Investigators Domestic and International
NSI and the INTERNET

NSI is a major participant in the National Internet community.
NSI connectivity is extended to other sites via NSF, DOE, DARPA, and other linkages.
International connectivity is augmented by DOE, ESA, PACCOM, and DARPA networks.

BARRNet
SDSCNET
WestNet
NorthWest Net
NCAR/USAN
THEnet
MIDnet
NCSA/UIUC
NYSERNet
JVNC
SUFANet
Sesquinet

NSFnet Map

NASA Science Internet Project Office
CMFalsetti 19

Other Interconnected Networks
Internet
400,000 Host computers
3,000,000 users worldwide
NSI Challenges

Environment:
- NSI is strictly requirements driven. Networking services are in high demand as shown by explosion in OSSA requirements. As OSSA requirements grow, then more resources are needed to satisfy demand, despite NSI's leverage & economies of scale, since every site demands unique attention.
- Current network architecture is a complex, interdependent service web with federal and international network service providers.
- Emerging NREN and new ISDN broadband technologies will provide challenges of incorporation in our networking infrastructure.

Current Issues:
- Requirements are growing much faster than current NSI resources can meet; growth rate is ~400 requirements per year vs. implementation capacity of 200 per year; many FY92 requirements will be delayed to FY93 & 94. Tight FY92 budget put NSI behind the curve and it cannot catch up.
- Dependency on NSFnet as backbone supplier in FY94 uncertain. NSF plans to dismantle NSFnet on April 1994 & switch to NREN, without testbed demo. for routing & backbone mgmt. NSI needs to use PSCN backbone links to Regionals/Commercials.
- EOSnet is the most critical 'success' component of EOSDIS, as determined by NRC Review.
**NETWORK REQUIREMENTS**

Projected Requirements  
(with EOS)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Infrastructure Users</th>
<th>New Mission Users</th>
<th>Specific Users Funding Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>1,000</td>
<td>2,000</td>
<td>3,000</td>
</tr>
<tr>
<td>1993</td>
<td>2,000</td>
<td>3,000</td>
<td>4,000</td>
</tr>
<tr>
<td>1994</td>
<td>3,000</td>
<td>4,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>

**NSI Management Options**

1. Advocacy of Ossa Information Systems Budget to include NSI overguideline requests. In FY93, this would accommodate new/delayed requirements from EOSDIS, UARS, Crustal Dynamics, Mars Observer, ISTP, SLS & IML, FLINN, rockets/balloons, etc. In FY94, NSI would establish a new baseline to catch up with requirements growth, use new PSCN circuits during NSFNET transition & stabilization to NREN, continue to build EOSDIS Network, accommodate emerging local site ethernet with high bandwidth workstations, and address proliferating Ossa requirements for NREN usage.

   **Advantage:** Program retains its interdisciplinary perspective and leverage. Economies of scale and networking efficiencies are maximized across disciplines and priorities are established at an interdisciplinary level with support from the ISMB.

   **Result:** Economies of scale and efficiency are maintained as interdisciplinary perspective is ensured.

2. NSI directly negotiates supplemental funds from each Division. Initiate a division tax scheme in FY93/94 time frame.

   **Disadvantage:** Program serves individual discipline interests as opposed to a unified Ossa program. Many captans leading ship, loss of interdisciplinary efficiencies and control.

   **Result:** Economies of scale and efficiencies compromised. Interdisciplinary perspective is not ensured. Program may become fragmented as discipline interests are not moderated.

**NSI Recommends Management Option Number 1**
Outline

I. Background

II. Current Services and Architecture

III. Future Directions

Vision

- A single integrated network, under OSSA control, tailored to NASA science needs
- Transparent ubiquitous access to science data archives, computational resources, and colleagues worldwide
- Total spectrum of network services: guaranteed bandwidth, priority routing, selective routing, protocol transparency, multi-media, etc.
- Common use of distributed network applications & services: online directories (white & yellow pages), robust electronic mail, distributed databases, etc.
- Full interconnection with national network infrastructures, especially the NREN
- Fully controlled access to NASA resources
National Research & Education Network: Plan

The NREN will be a computer communications network that interconnects:
• educational institutions
• national laboratories, non-profit research institutions, and government facilities
• commercial organizations engaged in government-supported research or collaborating in such research
• unique national scientific and scholarly resources such as supercomputer centers, major experimental facilities, databases, and libraries

The NREN will provide high speed communications access to over 1300 institutions across the United States within 5 years.

NREN Stages

Stage 1 - upgrades existing agency trunks to 1.5 Mbps

Stage 2 - combines multiple agency trunks into a shared 45 Mbps trunk system

Stage 3 - research & development phase to result in a shared national network with multi-gigabit-per-second trunks; technologies yet to be developed.
**NREN Phases**

Stage 3
---
Gbps

Testbeds and Experimental Networks

Research and Development

Revolutionary Technology Changes

Operational Network

Transition to Commercial Services

Stage 2
---
45 Mbps

Operational Network

Evolutionary Changes

Stage 1
---
1.5 Mbps

Operational Network

Stages 1 & 2 Development

---

89 90 91 92 93 94 95
Overview

I. Organization

II. Services Provided

III. OSSA Requirements Profile

III. Highlights and Future Growth

Planning Office Organization

NSI Planning Office
John Martin, Manager

Requirements Management
John Martin (Acting) Group Leader

Work Control Group
Kathy Bosovich, Group Leader
**Requirements Management Group**

Provide "Customer Service" to OSSA Scientific User Community
Define, Document, and Report all OSSA Communication Requirements
Manage Requirements Throughout Entire Process
Draft and Facilitate MOUs with Disciplines
Plan Future Networking Requirements with Disciplines
Involved with Planning and Development of OSSA Integrated Scientific Resources/Systems
Provide OSSA Conference Support and Outreach Activities

**Work Control Group**

Track OSSA Requirements and Manage Requirements Information
Provide Requirements Reporting Information Tools (charts, graphs, reports) to Increase NSI Responsiveness to OSSA Community
Provide Tracking and QA of NSI Internal Requirements Processing
Management of NSI Database Systems
Provide NSI Circuit and Reporting Information to Communications Carriers
Overall Tracking of NSI Processes and Procedures (i.e., validations, NSR, RFS, USR, outreach documentation)
### Overview

I. Organization

II. Services Provided

III. OSSA Requirements Profile

III. Highlights and Future Growth
Planning Office Services

- Requirements Planning
  - Long Range Requirements Projection
  - Intradiscipline Requirements Prioritization
  - Requirements Impact Analysis/Planning
  - Discipline Level MOU Development
  - Resource and Systems Planning
  - Discipline Level Overview of Req's set with HQ Validator

- Requirements Management
  - Project Requirements Statuses
  - Manage Requirements Throughout Process
  - Communications Requirements Reviews
  - Work with Customer to Meet Scientific Goals
  - Continual User/PI Customer Contact and Feedback
  - Conference Support/Outreach

Requirements Processing

"Coordinating and assuring requirements are met"

NASA SCIENCE INTERNET

- REQUIREMENT IDENTIFIED AND PRIORITIZED
  - ALL OSSA RESEARCHERS
  - FLIGHT PROJECTS
  - CAMPAIGNS
  - COLLABORATORS

- NETWORK SERVICES REQUEST
  - USER SUPPORT
  - ANALYSIS ENGINEERING COSTING

- Ossa Program Management
  - IF COST, THEN HQ FUND CERTIFICATION

AVERAGE IMPLEMENTATION (12-18 MONTHS)
**MOU Development Process**

Understand and Participate in Discipline Communications Planning Process and Requirements Development

Identify and Conceptualize Communications Architecture

Longer Standing - At Discipline Level

Draft and Sign OSSA Discipline MOU

Project Review Cycle

Develop Requirements Processing Priorities/Schedules

Draft Project Specific Requirements Reference Documents

Program Review Cycle

I. Organization

II. Services Provided

III. OSSA Requirements Profile

III. Highlights and Future Growth
Ossa Current Requirements

NSI OSSA Requirements Complement

<table>
<thead>
<tr>
<th>Code</th>
<th>Division</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Office of Space Science &amp; Applications</td>
<td>148</td>
</tr>
<tr>
<td>SB</td>
<td>Life Sciences Division</td>
<td>21</td>
</tr>
<tr>
<td>SE</td>
<td>Earth Science &amp; Applications Division</td>
<td>886</td>
</tr>
<tr>
<td>SL</td>
<td>Solar System Exploration Division</td>
<td>260</td>
</tr>
<tr>
<td>SM</td>
<td>Flight Systems Division</td>
<td>8</td>
</tr>
<tr>
<td>SN</td>
<td>Microgravity Science &amp; Applications Division</td>
<td>4</td>
</tr>
<tr>
<td>SP</td>
<td>Administration and Resource Mgmt Division</td>
<td>0</td>
</tr>
<tr>
<td>SS</td>
<td>Space Physics Division</td>
<td>158</td>
</tr>
<tr>
<td>SZ</td>
<td>Astrophysics Division</td>
<td>82</td>
</tr>
</tbody>
</table>

TOTAL number of OSSA requirements: 1567
**Overview**

I. Organization

II. Services Provided

III. OSSA Requirements Profile

III. Highlights and Future Growth
Planning Office Highlights/Improvements

Increased Requirements Management Staff to Offer Better Level of Service

Begun Movement Towards "Discipline Level" MOUs

Integrated Work Control Group within NSI Planning Office

Further Refined Conference Support Policy and Requirement Documentation/Tracking

Improved Validation Time Through Requirements Managers and WCO

Greater Emphasis on Planning Effort (Projecting, Scoping, etc.)

Increased Capacity to Process and Manage Requirements

Planning Office FY 92 Activities

Refine and Update NSR Process Through NSR Workshop - Look to Include Cost Weighting and NIC Requirements

Look to Increase User Services/NIC Requirements Definition/Tracking Effort to Incorporate into Existing OSSA NSR Process

Increase Requirements Manager's Outreach to Scientific Community

Redesign MOU Process to Develop Discipline Level MOUs

Step-up Planning Efforts with HQ Disciplines - Schedule Requirements

Continue Outreach and Conference Support Effort

Increase User Feedback and Quality Service Mechanisms/Measurements

Hold Communications Requirements Reviews Annually

Standardize Requirements Reporting Format
NASA Science Internet Engineering Status Report

March 31, 1992
NSIUWG

Jeffrey G. Burgan
NASA Science Internet Office
NASA Ames Research Center
Engineering Highlights

• Backbone circuits upgraded to T1
  ARC, GSFC, JPL, LaRC, MSFC
  JSC - JPL (448Kb)
  NASA HQ (448Kb)

• OSI (CLNP and IS-IS) capabilities deployed

• DECnet Phase IV routing enabled on the backbone
  ARC, GSFC, JPL, JSC, MSFC

• Phase 1 of DECnet circuit upgrades to 56K completed

Engineering Highlights (cont.)

• Arizona DECnet consolidation completed
  via T1 to University of Arizona

• Colorado DECnet consolidation currently being implemented
  via T1 to NCAR, Boulder, CO

• DECnet routing implemented between NSI and ESnet
  at both FIX interconnects

• Upgraded circuit to Univ of Alaska, Geophysical Institute
  PSCN provided T1 to be shared with EOS V0 network

• NSFnet access being upgraded to T3
International Access

• NASA/ESA Connectivity
  NSI connectivity to ESAnet via NASA/PSCN links
  ESOC (256Kb)
  ESTEC (576Kb)
  Currently supports IP routing
  DECnet IV routing being implemented
  PSCN upgrading links in June

• United Kingdom
  Univ of London (128Kb)
  Oxford University (128Kb)
  Rutherford Appleton Lab (64K)

International Access (cont.)

• PACCOM (Pacific Rim)
  Univ of Hawaii (1.5Mb)
  Australia - AARnet (512Kb)
  New Zealand (64Kb)
  Hong Kong (64Kb)
  Japan (multiple circuits)

• Chile - Cerro Tololo Inter-American Observatory (56Kb)

• Greenland - Sondrestrom Radar Facility (56Kb)

• Antarctica - McMurdo Station (56K)
Network Operations

• Network Operations Center (NOC) located at ARC

• 24 hour / 7 day availability

• Toll free international access

• Network management of routers using SNMP (Overview)

• Monitoring of DECnet circuits using NICE (custom program)

• Evaluating DEC MSU to provide integrated IP and DECnet management capability

Network Configuration

• 112 sites connected
  71 using multi-protocol routers
    (54 routing DECnet Phase IV)
  29 using DEC's DDCMP
  12 utilizing DECnet encapsulation

• 2 interconnections with other Federal Agency Network's (NSFnet, ESnet, TWBnet, MILnet)
  FIX-East  (SURAnet, College Park, MD)
  FIX-West  (NASA Ames)

• Traffic increased 250% during past 12 months
NASA Science Internet (NSI) User Support Office (USO) Objectives and Recent Accomplishments

J. Patrick Gary
Science Network Office
Code 930.6
Goddard Space Flight Center

March 31, 1992
Presentation to the NASA Science Internet User Working Group (NSIUWG) Conference

Objective

• Meet user needs for NSI information and applications services through the establishment and coordination of an effective set of Network Information Center (NIC) and network applications development efforts.

Key Functional Activities

• NIC Requirements Definition and Analysis
• Network User Help Desk
• Publications/Documentation
• On-Line Services
• User Outreach
NASA Science Internet User Support Office
NIC Requirements Definition and Analysis

Objective

- Collect and document NIC requirements in User Services Request (USR) form
  - Information services, e.g., Yellow Page NSI Resource Guide
  - Application services, e.g., IP-OSI Interoperability Gateway
- Identify existing or emerging products and applicable R&D efforts
- Identify remaining resources needed to meet users' requirements

Recent Accomplishments

- Drafted separate Information Service Request and Applications Service Request forms to facilitate:
  - Work planning
  - Progress/status reporting
  - Product documentation
- Reviewed justification and prioritization factors with NSI's Deputy PM, e.g.,
  - Extent of user demand
  - Who and which sites will use this service and how often
  - Availability of this service in other NICs
  - Maturity of the technology/products related to this service

NASA Science Internet User Support Office
Network User Help Desk

Objective

- Maintain 8 hr/day x 5 days/week NIC help desk with >90% live phone response
- Respond to user requests
  - General network information
  - Network user problem diagnosis
  - Referrals (e.g., to NSI NOC, other NICs)
  - User node configuration/optimization

Recent Accomplishments

- On-going Help Desk operations routinely handling approximately 20 Email requests and 10 phone requests per week; over 90% responses to Email by close of business next day
- Assembling reference files covering a wide variety of topics (e.g., internetworking, online resources, the NSI-DECnet node database, the NPSS, etc.) for use in day-to-day operations
- Planned Help Desk improvements in NSI NIC-NOC coordination, cooperation and information exchange
- Initiated contact with NIC-related personnel at MSFC NPSS, Merit, NSFNet Network Service Center, SURAnet, THEnet, and other Help Desks as part of inter-NIC liaison activities
- Co-chairing IETF User Documentation Working Group with near-term goal of improving internetworking bibliography
Objective

- Coordinate the development and distribution of quality documentation

Recent Accomplishments

- Prepared several new mini-guides designed to assist network users in better understanding various network commands and in accessing numerous on-line services
  - How to Access the NSI Online Network Aide (NONA)
  - The NSI DECnet Node Data Base
  - Using the EAST Interoperability Gateway
  - Basic TCP/IP (Internet) Commands for DECnet/VMS Users
  - Using the File Transfer Protocol (FTP)
  - "Rule of Thumb" for Determining the Source of Electronic Mail
  - The MacSecure Anti-Virus Tool Kit for Macintosh Computers
- Planned contents for a NSI New User Packet, e.g.,
  - What is NSI
  - Various mini-guides
  - Internetworking bibliography
- Internetworking bibliography
- What is the NSI NIC, NOC, NSIUWG, ...
- Glossary of basic networking terms
- NSI Resource Guide

NASA Science Internet User Support Office
On-Line Services

Objective

- Provide NSI users with easy on-line access to networking information and utilities

Recent Accomplishments

- Installed and configured NSINIC VAX 3400 running VMS and NSISRV
  - DECstation 5000/200 running ULTRIX as NSI-dedicated computers for hosting on-line USO services
- Enhanced the NSI On-line Network Aide (NONA) system since its V1.0 release
  - Completed various menus/informational files previously under construction
  - Added "Hot News" feature to top menu
  - Updated Electronic Mall Matrix information; also added a "knowbot" to handle interactive user inquiries in this subject area
  - Upgraded the on-line problem reporter and comments subsystem
  - Designing and testing Version 2 of NONA
Recent Accomplishments (cont'd)

- Created the NSI File Cabinet and updated its informational holdings
  - Presently contains 39 directories, 1392 files
  - Major directories are IMAGE, MAC, NSINIC, RFC, and SOFTWARE
- Created NSI_DB as a replacement for the old SPAN_NIC Yellow Pages
- Continued approximately bi-monthly updates to the NSI-DECnet node data base
- Providing USENET News feed for several NSI-connected sites
- Created NSI Electronic Postal Facility/POBOX capability
  - Maintains various mailing lists to send announcements and bulletins
  - Presently supporting the following groups:
    - International Forum on the Scientific Users of Space Station (IFSUSS)
    - AAS High Energy Astrophysics Division (HEAD)
    - Applied Information System Research Program (AISRP)
- Developed IKI-NASA Gateway system (now planned to be shut off)

Objective

- Present NSI capabilities and demonstrate network information and application services through active participation in user conferences, symposia, and Working Groups

Recent Accomplishments

- Provided significant planning for the annual NSI User Working Group Conferences
  - Coordinated numerous arrangements for Third Annual NSIUWG Conference, March 30 - April 3, 1992
Recent Accomplishments (cont'd)

- Assisted in staffing the NSI booths at key scientific conferences, e.g.,
  - December 7-11 AGU conference in San Francisco, CA
  - January 12-16 AAS conference in Atlanta, GA
  - March 16-20 LPSC conference in Houston, TX
- Presented NSI User Support Services at various project working group meetings, e.g.,
  - March 10-12 EOSDIS DAAC User Services Work Group Workshop in Sioux Falls, SD
- Provided network usage consultation and tutorials on NONA, the NSI File Cabinet, and several other on-line systems to over 800 NSI users
- Establishing process of contacting user representatives at newly-connected NSI sites

New User Requirements and Recommended Changes —

We're Receptive!

- At This Conference:
  - Discussion during Plenaries
  - Discussion during User Services Subgroup
  - Discussion during User Services Tutorial
  - Discussion at NSI NIC Exhibit Booth
  - Other...
- Anytime:
  - Call and/or Email and/or FAX Help Desk
  - Leave message in NONA comments/suggestion box
  - Other...
WHO YOU GONNA CALL?

NSI Network Information Center

Code 930.6
Goddard Space Flight Center
Greenbelt, MD 20771

301-286-7251
(FAX) 301-286-5152

nsihelp@nic.nsi.nasa.gov
nsinic::nsihelp
NSI SECURITY Update

RON TENCATI
NSI SECURITY MANAGER
March 31, 1992
NSI SECURITY UPDATE

HACKERS ON NSI:

HOW THEY GET IN:

• DIAL IN VIA ROLM LINES
• NPSS (X.25)
• TCP/IP OR DECNET NETWORK (NSI)

TYPICAL HACKER ACTIVITY:

• TRY TO GUESS PASSWORDS
• EXPLOIT GUEST ACCOUNTS THAT ALLOW OUTBOUND ACCESS
• SEARCH FOR WORLD-READABLE SYSTEM FILES.
• USE NSI/OSSA SYSTEMS AS STAGING AREAS FOR FURTHER ATTACKS.

CURRENT VULNERABILITIES BEING EXPLOITED

• TFTP (Used if a node is a boot-server)
  Allows files to be read/copied w/out specifying a userid/password
  /etc/passwd

• GAINING ROOT ACCESS VIA EXPLORITING BUGS, INSTALLING TROJAN HORSE BINARIES

• TRIVIAL PASSWORDS

• DEFAULT ACCOUNTS AND "r" COMMANDS
NSI SECURITY UPDATE

IMPROVING OVERALL SECURITY

• USE PASS-PHRASES

• REQUIRE PASSWORDS ON ALL ACCOUNTS

• ONE ACCOUNT PER USERNAME

• GENERATE AUDIT TRAIL (ACCOUNTING) DATA - REVIEW DAILY

• INSTALL PATCHES AS THEY BECOME AVAILABLE

• RUN SECURITY "TOOLKIT" SOFTWARE
  UNIX: "COPS"     VMS: "SPAN TOOLKIT"

• REPORT INCIDENTS WHEN THEY HAPPEN

• Come to the Tutorials on Thursday!

INCIDENT HANDLING

• DO NOT REPORT NASA INCIDENTS TO THE "CERT"

• USERS SHOULD REPORT ANY ANOMALY TO THEIR SYSTEM ADMINISTRATOR

• SYSTEM ADMINISTRATORS SHOULD REPORT ANY SECURITY INCIDENT TO THEIR DPI-CSO

• IF INCIDENT INVOLVES AN EXTERNAL SITE, REPORT IT ALSO TO NSI-SECURITY OFFICE, SECURITY@NSINIC.GSFC.NASA.GOV

• NSI SECURITY OFFICE ISSUES SECURITY BULLETINS TO NSI COMMUNITY VIA ROUTING CENTER MANAGERS AND NASA AIS CONTACTS
NSI SECURITY UPDATE

SECURITY ALERT DISTRIBUTION

• NSI ROUTING CENTERS
  - ARC (Warren Van Camp, Milo Medin)
  - GSFC (Dave Stern, Jerome Bennett, Rick Dunbar)
  - JSC (Dan Anderson)
  - JPL (Sandy George, Joe Wieclawek)
  - MSFC (Sam Pizzano, Linda Porter)
  - ESOC (Paul Hughes)
  - KSC (Mark Juhr, Mark Mason)

• OTHER NASA CONTACTS
  - SSC (Paula LeBlanc)
  - LeRC (Steve Praht)
  - LARC (Steve Derry)
  - HQ (Janet Keys, Russ Davis)
  - JTD (Rick Carr)

• OTHER NETWORK/SECURITY CONTACTS
  - ESnet/DECnet (HEPnet)
  - INFN (Italy)
  - ISAS/NASDA (Japan)
  - DAN (Canada)
  - RIKEN (Japan)
  - SPAN France
  - European SPAN
  - SDSC
  - DOE/GIAC
  - ESTEC
  - DARPA/CERT
  - FIRST (Int'l CERT Group)
  - NSI-NOTIFY@NSIPO

NSI Acceptable Use Policy

SUMMARY:

NSI supports all NASA science flight missions, discipline research programs, and collaborating scientists at NASA Centers and elsewhere. NSI is not to be used for private gain or profit.

SPECIFIC:

1) Use of NSI must be in support of official NASA programs; all user requests for NSI connectivity must be validated and supported by cognizant OSSA Discipline Chiefs.

2) Use of NSI to support coordination and administrative execution of OSSA research grants is permissible;

3) Use of NSI to support NASA research, related training, and associated technical activities at non-profit institutions of research and education is acceptable.

4) Use of NSI for commercial or intellectual gain by for-profit organizations is not acceptable, unless those organizations are using NSI to satisfy specific NASA contract or grant requirements.

5) Use of NSI for research or education at for-profit institutions will be reviewed on a case-by-case basis to ensure consistency with OSSA programs; lack of program approval will result in disconnection.

6) Use of NSI to gain unauthorized use of resources attached to NSI will result in disconnection and legal prosecution. NSI will make every attempt to implement precautions to safeguard against unauthorized use of NASA computers, databases, and other attached federal resources.

7) Use of NSI for the introduction of worms, viruses, trojans, or other software which maliciously interferes with normal NSI operations is unlawful.
KEY POINTS:

• NSI ≠ "The Internet"

• NSI Resources are for OSSA Support Only

• OSSA/NSI Users enjoy full network access

• Unauthorized use of NSI is unlawful

• Violators will be prosecuted

CONTINUING INITIATIVES

○ REVISED POLICIES

○ TOOLKITS (VMS & UNIX IN FY92)

○ IMPROVED INCIDENT RESPONSE MECHANISM

○ EDUCATION
NSI Acceptable Use Policy

SUMMARY:

NSI supports all NASA science flight missions, discipline research programs, and collaborating scientists at NASA Centers and elsewhere.
NSI is not to be used for private gain or profit.

SPECIFIC:

1) Use of NSI must be in support of official NASA programs; all user requests for NSI connectivity must be validated and supported by cognizant OSSA Discipline Chiefs.

2) Use of NSI to support coordination and administrative execution of OSSA research grants is permissible;

3) Use of NSI to support NASA research, related training, and associated technical activities at non-profit institutions of research and education is acceptable.

4) Use of NSI for commercial or intellectual gain by for-profit organizations is not acceptable, unless those organizations are using NSI to satisfy specific NASA contract or grant requirements.

5) Use of NSI for research or education at for-profit institutions will be reviewed on a case-by-case basis to ensure consistency with OSSA programs; lack of program approval will result in disconnection.

6) Use of NSI to gain unauthorized use of resources attached to NSI will result in disconnection and legal prosecution. NSI will make every attempt to implement precautions to safeguard against unauthorized use of NASA computers, databases, and other attached federal resources.

7) Use of NSI for the introduction of worms, viruses, trojans, or other software which maliciously interferes with normal NSI operations is unlawful.
B. NSI User Projects Plenary
Upper Atmosphere Research Project (UARS) Project Update

NSIUWG
April 1, 1992

Daniel S. DeVito
Code 430
UARS CONF Manager

Agenda

- Background
  - UARS
  - Ground System
  - NSI Support

- Lessons Learned
  - Performance
  - Engineering Support
  - Operations Support
  - Management
The UARS, deployed by Discovery on September 14, 1991, is the first of a series of observatories to be launched as part of the "Mission to Planet Earth" program.

UARS carries nine complementary experiments performing three types of measurements as follows:

<table>
<thead>
<tr>
<th>Composition &amp; Temperature</th>
<th>CLAES: Cryogenic Limb Array Etalon Spectrometer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HALOE: Halogen Occultation Experiment</td>
</tr>
<tr>
<td></td>
<td>ISAMS: Improved Stratospheric And Mesospheric Sounder</td>
</tr>
<tr>
<td></td>
<td>MLS: Microwave Limb Sounder</td>
</tr>
<tr>
<td>Winds</td>
<td>MRDI: High Resolution Doppler Imager</td>
</tr>
<tr>
<td></td>
<td>WINDII: Wind Imaging Interferometer</td>
</tr>
<tr>
<td>Energy Input</td>
<td>PEM: Particle Environment Monitor</td>
</tr>
<tr>
<td></td>
<td>SOLSTICE: Solar/Stellar Irradiance Comparison Experiment</td>
</tr>
<tr>
<td></td>
<td>SUSIM: Solar Ultraviolet Spectral Irradiance Monitor</td>
</tr>
</tbody>
</table>

The UARS Science Team consists of 20 Principal Investigators at various international locations:

<table>
<thead>
<tr>
<th>Principal Investigator</th>
<th>Location</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. E. Roache</td>
<td>LPARL; Palo Alto, Ca</td>
<td>CLAES</td>
</tr>
<tr>
<td>J.M. Ruskel</td>
<td>LaRC; Hampton, Va</td>
<td>HALOE</td>
</tr>
<tr>
<td>J.W. Waters</td>
<td>JPL; Pasadena, Ca</td>
<td>MLS</td>
</tr>
<tr>
<td>P.B. Hayes</td>
<td>Univ. Of Michigan; Ann Arbor, MI</td>
<td>MRDI</td>
</tr>
<tr>
<td>G.G. Shepherd</td>
<td>York Univ.; Toronto, Canada</td>
<td>WINDII</td>
</tr>
<tr>
<td>J.D. Winningham</td>
<td>SwRI; San Antonio, Tx</td>
<td>PEM</td>
</tr>
<tr>
<td>G.J. Rottman</td>
<td>Univ. of Colorado; Boulder, Co</td>
<td>SOLSTICE</td>
</tr>
<tr>
<td>G.E. Brueckner</td>
<td>NRL; Washington D.C.</td>
<td>SUSIM</td>
</tr>
</tbody>
</table>

Instrument Investigators:

<table>
<thead>
<tr>
<th>Theoretical &amp; Collaborative Investigators</th>
<th>Location</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.M. Cunnotl</td>
<td>Georgia Tech; Atlanta, Ga</td>
<td></td>
</tr>
<tr>
<td>M. Geller</td>
<td>SUNY; Stony Brook, NY</td>
<td></td>
</tr>
<tr>
<td>J. Gillie</td>
<td>NCAR; Boulder, Co</td>
<td></td>
</tr>
<tr>
<td>W.L. Grose</td>
<td>LaRC; Hampton, Va</td>
<td></td>
</tr>
<tr>
<td>J.R. Holton</td>
<td>Univ. of Washington; Seattle, Wa</td>
<td></td>
</tr>
<tr>
<td>J. London</td>
<td>Univ. of Colorado; Boulder, Co</td>
<td></td>
</tr>
<tr>
<td>A.J. Miller</td>
<td>NOAA; Camp Springs, Md</td>
<td></td>
</tr>
<tr>
<td>C.A. Reber (Proj Sci)</td>
<td>GSFC; Greenbelt, Md</td>
<td></td>
</tr>
<tr>
<td>A. O'Neill</td>
<td>UKMO; Bracknell, England</td>
<td></td>
</tr>
<tr>
<td>D. Wubbeles</td>
<td>LLNL; Livermore, Ca</td>
<td></td>
</tr>
<tr>
<td>R.W. Zureck</td>
<td>JPL; Pasadena, Ca</td>
<td></td>
</tr>
</tbody>
</table>
Background: Ground System

• Instrument Investigator Teams provide daily science and activity plans to the Command Management System (CMS) based on planning aids.

• The CMS provides command loads to the Payload Operations Control Center (POCC) which are subsequently uplinked to the observatory via the TDRSS.

• Telemetry and Tracking data are downlinked to the Data Capture Facility (DCF) and Flight Dynamics Facility (FDF) via the TDRSS.

• The DCF archives the telemetry data, reverses the data to time-increasing order, removes redundant data, and decommutes and formats the data for transmission to CDHF.

• The CDHF provides non-critical mission support and data management functions:
  - Ingest UARS Level 0 data and correlative data
  - Process Level 0 data using PI-provided software
  - Store UARS data products and correlative data
  - Provide access to UARS data products and correlative data to UARS science community via network communications (managed by NSI).

Background: UARS (cont.)

• UARS mission lifetime

<table>
<thead>
<tr>
<th>Flight Operations</th>
<th>Ground Data Processing Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Plan</td>
<td>1.5 years</td>
</tr>
<tr>
<td>Current Plan</td>
<td>5 years</td>
</tr>
</tbody>
</table>
Background: Ground System (cont.)

- UARS data available from the CDHF are:
  - Level 0: pre-processed telemetry
  - Level 1: output of sensors (e.g., radiances)
  - Level 2: geophysical data (e.g., ozone mixing ratio at footprint of sensor)
  - Level 3A: geophysical data transformed to a common format and interpolated to equal time and latitude steps (approximately one-minute centers)
  - Level 3B: latitude/longitude maps on a daily basis at one-half height intervals

- Correlative data, supplied by Correlative Measurement Investigators (CMIs) via PIs, are available from the CDHF.

Background: NSI Support

- Engineer, reliable, DECnet connectivity between the CDHF and RACs
- Analyze external network reconfigurations and technology advancements for impact to the "UARSnet" (e.g., DECnet Phase V)
- Provide a minimum bandwidth equivalent to a 56 kbps dedicated circuit between the CDHF and each RAC
- Provide around the clock monitoring of all communication links
- Perform trend analysis on network links to monitor shared line utilization and track reliability, maintainability, and availability (RMA) of the "UARSnet"
- Report all line outages impacting the "UARSnet" and associated resolutions to CDHF operations and Project personnel
- Provide utilization statistics for each "UARSnet" link
- Present NSI status at the UARS Data Systems Working Group Meetings (DSWGs) and Systems Managers Meetings (SMMs)
CDHF and UARSnet (Primary Circuits)

Functions
- Data Ingest
- Data Storage and Access
- Production Data Processing
- PI Initiated Processing
- Communications

Launch Configuration
- 156 MIPS CPU Power
- 72 GBytes Magnetic Disk Storage
- 128 GBytes Optical Disk Storage
Lessons Learned: Performance

- Losses and subsequent acquisitions of communication links impacting CDIMF/RAC connectivity are reported by the NSI Network Operations Center (NOC) to UARS operations and Project personnel via e-mail. Each loss and gain of a link to a RAC is termed an "event".

- Events are categorized by cause as follows:
  - Line: outages caused by failure or planned maintenance outside the control of the RAC site
  - RAC: outage caused by failure or planned maintenance of RAC site
  - Unknown: outage reported by the NSI NOC but without sufficient information to determine cause

- E-mail messages from the NSI NOC were saved by the UARS Project for a period of 17 months (10/90-2/92) to use as a basis for trend analysis of the UARSnet performance. During the 17 months:
  - Over 1500 mail messages were sent to UARS by the NSI NOC concerning events
  - 731 events were recorded

Lessons Learned: Performance

UARSnet Event Statistics

<table>
<thead>
<tr>
<th>Location</th>
<th>Circuit Type</th>
<th>Number of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Line</td>
<td>Unknown</td>
</tr>
<tr>
<td>NCAR Boulder, Co</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>NOAA Camp Springs, Md</td>
<td>56 kbps (Dedicated)</td>
<td>2</td>
</tr>
<tr>
<td>LPARL Palo Alto, Ca</td>
<td>T1 (Shared)</td>
<td>8</td>
</tr>
<tr>
<td>SUNY Stony Brook, NY</td>
<td>T1 (Shared)</td>
<td>27</td>
</tr>
<tr>
<td>Ga. Tech Atlanta, Ga</td>
<td>T1 (Shared)</td>
<td>12</td>
</tr>
<tr>
<td>LaRC Hampton, Va</td>
<td>56 kbps (Dedicated)</td>
<td>19</td>
</tr>
<tr>
<td>LPARL Palo Alto, Ca</td>
<td>T1 (Shared)</td>
<td>22</td>
</tr>
<tr>
<td>JPL Pasadena, Ca</td>
<td>728 Kbps (Shared)</td>
<td>13</td>
</tr>
<tr>
<td>Oxford U Oxford, England</td>
<td>56 kbps (Dedicated)</td>
<td>6</td>
</tr>
<tr>
<td>SwRI San Antonio, Tx</td>
<td>56 kbps (Dedicated)</td>
<td>39</td>
</tr>
<tr>
<td>U of Mich Ann Arbor, MI</td>
<td>T1 (Shared)</td>
<td>14</td>
</tr>
<tr>
<td>NRL Washington D.C.</td>
<td>T1 (Shared)</td>
<td>24</td>
</tr>
<tr>
<td>U of Wash Seattle, Wa</td>
<td>T1 (Shared)</td>
<td>6</td>
</tr>
<tr>
<td>U of Colo Boulder, Co</td>
<td>T1 (Shared)</td>
<td>12</td>
</tr>
<tr>
<td>York U Toronto, Canada</td>
<td>56 kbps (Dedicated)</td>
<td>5</td>
</tr>
<tr>
<td>CNES Toulouse, France</td>
<td>56 kbps (Dedicated)</td>
<td>16</td>
</tr>
</tbody>
</table>

Total 247 164 228 639
Average 39 26 36
<table>
<thead>
<tr>
<th>Node Name</th>
<th>Location</th>
<th>Circuit Type</th>
<th>MTBF (Days)</th>
<th>MTTR (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACDURS</td>
<td>Boulder, Co</td>
<td>T1 (Shared)</td>
<td>24.8</td>
<td>5.7</td>
</tr>
<tr>
<td>AIBROU</td>
<td>Camp Springs, Md</td>
<td>56 kbps (Dedicated)</td>
<td>181.1</td>
<td>10.7</td>
</tr>
<tr>
<td>CLAES</td>
<td>Palo Alto, Ca</td>
<td>T1 (Shared)</td>
<td>33.3</td>
<td>5.2</td>
</tr>
<tr>
<td>GELUA1</td>
<td>Stony Brook, NY</td>
<td>T1 (Shared)</td>
<td>9.2</td>
<td>3.2</td>
</tr>
<tr>
<td>GTUARS</td>
<td>Atlanta, Ga</td>
<td>T1 (Shared)</td>
<td>41.1</td>
<td>4.4</td>
</tr>
<tr>
<td>HALOE</td>
<td>Hampton, Va</td>
<td>56 kbps (Dedicated)</td>
<td>18.2</td>
<td>7.4</td>
</tr>
<tr>
<td>LPAR5</td>
<td>Palo Alto, Ca</td>
<td>56 kbps (Dedicated)</td>
<td>21.3</td>
<td>4.3</td>
</tr>
<tr>
<td>MLSRAC</td>
<td>Pasadena, Ca</td>
<td>728 Kbps (Shared)</td>
<td>43.9</td>
<td>12.2</td>
</tr>
<tr>
<td>OXROU1</td>
<td>Oxford, England</td>
<td>56 kbps (Dedicated)</td>
<td>35.9</td>
<td>23.3</td>
</tr>
<tr>
<td>PEM</td>
<td>San Antonio, TX</td>
<td>56 kbps (Dedicated)</td>
<td>12.0</td>
<td>12.5</td>
</tr>
<tr>
<td>SPRLJ</td>
<td>Ann Arbor, Mi</td>
<td>T1 (Shared)</td>
<td>29.0</td>
<td>3.2</td>
</tr>
<tr>
<td>SUSIM</td>
<td>Washington D.C.</td>
<td>T1 (Shared)</td>
<td>18.9</td>
<td>8.0</td>
</tr>
<tr>
<td>UWASH</td>
<td>Seattle, Wa</td>
<td>T1 (Shared)</td>
<td>54.3</td>
<td>5.5</td>
</tr>
<tr>
<td>VIRGO</td>
<td>Boulder, Co</td>
<td>T1 (Shared)</td>
<td>35.2</td>
<td>1.4</td>
</tr>
<tr>
<td>WINDIC</td>
<td>Toronto, Canada</td>
<td>56 kbps (Dedicated)</td>
<td>96.4</td>
<td>2.8</td>
</tr>
<tr>
<td>WINDIF</td>
<td>Toulouse, France</td>
<td>56 kbps (Dedicated)</td>
<td>23.3</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Average   42.4  6.2  7.4  8.6

Note: "Totals" include outages caused by line, RAC or unknown.
Lessons Learned: Performance
Average of All CDHF-RAC Lines

- MTTR and MTBF appear to be closely tied to RAC location (as opposed to the type of service).

- The number of remote terminal sessions from the RACs to the CDHF was underestimated.

- Users tend to overestimate data transfer requirements (or underestimate the ability of the RAC to receive and properly archive data).

- Some users tend to expect near perfect reliability.

- Not all data products were available as soon as anticipated.
Lessons Learned: UCSS Data Transfer Load (During First Six Months)
Estimated vs. Actual

- The NSI NOC needs to standardize "event" mail messages for easier tracking and to support trend analysis.

- Communication between the NSI NOC, CDHF/RAC Systems Managers, and Network Affiliates (e.g. PSCN, NSFnet) needs to improve in order to achieve accurate problem tracking and timely resolution of connectivity problems.

- The frequency of partially reported "events" has steadily improved.
Lessons Learned: Engineering Support

- NSIO engineering support has always been outstanding when directly applied to a UARSnet task.
- NSIO often has difficulty providing engineering support for the UARSnet in a timely manner.
- The UARS Project has not seen trend analysis performed as originally advertised by NSIO.

Lessons Learned: Management

- The UARS Project underestimated the effort required to coordinate with NSIO on networking issues.
- The NSIO underestimated the effort required to design, implement, and manage the UARSnet.
- NSIO has become more realistic in advertising services and task completion dates.
- NSIO Management response to UARS Project concerns was inadequate. The appointment of a Project Coordinator by NSI has greatly improved NSIO/UARS Project communication.
Galileo
THE SECOND EARTH ENCOUNTER

PRESENTED TO THE NSI-UWG

Theodore C. Clarke
April 1, 1992
Production requirements and funding preclude the inclusion of Dr. Clarke's original color reproductions of Galileo images and maps.
Galileo

THE SECOND EARTH ENCOUNTER

- HISTORICAL PERSPECTIVE
- VEEGA TRAJECTORY TO JUPITER
- VENUS, EARTH1, GASPRA ENCOUNTERS
- GALILEO SCIENCE DATA SYSTEM PREPARATIONS FOR EARTH2
  - BACKGROUND
  - RESOURCES
  - FIRSTS
    - THE NETWORK
    - SCIENCE VAX CLUSTER
    - SPICE
    - SCIENCE CATALOG
    - "AS RUN" SPACECRAFT EVENTS FILE
- EARTH/MOON2 SCIENCE OBJECTIVES
- EARTH/MOON CONJUNCTION MOVIE - A SIMULATION
Galileo

HISTORICAL PERSPECTIVE

- 4TH CENT. B.C. - EARTH CENTERED COSMOS OF ARISTOTLE
- 1543 - HELIOCENTRIC COSMOS OF COPERNICUS
- 1610 - GALILEO DISCOVERS THE MOONS OF JUPITER, SUNSPOTS, AND THE IMPERFECTIONS ON EARTH'S MOON, LEADING TO OVERTHROW OF ARISTOTLE'S MODEL OF THE COSMOS
- 1958 - NASA FORMED, EXPLORATION OF SOLAR SYSTEM BEGINS
Galileo

SCIENCE DATA SYSTEM - PREPARATIONS FOR EARTH2 BACKGOUND

• ORIGINALLY SCHEDULED FOR 1982 LAUNCH AND 1985 JUPITER ARRIVAL
• LAUNCH VEHICLE PROBLEMS DELAYED LAUNCH TO 1986 WITH 1988 ARRIVAL
• CHALLENGER ACCIDENT SLIPPED LAUNCH TO 1989 WITH VEEGA TRAJECTORY RESULTING IN JUPITER ARRIVAL LATE 1995
• TECHNOLOGY DEVELOPMENT/EVOLUTION DURING DELAYS WERE SIGNIFICANT
• GALILEO SCIENCE DATA TEAM FORMED IN 1986 TO IMPLEMENT/TAKE ADVANTAGE OF TECHNOLOGY IMPROVEMENTS
  • ELECTRONIC DATA DISTRIBUTION REPLACES TAPE DISTRIBUTION
  • SPICE REPLACES SEDRs
  • REAL-TIME DISPLAY CAPABILITY REPLACES PRINTOUTS
• "TARGETS OF OPPORTUNITY" ENCOUNTERS ON WAY TO JUPITER PROVIDE OPPORTUNITIES TO TEST EVOLVING SCIENCE DATA SYSTEM
Galileo
RESOURCES

- MIPL VAX CLUSTER: 2 VAX 8650s, 2 VAX 11/780s
- SCIENCE VAX CLUSTER: 2 MICROVAX 4000s,
  8 MICROVAX 3100s, 5 SUN SPARC STATIONS,
  10 GBYTE ON-LINE DISC STORAGE, 600 MB R/W
  OPTICAL STORAGE
- INGRES DBMS MIGRATING TO SYBASE, MULTINET S/W
  TCP/IP IMPLEMENTATION, ROUTERs, TERMINALs,
  PLOTTER, LASER PRINTERS
- SPICE ANCILLARY INFORMATION SYSTEM, ON-LINE
  UPLINK PRODUCTS, SPICELIB TOOLKIT
- MAGPAC - MAGNETOSPHERIC OBSERVATION
  PLANNING SOFTWARE
- 56 KBPS NETWORK, MOSTLY
Galileo

ELECTRONIC COMMUNICATIONS AND DATA TRANSFER NETWORK

- NASA SCIENCE INTERNET T1 (1.5 MBPS) BACKBONE BETWEEN PRINCIPAL ROUTING CENTERS - GSFC, MFSC, ARC, JPL
- 32 REMOTE NODES, MOSTLY 56 KBPS TAILCIRCUITS
  - 23 DOMESTIC
  - 2 HAWAII
  - 6 EUROPE
  - 1 CANADA
- MULTIPROTOCOL - TCP/IP AND DECNET
  - LOCAL PROGRAMMABLE ROUTERS PROVIDE 1ST LEVEL SECURITY AND PROTOCOL SELECTION
  - EUA ROUTER PROVIDES HIGH LEVEL SFOC LAN SECURITY
- PERFORMANCE/CONNECTIVITY TESTS CONDUCTED BETWEEN GALILEO CENTRAL NODE (SVC) AND ALL REMOTE SITES
  - ASYMMETRIES DISCOVERED AND FIXES Addressed
- TIMELY COMMUNICATIONS WITH NSI PROJECT OFFICE ENSURE UNINTERRUPTED SERVICE DURING ENCOUNTERS
Galileo
Science Network Performance

Test procedure:
send/receive 800 records of 800 bytes each
calculate rates for each record transfer and
average transmission rates.

Results:

Brown University (PGGIPL)
Send: 35 kbps  Receive: 42 kbps

USGS - Menlo Park (MADMAX)
Send: 80 kbps  Receive: 107 kbps

University of Hawaii (UHCCVX)
Send: 119 kbps  Receive: 109 kbps

Germany/Oberpfaffenhofen (OOEPE5)
Send: 2.5 kbps  Receive: 3.0 kbps

France/Toulouse (CNESTA)
Send: 1.9 kbps  Receive: 2.9 kbps
Galileo

SCIENCE DATA SYSTEM LOCAL AREA NETWORK INTERCONNECT AND INTERFACE TO THE NSI

TAIL CIRCUITS TO LOCAL GALILEO INVESTIGATORS

DRYDEN PSCN NODE

T1 NSI BACKBONE

T1 LINES

ROUTING CENTERS

TAIL CIRCUITS TO REMOTE GALILEO INVESTIGATORS

JPL GATEWAY

TRUNK

NETWORK COMMUNICATIONS FACILITY NSI ROUTERS

TCP/IP

DECNET

JPL ILAN

BUFFERED REPEATER

SDS NETWORK INTERFACE

BUFFERED REPEATER

TCP/IP

DECNET

TCP/IP

DECNET & TCP/IP

ROUTER

DATA MANAGEMENT SYSTEM

SPACE FLIGHT OPERATIONS CENTER

MIPL VAX CLUSTER

SCIENCE VAX CLUSTER
Galileo

SCIENCE VAX CLUSTER

- SERVER
  - ELECTRONIC COMMUNICATION SERVICES FOR ALL SCIENCE TEAMS
  - TEMPORARY DATA STORAGE FOR LOW RATE SCIENCE
  - ELECTRONIC TRANSMISSION OF LOW RATE SCIENCE AND ANCILLARY DATA PRODUCTS
  - HOST FOR THE GLL SCIENCE CATALOG
  - HOST FOR ARCHIVE PRODUCTS TO BE DELIVERED TO THE PDS
  - HOST FOR SPICE KERNEL GENERATION, OPERATIONS, DATA AND TOOLKIT STORAGE AND DISTRIBUTION
  - TEMPORARY STORAGE OF UPLINK PRODUCTS FOR SCIENCE COORDINATOR AND PI TEAM REVIEW

- CLIENTS
  - HOST FOR CORRELATIVE DATA ANALYSIS FOR FIELDS AND PARTICLES SCIENCE, AND FOR MAGPAC
  - SUPPLEMENTARY SFOC INTERFACE UTILIZING PI SUPPLIED SOFTWARE FOR NERT PROCESSING
SPICE – A BRIEF DESCRIPTION

**LOGICAL ELEMENTS**

- **SPACECRAFT**
  - S

- **PLANET**
  - P

- **INSTRUMENT**
  - I

- **CAMERA**
  - C

- **EVENTS**
  - E

**KERNEL FILES**

- **SPK**
- **PcK**
- **IK**
- **CK**
- **EK**

**PRODUCT DESCRIPTIONS**

- **SPACECRAFT EPHEMERIS**
- **PLANET, SATELLITE, COMET AND ASTEROID EPHEMERIDES**
- **PLANET, SATELLITE, COMET AND ASTEROID PHYSICAL AND CARTOGRAPHIC CONSTANTS**
- **INSTRUMENT INFORMATION**
- **SPACECRAFT ROTATION AXIS AND INSTRUMENT PLATFORM ATTITUDE**
- **SPACECRAFT EVENTS FILE**
- **GROUND DATA SYSTEM LOGS**
- **SCIENTISTS' "NOTEBOOK" ENTRIES**
- **SPICELIB FORTRAN 77 SUBROUTINE LIBRARY**
- **EXAMPLE, UTILITY AND TEST PROGRAMS**

**SOFTWARE**

- **NAIF TOOLKIT**
- **USER'S SOFTWARE**
Galileo
SPICE SYSTEM DATA FLOW

SOURCE
- NAV
- NAV LOCK FILE
- INSTRUMENT PARAMETERS
- PREDICT S/C POINTING
- TELEMETRY S/C POINTING
- PLANNED SEQUENCE OF EVENTS
- REAL-TIME COMMANDS

SPICE KERNEL
- SP KERNEL GENERATION
- Pc KERNEL
- I KERNEL
- pointing
- C KERNEL GENERATION
- events
- E KERNEL GENERATION

KERNEL VERIFICATION

JPL
- GENERATE METADATA
- GALILEO SCIENCE CATALOG
- USER VF METADATA ARCHIVE
- PI QUERY
- SPICE FILES

FEED BACK INTO GENERATION PROCESS

USERS' HOME INSTITUTION

PI SOFTWARE
- NAIF TOOLKIT

EDRs of IDFs

VIA NSI
GALILEO SCIENCE CATALOG

- HIGH LEVEL CATALOG
  - MISSION INFORMATION
  - DATA SET INFORMATION
  - BIBLIOGRAPHY
- SPICE CATALOG
  - KERNEL METADATA, DATA ARCHIVE, AND NAIF TOOLKIT
- UPLINK PRODUCTS CATALOG
  - ORBIT ACTIVITY PLAN ELEMENT DICTIONARY
  - ORBIT ACTIVITY PLANs
  - SPACECRAFT EVENTS FILEs
  - INTEGRATED SEQUENCE OF EVENTS FILEs
- INTERFACE TO FIELDS AND PARTICLES BROWSE SYSTEM
  - MODIFIED PDS PPI NODE F&P BROWSE SYSTEM
- PPR DETAILED CATALOG (DESIGN AND IMPLEMENTATION BY SDT)
- INGRES DBMS MIGRATING TO SYBASE FOR COMPATIBILITY WITH PDS, SFOC, MIPL
- SSI, NIMS, UVS, RS DETAIL CATALOGS BY SCIENCE TEAMS, WITH METADATA LINKS TO GSC
Galileo
LUNAR SCIENCE OBJECTIVES AT EARTH2

• REMOTE SENSING COVERAGE OF THE LUNAR FARSIDE FOR UNIQUE COMPOSITION AND MULTISPECTRAL CHARACTERIZATION, ILLUMINATED AND DARK - ALL REMOTE SENSING INSTRUMENTS

• REMOTE SENSING COVERAGE OF LUNAR NEARSIIDE "KNOWN" AREAS FOR CALIBRATION - ALL REMOTE SENSING INSTRUMENTS

• REMOTE SENSING COVERAGE OF LUNAR NORTH POLAR REGION FOR COMPOSITION AND MULTISPECTRAL CHARACTERIZATION - ALL REMOTE SENSING INSTRUMENTS

• BRIGHT/DARK LUNAR LIMB DRIFT SEARCHING FOR H, O, OH OUTGASSING - UVS, NIMS

• MEASURE RADIOMETRIC BRIGHTNESS VS WAVELENGTH AND POSITION ON THE LUNAR DISK - PPR AND NIMS
Galileo

EARTH SCIENCE OBJECTIVES AT EARTH2

- DETECT/CHARACTERIZE POLAR STRATOSPHERIC CLOUDS - NIMS
- GLOBAL MOSAIC TO DETERMINE DISTRIBUTION OF GASEOUS SPECIES - NIMS
- CHARACTERIZE DYNAMICS OF THE PLASMA ENVIRONMENT IN THE EARTH'S MAGNETOSPHERE AND MAGNETOTAIL - ALL F&P, UVS
- SEARCH FOR AND CHARACTERIZE HIGH FREQUENCY FEATURES IN THE MAGNETOSPHERE AND BOWSHOCK - ALL F&P
- GROUND TRUTH SPATIAL RESOLUTION AND SPECTRAL MEASUREMENTS OF EARTH FEATURES FOR COMPARISON WITH OBSERVATIONS OF ASTEROIDS AND JOVIAN SATELLITES - SSI, NIMS, PPR
- MEASURE/CHARACTERIZE GEOCORONA - UVS
- MULTISPECTRAL OBSERVATION OF ANDES MOUNTAIN RANGE - SSI
- EARTH ZOOM/ROTATION MOVIE (C/A + 10HR TO 3D1HR) - SSI
- EARTH/MOON MOVIE, MOON PASSING EARTH (C/A + 8D TO 8D14H) - SSI
- DETECT SIGNS OF LIFE ON EARTH (VEGETABLE, ANIMAL, INTELLIGENT) - SSI, PWS
Galileo
ADDITIONAL SCIENCE OBJECTIVES AT EARTH2

- SEARCH FOR EVIDENCE OF SMALL COMETS BY CONDUCTING MEASUREMENTS FOR MOLECULAR HYDROGEN AND WATER IN VICINITY OF THE MOON - UVS, PLS
- DEMONSTRATE OPTICAL COMMUNICATIONS OVER DEEP SPACE DISTANCES - SSI
- CHARACTERIZE TIME VARIABILITY AND DYNAMICS OF THE SOLAR WIND - ALL F&P
- OBSERVATIONS OF SOLAR FLARE RELATED EVENTS IN THE SOLAR WIND - PWS, EPD, MAG, HIC
- OBSERVATIONS OF EARTH CROSSING ASTEROID TOUTATIS - EUV
PHASE ANGLE AND CONE ANGLE OF THE EARTH DURING THE EARTH ENCOUNTERS

- DARKSIDE (HIGH PHASE ANGLE) APPROACH
- TERMINATOR CROSSING AT CLOSEST APPROACH
- LIGHTSIDE (LOW PHASE ANGLE) DEPARTURE
- CLOSING RATE \( \sim 750,000 \) KM/DAY
- SUN POINTED SPACECRAFT REQUIRES USE OF LOW GAIN ANTENNAS
LUNAR ORBIT TRAVERSE AT EGA2

PHOTOIONIZATION CHARGE EXCHANGE

\[ \text{H}_2\text{O}^+ \]

\(~1\ \text{H}_2\text{O}\ \text{MOLECULE/cm}^3\)

\(~100\ \text{RE}\)

PLS SEARCH FOR COMETESIMAL CREATED WATER CLOUD OF THE MOON

SUN

WATER CLOUD

MOON

EARTH

GALILEO

MAGNETOPAUSE

BOWSHOCK

\(-11.8\ \text{hr}\)

\(+11.1\ \text{hr}\)

\(+11.1\ \text{hr}\)

SPACECRAFT TRAJECTORY

PLS MEASUREMENT

ANTICIPATED WATER ION DENSITY AT A: \(-10^{-3}\ \text{H}_2\text{O}^+$/cm$^3$)

FLUXES (DIRECTIOANL, NO THERMALIZATION): \(-10^5$/cm$^2 \cdot$ sec at 10 to 100 keV

GALILEO PLS THRESHOLD: \(-10^4$/cm$^2 \cdot$ sec at 10 keV (COMPOSITION MEASURED)

Ref: Louis Frank, Presented at Galileo Earth/Moon Science Workshop, 5/10/88
LUNAR ENCOUNTER GEOMETRY AT
EGA2 FOR 10/18/89 INJECTION

CLOSEST APPROACH ALTITUDE: 108,000 km
EARTH 2: C/A +2 DAYS, 17 HOURS
MOON ORBITING PAST EARTH
EGA2 + 8.3 days

- EARTH RANGE
  $6 \times 10^6$ km

- MOON RANGE
  $5.6 \times 10^6$ km

- EARTH SIZE IN
  SSI FOV
  2.0 mrad
  200 PIXELS

- MOON SIZE IN
  SSI FOV
  0.6 mrad
  61 PIXELS

SSI CAMERA
FOV
8 mrad
800 PIXELS

MOON ORBIT

4.5 x $10^4$ km
12.5 hr TRANSIT

SUN

EARTH
C. Network Information/User Services
   Plenary
Internet Information

Servers

NASA Science Internet
Users Working Group
Conference

30 March – 3 April 1992

Joyce K. Reynolds
Information Sciences Institute
University of Southern California
Marina del Rey, California
USA
Overview

Information Servers/Directory Services

RFCs & FYIs

Notable NICs

Mail Servers

Information Servers/
Directory Services

- De-centralized

- Independent

- Numerous
Information Servers/
Directory Services

- Archie
- Gopher
- Knowbot
- Netfind
- Prospero
- Whois
- Wide Area Information Server (WAIS)
- World Wide Web (WWW)
- X.500/White Pages

Archie

Archie provides public access files, documents, papers, programs

No “archie” protocol per se

Archie has adopted the Prospero protocol for its use

Plans to make information available through WAIS and WWW

Developers:
  Peter Deutsch & Alan Emtage
  McGill University
System is utilized by retrieving
file listings of predetermined
anonymous FTP archive sites

Information is processed and
entered into a dedicated
database system

User may then query this
database via:
Telnet
Email

or Prospero-based
archive client interfaces

Tests have been carried out
with WAIS & WWW

Currently the most used
Internet Information Service

Estimated that several servers
worldwide provide answers to
over 30,000 queries per day

Gopher and Prospero already
have gateways to archie
Archie

Future Plans Include:

Expansion of range of information to allow users to search for specific kinds of software packages

Determine location of anonymous FTP sites

Local mailing lists of interest

Archie

Discussion groups:

archie–people@cc.mcgill.ca

Documentation from:

archie.mcgill.ca: /archie/doc

Client source from:

archie.mcgill.ca: /archie/clients

(DOS, VMS, Unix Telnet, X11, NeXTStep)
Gopher

Is a distributed information system

Public access files, documents, papers, programs

Based on TCP/IP for sending servers to clients

Gopher is developed at the University of Minnesota

Gopher

Gopher uses its own protocol for transferring information

It is also designed to act as a gateway to other Internet Information Servers
Gopher

Client implementations exist for:
  UNIX
  MS-DOS
  Macintosh

Server implementations exists for:
  UNIX
  Macintosh
  NeXt

Software available:
  boombox.micro.umn.edu

Source from:
  boombox.micro.umn.edu:
  /pub/gopher/*

Documentation:
  boombox.micro.umn.edu:
  /pub/gopher/gopher_protocol/*
**Knowbot Program**  
*(KNOWledge roBOT)*

An active, intelligent program

Currently specialized for accessing information in the National Library of Medicine Medical Subject Heading (MeSH)

Acts on behalf of the user to carry out search & retrieval tasks.

Exchanges messages with other Knowbot programs

Moves from one system to another to carry out the user's requests

Developed by CNRI

**Netfind**

Internet White Pages tool

Information about people

Uses a database of hints and existing services (finger, SMTP, DNS) to search for information

Developed by Mike Schwartz  
University of Colorado, Boulder
Prospero

A distributed file system based on the Virtual System Model

Information is public access files, documents, papers, programs

Provides tools to help users organize Internet resources

Users may construct customized views of resources

Accomplished by creating links to remote and local files in directories

Prospero

Remote files may be available in various forms (FTP, NFS, etc.)

Files appear to the user to be in a local file system

The actual host and access to the file can be invisible to the user

Developed by Clifford Neuman of USC/ISI
Prospero

Combines with Information Providers such as WAIS and archie

Able to handle hypertext links of WWW

Plans underway to have Prospero and WAIS gatewayed

WWW is expected to be added in the future

---

Prospero

Discussion groups are:

info-prospero@cs.washington.edu

Source available from:

june.cs.washington.edu: pub/pfs/src

Documentation from:

june.cs.washington.edu: pub/pfs/doc/*
WHOIS

Oldest service

Simple access protocol

Information about people

One central database

Example:

%whois reynolds, joyce
Connecting to id Database . . . . .
Connected to id Database
Reynolds, Joyce K. (JKR1)
JKREY@ISI.EDU
University of Southern California
Information Sciences Institute
4676 Admiralty Way
Marina del Rey, CA 90292
(213) 822–1511

NIC.DDN.MIL

Record last updated on 07-Jan-91.
Wide Area Information Server (WAIS)

Allows for indexing, searching, and retrieval of documents across the Internet

Based on ANSI Z39.50

Spearheaded by a group at Thinking Machines, Inc.

Project headed up by Brewster Kahle

Wide Area Information Server (WAIS)

Basic architecture

WAIS servers running on a number of hosts in the Internet

Directory of Servers (DOS) server at top

DOS lists WAIS “sources”

User get to choose certain sources to which their question will be directed
Wide Area Information Server (WAIS)

Current implementation

Focuses on large text databases for which one subcomponent of the system created full-text indices

It is these indices which are queried

Server(s) return a set of document IDs to the client

Users can then choose certain documents for retrieval and use

WAIS

For more information:

* wais-discussion@think.com
  weekly digest of mail from users and developers on Electronic Publishing

* wais-talk@think.com
  interactive list of developers

* alt.wais
  a netnews discussion group on WAIS issues

* WAIS Unix Release
  Freeware releases of client code protocol code server code
World Wide Web (WWW)

An Internet-based hypertext system

Provides user with "links" that can be constructed from words or phrases in a WWW document to other documents

WWW is being run from CERN

Project headed up by Tim Berners-Lee

World Wide Web (WWW)

WWW uses its own protocol to transfer information

Provides a very powerful mechanism for locating and retrieving information
World Wide Web (WWW)

Plans are underway to have a WWW gateway to WAIS, archie, and possibly Gopher

World Wide Web (WWW)

The discussion groups are:
chi-arch@uccvms.bitnet

(LISTSERV)

www-talk@nxoc01.cern.ch

Source available from:
info.cern.ch: /pub/WWW/src

(NeXTStep, Unix command line)

Documentation is available from:
info.cern.ch: /pub/WWW/doc
X.500/White Pages

Peter Yee/ARC
Internet Documentation for USERS
(not WIZARDS!):

FYI RFCs

FYI 12: “Building a Network Information Services Infrastructure”


FYI RFCs (cont.)


Internet Documentation Process

1) Final documents are RFCs.

Available on-line in libraries around the world.

2) IETF Working groups develop drafts.

IESG reviews the drafts, makes recommendations.

IAB approves the drafts for RFC publication.

Request for Comments Document Series

- Started in 1969

- Now have 1304

- Since RFC 500, all are available on-line

- Distribution is primarily via the network (FTP & EMail)
RFCs & FYIs

Primary Repositories:

NIC.DDN.MIL,
FTP.NISC.SRI.COM,
NIS.NSF.NET, NISC.JVNC.NET,
VENERA.ISI.EDU,
WUARCHIVE.WUSTL.EDU,
SRC.DOC.IC.AC.UK
FTP.CENTER.NET

Secondary Repositories:

Sweden, Germany, France,
Netherlands, Finland, Norway,
Denmark, Australia, Pacific Rim
and the United States

The RFC Info Service

An email based service

Helps in the locating
and retrieval of RFCs
and FYIs

For example:

To: rfc-info@ISI.EDU
Subject: getting rfcs

help: ways_to_get_rfcs
Notable NICs

DDN (NIC)
Merit
NSF (NNSC)
SRI (NISC)

Defense Data Network (DDN) Network Information Center

Assists DDN users in obtaining information about the DDN and the Internet.

Assigns IP network numbers, autonomous system numbers, and administrates Domains

The DDN NIC is reachable at: (800) 365-3642, and via electronic mail to: “nic@nic.ddn.mil”
Merit/NSFNET Information Services

Services include:
- Merit Networking Seminars
- NSFNET publications
- online information services
- consulting

Merit/NSFNET is reachable at:
(313) 936–3000 and via
electronic mail to:
"nsfnet-info@merit.edu"

NSF Network Service Center

Provides information services to the NSFNET end-user community

Including:
- online information workshops
- resource cataloging
- technical support.

The NNSC is reachable at:
(617) 873–3400, and via electronic mail to:
"nnscc@nnscc.nsf.net"
SRI Network Information Systems Center

Provides network tools and information services to the Internet community.

Including:
- online information
- FTP repository of RFCs
- Only service offering hardcopy RFCs

The SRI NISC is reachable at:

(415) 859–6387
(415) 859–3695
(415) 859–6028 (FAX)
and via electronic mail to: nisc@nisc.sri.com

Mail Servers

RFC–Info

FAST

MOSIS
**FAST**

Electronic broker service for purchasing:
- electronic components test equipment
- optical parts & equipment
- communications equipment
- laboratory equipment and supplies

Via EMail

Contact:
To: FAST@ISI.EDU

In the body of the message:
Request: Information
Topic: Introduction
Request: End

**MOSIS**

Broker service for obtaining custom VLSI chips. Used by university researchers and students learning about VLSI, as well as professionals designing new chips

Contact:
To: MOSIS@MOSIS.EDU

In the body of the message:
Request: Information
Topic: Topics, Library
Request: End
Telnet

STIS
(NSF Science and Technology Information Service)
telnet to:
128.150.195.40
stit.nsf.gov

Telnet

GORD
(NIST GOSIP Register Database)
telnet to:
129.6.48.100
user-name:
gosip.db
X.500 Directory Services in NASA

Peter Yee
Ames Research Center

April 1, 1992

Directory Services in NASA

- What's an X.500?
- X.500 throughout the world
- X.500 in NASA
- Issues
- Status and Recommendations
What's an X.500?

- Service description
- How it works
- Directory Service Standards Bodies
- Directory Service Standards
- Implementations
- Directory Service Pilots

Directory Service Standards Bodies

- CCITT/ISO are joint issuers of X.500.
- OIW - designing profiles for real world use of the directory.
- NADF - working on making X.500 a commercial reality.
- IETF - targeting directories on the Internet and solving operational issues.
X.500 Service Description

X.500 is a:

- Distributed database.
- Name service.
- White pages system.
- The solution to all of OSI's problems.

Directory Information Tree

- A (suggested) hierarchical scheme for data organization.
- Has levels for countries, organizations, people, etc.
- Scalable for global usage.
How it works

• X.500 Model
• User's Perception
• Application of X.500

X.500 Model

X.500 service is made of two parts:

• DUA (Directory User Agent - a client)
• DSA (Directory System Agent - a server)

and it uses two protocols:

• DAP (Directory Access Protocol)
• DSP (Directory System Protocol)
**User's Perception**

- Consistent interface to data from all sources.
- X.500 model not apparent to user.
- May be accessed through directory browsers or other applications which incorporate DUAs.
Applications of X.500

- X.400 Electronic Mail
- White Pages
- Resource Locations
- Naming Services


- Naming and Addressing
- Distribution List Expansion
- Authentication and Security
- Capability assessment (i.e. supported recipient options.)
- Routing and path optimization.
Applications of X.500

White Pages

- A large telephone book
- Inexact matching
- Searching

Applications of X.500

Resource Location and Naming Services

- Locate computers, peripherals, and services.
- Translate human understandable names into machine identifiers (like the Internet DNS).
Implementations

Commercial:
- Retix, OSIWare, Unisys, and even Novell

Non-Commercial:
- QUIPU, Custos, Pizarro

QUIPU

- Major directory research platform capable of running on many UNIX systems.
- Basis for some commercial products.
- Widely used and well-tested.
- Directory Service Agent (DSA)
- Supports 1988 Standards
- Low initial cost
- Requires ISODE
Why QUIPU?

- Supports distributed directory information architecture.
- Includes replication and access controls.
- Integrates with PP X.400 electronic mail for distribution list expansion.
- Provides an important service with no current competition.
- The price is right!

QUIPU

Future of QUIPU:

- ISODE Consortium
  - Non-profit organization to foster the growth of the ISODE.
  - Responsible for future development.
  - NASA is a charter member.
Directory Service Standards

- CCITT/ISO X.500 - X.521 series of recommendations
- NIST - GOSIP Version 3
- OIW - OIW Profiles
- NADF - NADF 175, etc.
- IETF - numerous RFCs

Directory Service Pilots

- FOX
- PSI WPP
- PARADISE
- NIST/GSA
- Internet Pilot
- NASA Pilot
Fielding Operational X.500 (FOX)

- Jointly funded by DARPA, NSF, DOE and NASA.
- Testing interoperability of QUIPU and NIST's Custos implementation of X.500.
- Merit developed object identifiers to store the Internet network infrastructure information in X.500.
- SRI developed an X.500 version of the WHOIS database.
- PSI has created an index into the RFC/FYI document series and applications to locate and retrieve RFCs with X.500.

Performance Systems International (PSI) White Pages Pilot (WPP)

- Manages the US Directory Information Tree of the X.500 world pilot.
- 73 organizations
- Uses the QUIPU implementation of X.500.
- 300,000 entries
Piloting A Researcher's Directory Service In Europe (PARADISE)

- Actually manages the global directory pilot.
- 23 countries
- 420 organizations
- 500,000 entries
- Uses the QUIPU implementation of X.500.

NIST/GSA

- Currently serves NIST, GSA, and NSF.
- Uses Custos, NIST's implementation of X.500.
Internet Pilot

- Encompasses the PSI WPP and Paradise, plus several other countries.
- A major source of directory research and experience.
- Testbed for Internet RFCs and experimentation.

NASA Pilot

- Servers running at ARC, GSFC, JPL, LeRC, and MSFC.
- Proxy service provided for DFRF, JSC, KSC, and LaRC.
- Hope to have HQ join the pilot and move proxy servers to respective centers.
- Approximately 50,000 entries available.
X.500 in NASA

Directory Service Accomplishments

- Establish NASA White Pages Pilot under PSI WPP.
- Relational database front-end for QUIPU.
- Search for directory user agent.
- Actively participate in development of X.500 software and related support infrastructure.
How to populate QUIPU Entry Data Block (EDB)?

- Civil Servant information is from NASA Personnel and Payroll System (NPPS).
- Contractor information is from other applications on the same IBM Mainframe.
- Additional information is not centralized (i.e. electronic mail address).

Existing Method for Creation of Directory Entries

- Additional information cannot be stored on mainframe.
- Additional information would not be stored in EDB because they would be lost after each EDB creation.
New Method for creation of Directory Entries

- Relational Database becomes centralized master for additional directory information.
- Relational database can be modified to accept other data feeds.

X.500 Development

- Beta tester for QUIPU and ISODE software.
- Created Macintosh DUA called MacDish.
- Working in IETF, IEEE, and ANSI on X.500 standards, profiles, and additions.
**Directory User Agents**

**Terminal**

- **Dish** - Provides a very powerful interface into the Directory and gives a user full access to the Directory Access Protocol (DAP).
  - Can be used to build custom interfaces, which are easier and more intuitive.

- **Fred** - A DUA optimized for White Pages queries.
  - Can make complex searches, and compose mail addresses using the MH mail.

- **SD** - Screen Directory
  - Screen oriented interface with the same functionality as POD.

- **DE** - Directory Enquires

**X-Windows**

  - Supports user-friendly naming.

- **Pod** - X windows. Intended for naive users.
  - Click on buttons to pop up windows with more Directory Information.

- **XDI** - Advanced version of POD from Bellcore.

- **XT-DUA** - Commercial DUA from X-Tel. Motif-based user interface.
Directory User Agents

Macintosh and IBM PC

- MacDish - NASA/Ames Research Center
- maX.500 - University of Michigan (RFC 1249)
- PSIWP - Performance Systems International, Mac
  (RFC 1202)
- PCWP - Performance Systems International, PC
  (RFC 1202)

DISH

```
Dish -> 1
  1. organizationalUnit=Name=Research Center
  2. organizationalUnit=Bryson Flight Research Facility
  3. organizationalUnit=Earth Observing System
  4. organizationalUnit=Goddard Institute for Space Studies
  5. organizationalUnit=Space Flight Center
  6. organizationalUnit=Headquarters
  7. organizationalUnit=Jet Propulsion Laboratory
  8. organizationalUnit=Johnson Space Center
  9. organizationalUnit=Kennedy Space Center
 10. organizationalUnit=Library Research Center
 11. organizationalUnit=Lewis Research Center
 12. organizationalUnit=Marshall Space Flight Center
 13. organizationalUnit=Merrill Assembly Facility
 14. organizationalUnit=Middlet College Complex
 15. organizationalUnit=Space Station Freedom Project Office
 16. organizationalUnit=Serna Space Center
 17. organizationalUnit=Wallops Flight Facility
 18. organizationalUnit=White Sands Test Facility
 19. commonName=
 20. commonName=over-headed Spider Monkey
(DLlmit problem)
```

Dish -> next
Dish -> search -filter cn="Peter Ye"
### MacDish

<table>
<thead>
<tr>
<th>Entity Name:</th>
<th>om/Peter Van</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone:</td>
<td>+1 415-604-3812</td>
</tr>
</tbody>
</table>
| Address:    | NIMR Ames Research Center  
              | MS 239-10  
              | Moffett Field, CA 94035 |
| rfc822Mailbox: | yeo@nasa.arc.nasa.gov |
| OtherMailbox: | No Entry |
| PagerNumber: | +1 415-607-1821 |

---

### Other DUA's/Directory Users

- DS Agent/Quickmail Integration
- Internet whois server
- XUA
- PP
Directory Service Issues

- Standard is still evolving (X.500 1992)
- PC/MAC User Agents
- Vendor support and commitment
- User demand

Current Status

- ICCN/S recommends an engineering operations test period at (at least) 3 sites (Ames and two sites TBD).
- Continue to search for more DUA's.
- NAS purchased a machine to serve as Ames DSA.
Recommendations

- Determine level of support needed at each Center for a fully operational DSA, based on experiences from engineering operations test.
- Coordinate with personnel and payroll groups at each Center to obtain data for Center's DSA.
- Provide a mechanism for retrieving directory information via electronic mail.
- Work within ISODE Consortium to have QUIPU tested for X.500/GOSIP compliance.
D. Network Communications Technology
Plenary
NASA SCIENCE INTERNET
USERS WORKING GROUP
CONFERENCE

APRIL 2, 1992

"INTERNET FORECAST"

Vint Cerf

Corporation for National Research Initiatives
OVERVIEW

- Scaling
- Speed
- Services
- Constituents
- Applications
- Service Providers
- Government Roles
THE SCALING CHALLENGE

😊 Internet doubles every 7-12 months
تفسير
Running out of routing power
 بواسطة
Running out of Address Space
USE
We need to support a BILLION networks
емых
(see above)
تشجيع
Must deploy incrementally
تعزيز
Must deploy IN TIME!
MORE SCALING CHALLENGES

!! We need more capacity

NSFNET Packet Traffic History

February 1992, 13.4 billion packets

*Total packets, T1 and T3 networks

July 1988, NSFNET begins operation under Merit's management

178
ROAD WARRIORS

Co-Chairs: Phill Gross/ANS
Peter Ford/LANL

✓ IAB Charter
(Architecture Retreats)

📅 Their 4 month mission:

To boldly go where no routing and addressing architecture has ever gone before!

✓ March 92 IETF Report
✓ Various Working Group Spinoffs
ROUTING

THE ISSUE

- IS-IS for CLNP
  OSPF for IP
  Dual IS-IS/Proto.

- Border Gateway Protocol 4
  (Masking/CIDR)

- Internet Domain Routing
  Protocol (IDRP) for IP/CIDR

- Address Assignment Issues

- Internet Domain Policy
  Routing (IDPR)

Route Servers
Policy Routing
TOS/QOS Routing
SERVICES

- Network Services

  Frame Relay (56, DS1, DS3?)

  SMDS/DQDB (56, DS1, DS3, OC3, OC12...?)

  ATM (DS3, OC3, OC12, OC24, OC48,...)

  PLAnet (IBM)

  All Optical (1G, 10G, 20G, 1T,...)

- Transmission Services

  HiPPI/SONET (OC3, OC12,...)
  [800M, 1600M]

  All Optical?
SERVICES (2)

- Real-Time Voice/Video
- QOS Resource Management
- Mobility Support

  Mobile Hosts (LAN Reconnect, Cellular/PCN, Satellite)

  Mobile Nets (cars, planes)

- Ubiquitous Computing
  (tabs, boards, pads)
CONSTITUENTS

- CS/EE » R&D » Universities » Military » Government » Industry » K-12/Libraries » Residential

[Home Lans are HERE!]

- US/North America » EUROPE » Pacific Rim » East. Europe » Latin America » Mideast » CIS » Africa
APPLICATIONS

- Telnet, X-Windows, V-Reality

- EMAIL, Comm’l EMAIL, PEM, Info Services, EDI, Electronic Commerce

- FTP, Anonymous FTP, archie, gopher, Knowbot Programs, WAIS, digital libraries, electronic publishing

- Talk, Internet Relay Chat, shared windows/blackboard, video-conferencing, collaboration technologies

- Distributed Laboratories, Telepresence

**BANDWIDTH HOGS** Nightmare!
SERVICE PROVIDERS

- Government Private Nets
  (NSINET, DARTNET, ESNET, NSFNET, MILNET,...)

- Special Value-Added Nets
  (ANSNET, ALTERNET, PSINET, SURANET, CERFNET, JVNCNET LOS NETTOS, BARRNET, SESQUINET, PREPNET, NEARNET, EBONE, NORDUNET DFN, WIDE, AARNET,...)

- Public Carrier Nets
  (RBOC Frame Relay/SMDS Svc, IXC FR/SMDS, INFONET, SWIPNET, UK PIPEX, SPRINTLINK, ...)
Amendment to HR2936

Science Subcommittee (Boucher, VA):

Sec 3 of NSF Act of 1950 amended:

(g) ...the Foundation is authorized to foster and support the development and use of computer networks which may be used substantially for purposes in addition to research and education in the sciences and engineering, if the additional uses will tend to increase the overall capabilities of the networks to support such research and education activities.

[Full S&T Committee Markup 4/2/92]
President's Program: NREN Perspective

NREN is a national high speed network to provide distributed computing capability to research and educational institutions and to further advanced research on very high speed networks and applications.

NREN is a network for research and education, not general purpose communications.

The NREN builds on NSFNET, ESNET, NSI and other networks supporting research and education. During 1992, the NREN will accelerate the introduction of commercial 45 megabit transmission technologies and services into operational use, including SMDS.

Also: OSTP Press Briefing, January 30, 1992:
The NREN is a high performance technology testbed for research and education, not for commercial use.
President's Program: NREN Activities

- Assist upgrades of regional & community of interest networks, where appropriate, especially where these upgrades enhance end-to-end reliability.
- Produce improved user-level tools to enable scientists & educators to take advantage of the NREN's capabilities.
- Refine the understanding of requirements for high capability networks: bandwidth, latency, predictability & stability.
- Improve the technologies necessary for policy controls, resource allocation, fair sharing, accounting, security, peering, and routing coordination. Integrate commercial services fully and interconnect to other relevant networks.
- Provide for a network information service that acts as a primary source of information on access to and use of NREN.
- Enhance the current interconnected multi-agency architecture to provide for the interoperability of Federal and non-Federal networks, to the extent appropriate, in a way that allows for the autonomy of each network component.

President's Program: NASA & NREN

Goal: to accelerate the development and application of high performance computing technologies to meet NASA science and engineering requirements.

NASA's program will bring together interdisciplinary teams of computer and computational scientists to develop the necessary technologies within two vertically integrated NASA grand challenge projects that are unique to the NASA mission. These technologies include applications algorithms and programs, systems software, peripherals, networking, and the actual high performance computing hardware. NASA will develop a suite of software tools to enhance productivity, including load balancing tools, run time optimizers, monitors, parallelization tools, as well as data management and visualization tools.

NASA will provide high-speed network connections among NASA, industry and academic researchers.
HPCC Act, Section 101 (2)

(2) The Program Shall:

(A) Provide for the establishment of policies for management and access to the NREN;

(B) Provide for oversight of the operation and evolution of the NREN;

(C) Promote connectivity among computer networks of Federal agencies and departments;

(D) Provide for efforts to increase software availability, productivity, capability, portability, and reliability;

(E) Provide for improved dissemination of Federal agency data and electronic information;

(F) Provide for acceleration of the development of high performance computing systems, subsystems, and associated software;

(G) Provide for the technical support and R&D of high performance computing software & hardware needed to address Grand Challenges;

(H) Provide for educating and training additional undergraduate & graduate students in software engineering, computer science, library & information science, and computational science; and

(I) Provide for the security requirements, policies, and standards necessary to protect Federal research computer networks and information resources accessible through Federal research computer networks, including research required to establish security standards for high-performance computing systems and networks;

HPCC Act, Section 102. NREN

(a) NSF, DOD, DOE, DOC, NIST, NASA, etc. shall support the establishment of the NREN, portions of which shall, to the extent technically feasible, be capable of transmitting data at one gigabit per second or greater by 1996. The NREN shall provide for the linkage of research and education institutions, government, and industry in every state.

(b) Federal agencies shall work with private network service providers, state and local agencies, libraries, educational institutions, etc. to ensure that researchers, educators, and students have access to NREN. NREN is to provide users with appropriate access to high-performance computing systems, electronic information resources, other research facilities, and libraries.
HPCC Act, Section 102. NREN

(c) NREN characteristics. The NREN shall
1. be developed & deployed with the computer, telecommunications, and information industries;
2. be designed, developed, and operated in collaboration with potential users in government, industry, and research & educational institutions;
3. be designed, developed, and operated in a manner which fosters & maintains competition and private sector investment in high speed data networking within the telecommunications industry;
4. be designed, developed, and operated in a manner which promotes R&D leading to development of commercial standards that will encourage establishment of privately operated high speed commercial networks;
5. be designed and operated to ensure the continued application of laws that provide network and information resources security measures, incl. those that protect copyright and other intellectual property rights, and those that control access to databases and protect national security;
6. have accounting mechanisms which allow users to be charged for their usage of copyrighted materials available over the NREN, and for their use of NREN where appropriate & feasible;
7. ensure the interoperability of Federal and non-Federal computer networks, to the extent appropriate, in a way that allows autonomy for each component network;
8. be developed by purchasing standard commercial transmission and network services from vendors whenever feasible, and by contracting for customized services when not feasible, in order to minimize Federal investment in network hardware;
9. support research & development of networking software & hardware;
10. serve as a testbed for further R&D of high capacity and high speed networks

(e) Information services. The Director of OSTP shall assist the President in coordinating the activities of appropriate agencies and departments to promote the development of information services that could be provided over the NREN. These services may include the provision of directories of the users and services on computer networks, data bases of unclassified Federal scientific data, training of users of data bases and networks, access to commercial information services for NREN users, and technology to support computer-based collaboration that allows researchers and educators around the Nation to share information and instrumentation.

(g) The OSTP Director shall report to Congress on:
1. effective mechanisms for providing operating funds for the maintenance and use of the NREN, including user fees, Industry support, and continued Federal Investment;
2. the future operation and evolution of the NREN
3. how commercial information service providers could be charged for access to NREN, and how NREN users could be charged for such commercial information services;
4. the technological feasibility of allowing commercial information services providers to use the NREN and other federally funded research networks;
5. how to protect the copyrights of material distributed over the NREN; and
6. appropriate policies to ensure the security of resources available on the NREN and to protect the privacy of users of networks.
**NREN GOALS**

Priority:

1) Implement high performance network services and systems to support the networking needs of the HPCC program;

2) Enhance and expand, as required, existing regional research and education networks in order to provide appropriate access to HPCC sites and collaborators, and to HPCC networked resources;

3) Provide for a smooth and economical transition to the gigabit NREN; and

4) Provide for NREN access and use by the broader education (e.g. elementary, secondary, and higher) community and by libraries.

**APPROACH**

EXISTING FEDERAL INTERNET → INTERAGENCY INTERIM NREN → NREN

Agency Nets
Regionals
Campus Nets

NSFnet Extension
DARPA R&D
Agency (NSI) Upgrades
Regionals Upgrades
Education Access

Gigabits!
EOWG Coordination Activities

Coordinate plans and activities for the existing federal Internet systems to maintain stability, reliability, and uniform high quality of service:
- Review agency operations and engineering activities to assess their effectiveness
- Arbitrate routing issues for the federal domestic and collaborating international networks that are part of or connect to the Federal Internet
- Maintain working relationships with commercial product & service providers

Coordinate the NREN implementations of the HPCC agencies:
- Review & assess NREN architecture options and implications
- Provide recommendations to move from the current Internet to the NREN
- Analyze NREN requirements from HPCC agencies, with due consideration of other agencies as well as the broader research and education community
- Identify policy implications of technical alternatives
- Assist in documenting NREN status to HPCC Management

HPCC Committee Hierarchy

Federal Coordinating Council on Science, Engineering & Technology

Committees on Physical, Mathematical & Engineering Sciences

High Performance Computing, Communications, & Information Technology Subcommittee

Education Science & Engineering Computing Computer Research & Development High Performance Communications

Federal Network Council ADVISORY COMMITTEE FEDERAL NETWORK COUNCIL
ICCN/S = HPCC

Intercenter Council for Computer Networking - Science

ICCN-8

<table>
<thead>
<tr>
<th>CENTER</th>
<th>ORGANIZATION</th>
<th>RESPONSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARC</td>
<td>Code ED</td>
<td>J. Yin</td>
</tr>
<tr>
<td>GSFC</td>
<td>Code 520</td>
<td>G. Dorman</td>
</tr>
<tr>
<td>JPL</td>
<td>Div. 37</td>
<td>D. Gallop</td>
</tr>
<tr>
<td>LARC</td>
<td>ACD</td>
<td>J. Nolan</td>
</tr>
<tr>
<td>LERC</td>
<td>MS 1390</td>
<td>D. Cica</td>
</tr>
</tbody>
</table>

NSI - NASA Science Internet

Technology Migration Path

2488 mbps  633 mbps  155 mbps  45 mbps

FY92  FY93  FY94  FY95  FY96

OC-48  DS3   SMDS over ATM  B-ISDN

OC-xx  B-ISDN

NSI - NASA Science Internet
### Technology Risks

<table>
<thead>
<tr>
<th>ACCESS</th>
<th>SERVICE</th>
<th>RATE</th>
<th>SWITCHING</th>
<th>AVAIL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame relay</td>
<td>async</td>
<td>DS1</td>
<td>frame relay</td>
<td>now</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DS3</td>
<td>cell relay</td>
<td>1992</td>
</tr>
<tr>
<td>SMD/8IP</td>
<td>async</td>
<td>DS1/DS3</td>
<td>cell relay</td>
<td>1992</td>
</tr>
<tr>
<td></td>
<td>isoc</td>
<td>OC-3</td>
<td>cell relay</td>
<td>1993</td>
</tr>
<tr>
<td>ATM</td>
<td>async/isoc</td>
<td>DS3</td>
<td>ATM</td>
<td>1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OC-3</td>
<td>ATM</td>
<td>1993</td>
</tr>
<tr>
<td>B-ISDN</td>
<td>async/isoc</td>
<td>OC-3:12</td>
<td>ATM</td>
<td>1994</td>
</tr>
</tbody>
</table>

### Initial Implementation Schedule

<table>
<thead>
<tr>
<th>FY92</th>
<th>FY93</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3 NSFnet</td>
<td>ARC</td>
</tr>
<tr>
<td></td>
<td>GSFC</td>
</tr>
<tr>
<td>SMD/8IP</td>
<td>ARC</td>
</tr>
<tr>
<td></td>
<td>GSFC</td>
</tr>
<tr>
<td></td>
<td>LARC</td>
</tr>
<tr>
<td></td>
<td>LERC</td>
</tr>
<tr>
<td>DARPA R&amp;D</td>
<td>JPL</td>
</tr>
<tr>
<td>NSI upgrades</td>
<td></td>
</tr>
<tr>
<td>SONET upgrades</td>
<td></td>
</tr>
<tr>
<td>Bay Area Gigabit Testbed</td>
<td></td>
</tr>
</tbody>
</table>
**NSF: Tempering the Regionals**

**Regional Infrastructure Enhancements**

<table>
<thead>
<tr>
<th>MANAGEMENT &amp; OPERATIONS</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
<th>FY25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single point of control</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 x 7 operations staffing</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMC/ITC backup</td>
<td></td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENGINEERING &amp; TECHNOLOGY</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
<th>FY25</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 to campus networks</td>
<td>▲</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3 to campus networks</td>
<td></td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Mbps access to NREN</td>
<td>▲</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>823 Mbps access to NREN</td>
<td></td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USER SERVICES</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
<th>FY25</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSFNET NIC</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Applications: mail, X.500, etc.</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NREN NIC</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Advanced applications: multi-media</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Initial Milestones**

<table>
<thead>
<tr>
<th>Basic Connectivity to Centers</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3 NSFNET</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>SMDS Pilot</td>
<td></td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>OC-1 implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher OC level plans</td>
<td></td>
<td></td>
<td>▲</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INREN Technology &amp; Services</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3 NSFNET Backbone</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Regional T3 upgrades</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMDS/ATM backbone</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OC-3/12 planning</td>
<td></td>
<td>▲</td>
<td>▲</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gigabit Technology Deployment</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC-3 switches &amp; routers</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>OC-15 switches &amp; routers</td>
<td>▲</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OC-34 switches &amp; routers</td>
<td></td>
<td>▲</td>
<td>▲</td>
</tr>
</tbody>
</table>
NASA PERSPECTIVE

NASA'S NREN
- Funded by HPCC to provide investigator access to/between Grand Challenge facilities
- Represents less than 10% of overall NASA HPCC budget
- Primary role is to support HPCC!

REQUIREMENTS
- T3+ class service between 5 NASA HPCC Centers
- T1+ class service to ~100 Principal Investigators

NATIONAL CONTEXT
- NASA must coordinate NREN with other HPCC agencies
- NASA needs high performance national network infrastructure
- NASA supports U.S. science education and research
NASA Approach

T3 SERVICE BETWEEN NASA CENTERS
- Provided by SMDS switching fabric
- Used wherever high performance access is required
- Provides access to existing NASA networks with HPCC users
- Leverages on TELCO investments & directions

TI SERVICE TO NASA INVESTIGATORS
- Assumes Investigators at sites already connected (i.e., NSFNET)
- No NASA funds for point-to-point T1's
- Use T3 to NSFnet for aggregated T1 requirements
- NSFnet access via FIX's, after upgrade to FDDI

Current Telecommunications Infrastructure

DEDICATED POINT-TO-POINT LEASED LINES
- Local loop provided by Local Exchange Carriers (LEC's)
- Long haul provided by Inter-exchange Carriers (IXC's)
- No customer switching equipment at TelCo central offices
- Possibility of link failure requires redundancy
- Dedicated to single user use (and billing!)
- Limited bandwidths available (9.6, 56, 1544 kbps, etc...)
- User must provide network monitoring and diagnostics (e.g., PSCN COMM)
- Routers at user sites perform packet switching
  - LAN interfaces (e.g., Ethernet, FDDI, etc.)
  - WAN interfaces (e.g., serial sync lines using V.35, etc.)
  - Switch packets from serial line to serial line or LAN
  - Provide network layer routing
FAST PACKET TECHNOLOGY

USER SITE CONNECTS TO TELCO "CLOUD"
- Single access to TelCo local loop infrastructure
- Telco provides internal cloud redundancy
- Telco packet equipment switches link to link
- Multiple access rates (SMDS @ 1.5, 4, 10, 16, 34 ... Mbps)
- Protocol independent switching at high speed
- Telco provides packet monitoring and diagnostics
- Telco provides service - not links and hardware

ROUTERS INTERFACE SITE TO "CLOUD"
- Routers switch packets only between LAN and Telco "cloud" - Telco's do high performance switching, and allow routers to do more control!
- Routers still perform network layer routing

FRAME RELAY

ANSI I.122 & Q.931
- Designed for 56 - 1544 Kbps access
- Private addressing scheme (i.e., DLCI)
- Connection oriented
- Each station must be configured with "link" to neighbors
- No multicast capability
- Internally carried as variable length HDLC frames
- Available from carriers now
- Easy to build router interface hardware
Switched Multimegabit Data Service

SMDS (Bellcore specification)
- Designed for 1.5 - 155 Mbps (extensible to 622 Mbps)
- Public addressing standard (E.164 - phone numbers)
- Connectionless datagram protocol
- Neighbors can be configured as Virtual Private Net (VPN)
- Multicast supported inside the VPN
- Internally carried as 53 byte fixed length cells
- Available from some LEC's now at 1.5 Mbps
- Router interfaces more sophisticated (IEEE 802.6)
- Preferred by most LEC's and IXC's for service interface
- Requires SONET at 155 Mbps (STS-3c) and above

Asynchronous Transfer Mode

ANSI T1S1 Group
- Designed for use at 155 Mbps and above (requires SONET)
- 53 byte cell transport
- Addressing, routing, accounting, congestion & flow control not well defined as yet
- Many possible user interface standards (including SMDS)
- Also suitable for high speed LAN architectures
- Long term goal for Telco internal substrate
COST CONSIDERATIONS

POINT-TO-POINT LEASED LINES
- T3 price based on T1 price, T1 prices based on 56Kbps, etc.
- Strong price hierarchy to prevent reselling & undercutting supply carrier
- ARC-GSFC dedicated T3 cost = $3 Million/year
- ARC-GSFC Internal Telco cost significantly less!

SMDS APPROACH
- Prices based on access class (1.5, 4, 10, 16, 34... Mbps)
- Telcos can trunk internal net using internal cost, since no reselling of leased circuits is possible
- Distance insensitive pricing
- Same switching fabric can support Frame Relay and low speed uses

SMDS Implementation Approach

1. Leverage on DOE/LLNL procurement vehicle in FY92/93
2. Deploy DS-3 SMDS attachments at ARC, GSFC, JPL, LaRC & LeRC in FY93
3. Deploy new routers with DS-3 SMDS support with FDDI ring(s) in FY93
4. ARC and GSFC sites provide interface to T3 NSFnet connectivity via FIX-E and FIX-W
5. Deploy 155 Mbps support in FY94 given budget and requirements
6. Deploy 622 Mbps support in FY95 given budget and requirements
7. Prototype SMDS technology for use in other NASA and Federal programs as a production oriented network service
Issues & Concerns

REMOTE INVESTIGATOR ACCESS
- Assumes investigators are located at well-connected sites
- Future of NSFnet backbone still being defined
- Regionals vary in quality and service (little accountability!)

HIGH PERFORMANCE PACKET SYSTEM
- Vendor support is immature for routers, DSU's, switches
- Lack of Inter-Carrier-Interchange (ICI) protocol support
- IXC deployment of SONET proceeding at lackluster pace
- 155 Mbps and above to NASA sites is critically dependent on LEC SONET deployment
- Dependent on Telco support and deployment schedules
- Routing complexities when interconnecting VPN's over SMDS

SUMMARY
- Focus on meeting NASA HPCC Grand Challenge requirements
- Maximizes use of existing network resources, NASA & non-NASA
- Strongly leverages on telecommunications carrier plans and investments: no private dedicated systems
- Minimizes NASA costs while still providing high performance capabilities
- Fully consistent with national program objective to construct a high performance national network infrastructure
- Provides for strong technology transfer to other programs
- Provides testbed for advanced routing and management designs for large scale public data networks
E. Network Applications Technology
Plenary
Distributed Visualization

Horace Mitchell
NASA Center for Computational Sciences
NASA/Goddard Space Flight Center
The User's Perspective
My Personal View of Scientific Visualization

Can I coerce my data into a visual image that matches my mental image of what's going on?

Remember the scientific method:

Hypothesis (mental image)
Experiment (visual image)
Verification (do they match?)

A scientific visualization is a form of experiment. If the images match I have verification and if they don't I have new information.
What characteristics do I, as a user, want in a visualization tool?

- A flexible, easy-to-use user interface
- High performance 2D and 3D visualization capability (fast and/or high quality)
- Adaptable to many scientific disciplines/data types
- Customizable for user-specific requirements
- Scalable from my workstation to a supercomputer
- Usable in three modes:
  - immediate mode
    (during computation or data acquisition)
  - analysis mode
    (after computation or data acquisition)
  - production mode
    (unattended immediate/analysis mode)
The Randall Report –

In 1986, this report outlined the components that a centralized computer facility should have in order to satisfy NASA's computing requirements for the Space and Earth Sciences.

These components were:
- A Supercomputer
- A Data Management and Archival System
- A Central Graphics Facility
- A High-Speed Network

The purpose of the Central Graphics Facility would be to provide publication-quality monochrome and color output and movie-making facilities.
The Randall Report -

The Randall Report also recognized that much of the smaller-scale analysis and graphic production would migrate to local user workstations that were linked to the central computer facility by the high-speed network.

Since a user would want to do analysis locally and use the central facility for high-quality and/or specialized graphics services, the user's local efforts should interface smoothly with those of the central facility.

What is the role of a supercomputer center in the area of graphics and visualization?
The supercomputer center certainly has a role in providing high-end, specialized hardware for visualization.

- High-quality/high volume printers
- Professional quality movie making
- High-performance processors for immediate visualization and high-quality rendering

The supercomputer center also provides software environments:

- Testbed environments for introducing users to new methods
- Production environments linked to specialized hardware
What are the supercomputer support requirements for visualization software?

- Open systems (Unix, X-Windows, PEX)
- Compatibility with existing networks and platforms
  - in-house platforms
  - user platforms
- Distributed processing capability
- Customizable for system-specific requirements
  - specialized production facilities
  - other visualization software
- Vendor and/or user community supported

It has become increasingly clear that a supercomputer center may not have the resources to develop and maintain its own software.
Data Flow Visualizers

Interactive visualizers, user programmable through "data flow networks" composed of system and user-defined elements

- AVS (Advanced Visual Systems Inc.)
- apE (TaraVisual Corporation)
- Iris Explorer (Silicon Graphics)
- Power Visualization Data Explorer (IBM)

Data flow visualizers combine "visual programming", networked modularity, and customizability
Distributed Visualization at the NCCS

AVS has been identified by the NCCS as the initial software of choice for distributed visualization for a variety of reasons:

- established vendor support over a variety of platforms to support the heterogeneous NCCS user community

- availability on a major NCCS platform (Convex) as a testbed for NCCS users

- distributed multiprocessing capabilities over both the NCCS systems and the user workstations
Methods of Distributed Visualization

Convex

- Input
- Filter
- Map
- Render

AVS

Testbed/Low-end

user workstation
or
X-terminal

2D color
X server

NCCS
Methods of Distributed Visualization

Convex

Input -> Filter -> Map -> Render

Graphics Server

user workstation or PEX-terminal

3D color graphics server

NCCS
Methods of Distributed Visualization

Convex, Cray

**AVS command line**

**Calculation**

**Filter**

**AVS modules**

user workstation

Map

Render

2D/3D graphics server

socket

NCCS
Methods of Distribution within AVS (historical)

- AVS Kernel
- Input
- Filter
- Map
- Render

socket

NCCS

separate unix processes
Methods of Distribution within AVS (current)

socket

NCCS

shared memory

Input
Filter
Map
Render

separate unix processes (same machine)
Methods of Distribution within AVS (current)

Input

Filter

Map

Render

NCCS

single unix process

socket

shared memory

AVS Kernel
Methods of Distribution within AVS (future)
Collaborative Distributed Visualization (future)
Issues

- **Performance**
  
  A general purpose tool such as AVS tends to be inadequate for high-performance applications such as those requiring large data sets or rapid, interactive animation.

  This issue may resolve itself as workstation and network performance improves.

- **Licensing**
  
  Some users are reluctant to commit themselves to an application that cannot be shared with their collaborators without significant expense.

  This issue corresponds to the support issue with free license software.
Future Directions:

- **Software Connectivity**
  No one environment can satisfy all visualization requirements. A number of vendors are planning software development within AVS or software connectivity to AVS that will expand the scope of the AVS environment.

- **Parallel Computing**
  AVS has been chosen by a number of vendors of parallel computers as a possible software environment. The network programming environment of AVS could separate "front-end" user interface elements from "back-end" high performance computation elements.
Conclusion

The goal of the scientific visualization effort within the NCCS is to provide an environment for scientific visualization that serves as much of its user base as possible.

AVS is our current testbed for providing distributed visualization services due to its scope, modularity, and network transparency.

The NCCS has several other testbed visualization environments involving visualization on high-performance graphics hardware for those tasks which cannot be served by a broad spectrum tool such as AVS.
TAE Plus
Transportable Applications Environment Plus
A Tool for Building and Managing
Graphical User Interfaces

Marti Szczur
NASA/Goddard Space Flight Center

NASA Science Internet User Working Group Conference

April 2, 1992
Greenbelt, Maryland

TAE Plus Overview

- Background
- Architecture
- Development Environment
- Runtime Environment
- User Community
- Future Direction
What is TAE Plus?

TAE Plus is a portable software development environment designed to support the

*rapid building,*

*tailoring,* and

*management*

of an application's user interface.

TAE Plus can be viewed as a tool for increasing developer's productivity.
TAE Plus Key Objectives

- Improve productivity of application UI development
  -- Support WYSIWYG design of the UI elements
  -- Support evolution from rapid prototype to baseline system
  -- Provide reusable software components
  -- Provide less complex set of application services
  -- Support for UI expert (who may be a non-programmer)

- Provide buffer from technology changes
  -- Separate the UI definition from the application
  -- Provide application programs with toolkit-independent runtime services
  -- Support portability of applications across workstations (e.g., UNIX, VMS)

TAE Plus Environment

- Development Environment
- Application
  - WPTs
    - OSF Motif™
    - X Window System™
  - Resource File
- Run Time Environment

NASA/GSFC
What does the X Window System provide?

- a standard for device independent window management
  - public domain protocol for window management services
  - low-level graphic and window management primitives
  - MIT's X-Window system is a public domain implementation of the protocol

- support for network interconnection
  - display process (X Server) and application (X Client) can exist on separate machines
  - X Protocol provides the network connection between X Server and X Client

Distributed Applications in X Environment

- single workstation
  - no network
- multiple workstation
  - single client/server
- multiple workstation
  - multiple client/servers
TAE Plus WorkBench Functions

- Uses X Window System™ and OSF/Motif™
- Create, modify and save user interaction objects
- Support for drawing, editing and saving data-driven objects
- Define links between user interface objects
- Rehearse a designed user interface
- Icon editor
- On-line help on how to use WorkBench
- Support for application context sensitive help
- Generates multi-language application source code (C, Ada, or TCL)
- Object-oriented (written in C++)
WorkBench in Action

User Entry Interaction Objects

Selection Category:
- Checkbox
- Icon
- Keyin
- Label
- Multi-line Edit
- Pulldown Menu
- Push Button
- Radio Buttons
- Scale (Slider)
- Selection List
- Text Display
- X Workspace

Text Category:
- Dynamic Text: Value
- Keyin
- Label

Multi-Line Edit:
This item accepts multiple
You can constrain the input
Scrollbars are optional.

Text Display (text source: text)
This is the first line of text to display it must only take
This is the second line,
This is the third line,
This is the fourth line.
Data-Driven Interaction Objects

- Mover
- Data Rate = 98 kbps
- Stripchart
- Rotator
- Stretcher

DDO Drawing Editor

- data value (optional)
- static background
- dynamic foreground
User Interface Designer Scenario

- Create a panel
- Add interaction items
- Include another resource file
- Design icons and DDOs
- Make connections
- Create help information
- Rehearse
- Modify the design
- Generate code

WorkBench Main Menu

Resource File: tutorial

WorkBench Model:
- Move/Resize/Edit
- Define Connections
- Set Panel Default
- Set Item Default

Current Selection:

File   Edit   Arrange   Auxiliary   Help

- New... Ctrl+N
- Open... Ctrl+O
- Save... Ctrl+S
- Save As...
- Include...
- Quit...

- Modify...
- Undo...
- New Panel...
- New Item...
- Duplicate...
- Select All...

- Align...
- Specify Align...
- Toggle Grid...
- Snap to Grid...
- Specify Initial Panel...

- Generate Code...
- Rehearse...
- Identify WBS Panels Ctrl+B
- Create Terminal Ctrl+K
- WorkBench Preferences...
Select New Item from WorkBench Panel

Item Specification

Target
- Item Name: [edit]
- Data Type: String, Integer, Real
- Null Value Allowed
- Generates Events

Panel Name: [edit]

View
- Title: [edit]
- Presentation Category: Data Driven Objects, User
- Presentation Type: Push Button, Radio Button
- Font: [edit]
- Background Color: [edit]
- Foreground Color: [edit]
- Border Width: [edit]
- Shadow Thickness: [edit]

Item Constraints
- Candidate Strings
  - Enter one string per line.
  - Press SetConstraints Button.
  - Enter values for radio button list.

NASA/GSFC
Creating a Data-Driven Object

Item Details Panel
Stretcher Item Detail

Connection Panel

Select Define Connections on Main Menu
TAE Command Language (TCL)

- Interpreted
- Interactive or procedural
- General capabilities
  - Intrinsic TAE commands
  - Online help
  - Local and global variables
  - Variable assignment and expressions
  - Macro-level substitution
  - Abbreviated command and parameter names
  - Constructs for conditional execution and looping
  - Proc invocation and inter-proc communications
  - Graphic Window Manipulation

Create Help Information

- Select yes for "Help Item?" in the presentation panel for a button or an icon.
- Click on "Edit Help File" in the specification panel for the selected panel.

```
.help
"place panel help information here"

.help action
The action selections are: <fill in help text for each>
Display:
Print:
Delete:

.help select
The selections are: <fill in help text for each>
File A:
File B:
File C:

.help question
```
Rehearse

- Select \textit{rehearse} under the \textit{Auxiliary} ... menu
- The WorkBench collapses to an icon
- All application panels disappear
- A window labelled "Rehearsal" appears
- The initial application panel is displayed
- Application panels are displayed as prototyped
- Click on WorkBench Icon to restore WorkBench

Code Generate

\textit{Select Generate Code... under the Auxiliary menu}

<table>
<thead>
<tr>
<th>Application Specification</th>
<th>Code Style</th>
<th>Type of diagnostic messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial</td>
<td>Multiple Files</td>
<td>Summary Only</td>
</tr>
<tr>
<td>Ada</td>
<td>Single File</td>
<td>Progress and Summary</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>Verbose</td>
</tr>
<tr>
<td>Fortran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Print diagnostic messages, but don't create files
- Generate default print statements in Event Handlers
Why use WPT Services?

- Improve portability of applications (i.e., shelter from toolkit changes)
- Improve programmer productivity (i.e., less complex set of routines to master)
- Support multi-language applications (C, Ada, TCL, C++)

TAE Plus Application Services
(Supporting User Interfaces)

Window Programming Tools (WPTs)
A subroutine package that displays and controls the TAE interaction objects during an application's execution. [40 routines]

Collection Package (COs)
A subroutine package that supports the association and management of groups of TAE objects [8 routines]

Variable Manipulation (VMs)
A utility package that receives, sends and manipulates TAE Plus variable objects. [18 routines]
**WPT Routines**

Add/Remove Event - register other event sources for Wpt to receive

Begin/EndWait - visual indication that application is busy

CloseItems - closes items in specified panel

Get/Setxxxx - set item (data type=xxxx) attributes, values and update displays

Hide/ShowItem - remove/replace item from/to display

Init - initialize window system

ItemWindow - get window ID for specified item

MissingVal - display botherbox if input value is missing

NewPanel - create BulletinBoard with items; various states

NextEvent - get events from displayed items

PanelErase - erase a panel

PanelMessage - display dialog box with message(modal)

PanelTopWindow - return parent shell window

PanelWidgetID - get toolkit defined panel handle

PanelWindow - returns window system's window id

**WPTs, continued**

PanelReset - redisplay panel with initial values for all items

ParmReject - reject user input: replace with previous value

ParmUpdate - change an item's target value (as opposed to view)

Pending - checks if an event is pending

Rehearse - auto updating of a DDO's value

Setxxxx - set item (data type=xxxx) attributes, values and update displays

SetTimeOut - set or clear timeout interval for event loop

ViewUpdate - update item's view (i.e., visual appearance)
Code Analysis for TAE Plus V5.1

- 72,000 lines of C and C++ code
- 12 megabyte recommended minimum memory
- .4 - 42 megabytes required disk space
  - .4 mb: TAE runtime libraries, executables only
  - 2 mb: WorkBench executables only
  - 12 mb: no source, no demos, binary libraries
  - 42 mb: all source and all binary libraries, demos
- 11,000 and 5,500 LOC, respectively, for Stanford's interviews and idraw packages
- requires X11R4 and Motif 1.1

NASAGSFC

TAE Plus Implementations

<table>
<thead>
<tr>
<th>Validated Ports</th>
<th>User Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUN3/UNIX</td>
<td>Silicon Graphics/UNIX</td>
</tr>
<tr>
<td>SUN4/UNIX</td>
<td>NEC EWS 4800/220</td>
</tr>
<tr>
<td>SparcStation/UNIX</td>
<td>Masscomp/UNIX (V4.1)</td>
</tr>
<tr>
<td>Apollo/UNIX</td>
<td></td>
</tr>
<tr>
<td>HP9000/300 &amp; 700/UNIX</td>
<td></td>
</tr>
<tr>
<td>DECstation 3100/ULTRIX</td>
<td></td>
</tr>
<tr>
<td>VAXStation II/ULTRIX</td>
<td></td>
</tr>
<tr>
<td>386/486 series</td>
<td></td>
</tr>
<tr>
<td>IBM 6000 (in progress)</td>
<td></td>
</tr>
<tr>
<td>MAC II A/UX (V4.1, only)</td>
<td></td>
</tr>
<tr>
<td>VAXStation II/VMS</td>
<td></td>
</tr>
</tbody>
</table>

NASAGSFC

248
Adding New Presentations To TAE Plus

- Highly modular - almost no change to existing WB/WPT modules
- 150 new lines of WPT code -- in C++
- 100 new lines of WorkBench code -- in C++
- New code may be written using TAE Plus templates
- Involves three basic steps:
  1. Write the widget, compatible with the referenced widget set
  2. Integrate with WPT
     - Make a new presentation type, subclass from WptItem
  3. Integrate with TAE Plus WorkBench
     - Design Presentation panel for the new presentation
     - Add to WorkBench Resource file

Productivity Case Studies

Case 1: Develop application with realtime object using
  (1) Xt and widgets, directly
  (2) TAE Plus WorkBench and Wpts

Case 2: Develop same interactive application using
  (1) Xlib directly,
  (2) UIL and UIL service routines
  (3) TAE Plus WorkBench

Measure application development time
Development Benchmark 1
A program that has two panels, a few action icons, a radio button
bank and a dynamic mover object that moves along a static
background when the associated data value changes.

Hours

0 10 20 30 40 50

TAE+ Novice 52
X Novice 4
TAE+ Experienced 1.5

NASA/GSFC

Development Benchmark 2
A screen copy utility which gathers information through radio
buttons, action icons, and text input. Then, it sends the information
to an HP printer, as well as updating a text widget on the screen.

Hours

0 20 40 60 80

X lib/ Xray 80
UIL 40
TAE+ 4

NASA/GSFC
TAE User Distribution: 836 Total Sites (646 TAE Plus)

- NASA: 32%
- Private Industry: 40%
- University: 15%
- Other Gov't: 13%

NASA-funded Distribution: 280 Sites

- GSFC: 31%
- JSC: 20%
- Others: 21%
- JPL: 14%
- ARC: 7%
- MSFC: 7%
Who is Using TAE?

Outside of NASA:

DOD: Army, Navy, Air Force, DIA, DMA, DARPA

Other Gov't: EROS Data Center, Bureau of Land Management, NCAR, NIH, NIST, NSA, NOAA

Universities: C.U., Duke, Boston, Cornell, Georgia Institute of Technology, CalTech, Arizona State, Purdue, UCLA, U. of Md., MIT, Stanford


Outside of U.S.:


Other: United Nations Environmental (Kenya, Switzerland), New Zealand Government
TAE User Profile: Application Types

"Check the categories that best describe your application"

- Engineering Analysis: 33%
- Operations/Control: 33%
- Realtime: 24%
- Scientific Analysis: 24%
- Database Application: 22%
- Near Realtime: 18%
- Image Processing: 16%
- Office Automation: 2%

Data Base/Analysis Applications

- GSFC's National Space Science Data Center (NSSDC)
- GSFC's Distributed Access View Integrated Database (DAVID)
- GSFC's International Solar Terrestrial Data Distribution Facility (ISTP DDF)
- Wallops Flight Facility image analysis tool (COLOR)
- JPL's IPAC database search program
- NOAA's user interface to oceanographic database
- U. of MD's Viewcache, access for interoperable databases
- EROS Data Center browse/retrieval of satellite imagery
- Wallops Island's image retrieval/processing system
- Contel's meteorological data retrieval system
- National Library of Medicine browse/retrieval of biotechnology data
- National Cancer Institute's user interface to analysis data base
- JPL's Planetary Data System (PLDS)
- Pennsylvania State University (geographic information)
- USAF Plume Date Center (analysis data base)
- Langley Research Center user interface to atmospheric data
- U.S. Geological Survey (analysis data base for 3-D image cubes)
- Hughes Aircraft (geographic data base)
- Shell Development Co. (user interface for DBMS)
- Stanford's Solar Oscillations Imager
Operations/Control Related Applications

- GSFC's Packet Processor Enhanced Front End & Control System
- CU's Operations and Science Instrument Support System (OASIS)
- GSFC's Request-Oriented Scheduling Engine (ROSE)
- GSFC's Network Control Center User Planning System (NCC/UPS)
- Georgia Tech's Multi Operations Control Center Simulator (GT-MSOCC)
- GSFC's Generic Telemetry Simulator (GTSIM)
- GSFC's International Solar Terrestrial Physics Central Data Handling Facility
- Air Force's Tactical Air Combat Simulation (TACS)
- GSFC's Space Network Control System prototype scheduler
- Army's Tactical Command and Control System
- Martin Marietta's Access Control System for secure network access
- ESA's Columbus Crew Workstation prototyping
- General Dynamic's Real-Time Control System for Ground Operations
- Army's Operation Order Generation for Battalion and Below Command and Control Program
- GSFC's SAMPEX Command Management System
- MSFC's ECLSS Process Control Prototype
- Lockheed's Advanced Tomahawk Weapons Control System
- JSC's Shuttle Mission Control Center Upgrade (MCCU) for TSS Mission
- Northern Telecon's Technical Assistance Service (TAS) System

Primary Concerns

- Performance
  - all events/messages go across network
    --- distribute UI manager/dispatcher with server
    --- display and hide UI elements
  - multiple software layers (e.g., X11, Xtoolkit, WPTs)
  - workstation limitations

- Size
  - overhead to application code includes X, Motif, WPT
  - not currently utilizing shared libraries
What Sets TAE Plus Apart from Other Motif Tools?

- User Focus (ease-of-use for UI design professionals)
- Spans all tool categories (virtual API, layout description language, interactive design tool, UIMS)
- Higher level API abstraction
- Data-driven objects
- Help facility
- Auto constraint checking
- Support for WYSIWYG panel connections
- Code generation for multiple programming languages
- TAE Command Language
- Dynamic resource file (no compiling; make changes during runtime)
- Source code included
- Government software (low cost, liberal license)
- User support (technical advice, newsletter, conferences)

Future Directions

- User Interface "object" builders
- User Interface designers
- Application programmers
- Enhanced tools
- Automated design tools
- User Interface Designer WorkBench
- Visual programming tools
- Expert system tools
TAE Plus V5.2 Features

- New interaction objects: Menu Bar with Cascading Menus, Option Menu, File selection dialog, Message boxes (error, information working, warning, question)
- Support for Accelerators/Mnemonic specification
- Improved color/font selection
- Scrollable panels and workspaces
- C++ code generation
- Support for multiple console displays and screens
- Support for tabbing/traversal
- Help and message panel tailoring
- Support for object stacking

Acknowledgements

TAE Plus is available from COSMIC, the NASA Software Distribution Center located at the University of Georgia.
(404) 542-3265

The TAE Support Office is located at GSFC and is available to answer questions and distribute information.
(301) 286 - 6034

TAE Plus development is sponsored by the NASA Office of Space Operations.

TAE Plus is being developed with the prime contractor, Century Computing, Inc.

TAE™ is a registered trademark and service mark of NASA.

TAE Plus uses the Open Software Foundation's Motif™ and MIT's X Window System™
F. User Services and Applications
Subgroup Presentations
User Services Planning in the Internet

NASA Science Internet Users Working Group

30 March – 3 April 1992

Joyce K. Reynolds
Information Sciences Institute
University of Southern California
Marina del Rey, California
USA
Overview

1. Glossary
2. Internet Society
3. IETF User Services
4. RFCs

GLOSSARY

ISOC = Internet Society
IAB = Internet Activities Board
IRTF = Internet Research Task Force
IETF = Internet Engineering Task Force
RFC = “Request for Comments” document
FYI = “For Your Information” document
INTERNET SOCIETY

GOALS

- Multiprotocol Evolution
- TCP/IP, OSI...
- Encourage Internet Growth
- Educate the Public
- Stimulate Provision of Service
- Recognize Individual Contribution
- Promote and Explore Scientific, Educational, Business Use
- Facilitate Collaboration

INTERNET SOCIETY

Organizers: CNRI, EDUCOM, RARE

General Operations: Started 1 Jan 92

Individual and...

Founding Organizational Members are invited to join now.
INTERNET SOCIETY

ACTIVITIES

* Evolution of Internet Technology
* Incorporate IAB, IETF, IRTF
* Newsletter and Journal
* Annual Conference: INET
  INET 92: June 15–19, 1992
  Kobe, Japan
* Possible Infrastructure Assistance
  - CERT–System
  - Crypto–Certificates
  - Internet Registry
  - Referral Services

INTERNET SOCIETY

SUMMARY

* Nourish the Community now
growing up around networks.

* Our packets cross borders
freely and our sense of
community should be equally
open.

* Continue the Grand Collaboration

7,500
now linking 5,000+ nets and

3,000,000+ people, 700,000 hosts

4,000,000+
FOR MORE INFORMATION...

ISOC@NRI.RESTON.VA.US

FAX: +1 703 620 0913

TEL: +1 703 620 8990
IETF User Services
Working Groups and Projects

Directory Information Services Infrastructure (DISI)
Internet Anonymous FTP Archives (IAFA)
Internet School Networking (ISN)

Network Information Services Infrastructure (NISI)
NOCTools
User Documentation (UserDoc)
User Glossary (UserGloss)
User Services (USWG)
User Services Area Council (USAC)

Directory Information Services Infrastructure (DISI)

Chaired by Christopher Weider

DISI chartered to facilitate deployment of X.500 Directory Services on the Internet, by producing "Administrator's Guides".

Current working Internet-draft: "Executive Introduction to Directory Services using the X.500 Protocol".
Internet Anonymous FTP Archives (IAFA)

Chaired by Peter Deutsch and Alan Emtage

IAFA is chartered to define a set of recommended standard procedures for the access and administration of anonymous ftp archive sites on the Internet.

Internet School Networking (ISN)

Chaired by

John Clement
Art St. George
Connie Stout

ISN is chartered to facilitate the connection of the United States’ K–12 (Kindergarten–12th Grade) schools, public and private, to the Internet, and promote school networking in general.
NOCTools

Chaired by Robert Enger and Darren Kinley

"Son of NOCTools" is updating and revising their catalog to assist network managers in the selection and acquisition of diagnostic and analytic tools for TCP/IP Internets.

Network Information Services Infrastructure (NISI)

Chaired by April Marine and Patricia Smith

NISI is exploring the requirements for common, shared Internet-wide network information services. The goal is to develop an understanding for what is required to implement an information services "infrastructure" for the Internet.

Current working Internet-draft: "Building a Network Information Services Infrastructure"
User Documentation (UserDoc)

Chaired by Lenore Jackson
and Ellen Hoffman

User-Doc is preparing a revised
bibliography of on-line and hard
copy documents/reference materials/
training tools addressing general
networking information and how
to use the Internet. (Target audience:
those individuals who provide services
to end users and end users themselves.)

User Glossary (UserGloss)

Chaired by Gary Malkin and
Tracy LaQuey Parker

User-Gloss is chartered to create
an Internet glossary of networking
terms and acronyms for the Internet
community.
User Services (USWG)

The User Services Working Group provides a regular forum for people interested in all user services to identify and initiate projects designed to improve the quality of information available to end-users of the Internet.

User Services Area Council (USAC)

USAC is responsible for researching and defining short term and long term user services needs internationally, and coordinating developments in finding solutions.
Philosophy for Membership

1) People are selected as individuals, NOT representatives of organizations, countries, networks, or anything else.

2) We like to have people with a variety of backgrounds and experience.
IETF User Services
Area Plan

Seven types of User Services objectives:

- User Information
- Network Information Services Infrastructure
- Network Operational Management
- Education
- Documentation and Distribution
- Interaction with IESG Areas
- Interaction with other international user services entities

- User Information

The Internet community requires up-to-date, basic Internet knowledge and experience. These can be achieved by publication of handbooks, bibliographies, directories, and glossaries.

Yet, how does the IETF "get the word out" beyond the normal distribution and announcement via the RFC series??

Identification and research on various existing distribution resources, and consideration of possible long term distribution methods are required.
- Network Information Services Infrastructure

A global infrastructure for common shared Internet-wide network information services is needed.

Research and development for an information services "infrastructure" for the Internet community.

Documentation of methods for the interaction and cooperation among NICs.

We intend to coordinate closely with other efforts in the international networking community.

- Network Operational Management

This topic overlaps with other IETF Areas such as network management, operations, and applications. Yet, development of general information to users is essential.

The User Services Area intends to contribute by providing documentation that will be developed in tandem with technical specifications.
- Education

The educating of new network users is mandatory.

For teachers, trainers, etc., provide organized Internet tutorials, "hands on" training programs, active participation in the K-12 education initiative, and Internet specific documentation.

- Documentation and Distribution

Coordinate the development of informational documentation and distribution methods for the Internet community.

FYI RFCs are introductory and overview documents for network users. Their purpose is to make available general information, rather than the protocol specifications or standards that is typical of other RFCs.
- Interaction with IETF Areas

Coordination with other IETF Areas to work together on topics of common interest.

- International Cooperation

Interaction with other international user services organizations.

Helping New Users

Task for the Networks (e.g., Regionals)

- Newsletters

- New User Guides

- Etc., etc.

IETF User Services is second level. Dealing with real users is first level. IETF User Services provides information to people doing first level services.
Liaison Role

Promote information sharing and cooperation between Network Information Centers.

SRI NISC
Merit
BBN NNSC
CERF-NIC
Others

Internet Documentation for USERS (not WIZARDS!):

FYI RFCs


FYI 5 "Choosing a Name for Your Computer", Aug. 1990.


Request for Comments

Document Series

- Started in 1969
- Now have 1292
- Since RFC 500, all are available on-line
- Distribution is primarily via the network (FTP & EMail)

Internet Documentation Process

1) Final documents are RFCs. Available on-line in libraries around the world.

2) IETF Working groups develop drafts. IESG reviews the drafts, makes recommendations.

IAB approves the drafts for RFC publication.

RFC-Info Service
Rfc-info@isi.edu
The Internet Cruise

Laura Kelleher
Merit, Inc.

Due to copyright considerations and changes in the source material, the Internet Cruise can be acquired from the Merit NIS at 1-800-66-MERIT
Requirements Processing Update
NSIUWG User Services Subgroup Meeting

April 1, 1992

John H. Martin

NASA Science Internet Office
Information and Communications Systems Division
AMES RESEARCH CENTER

NASA
Overview

I. Requirements Processes Overview

II. Future Requirement Process Evolutions

III. Conference Support Update
<table>
<thead>
<tr>
<th>CODE</th>
<th>DISCIPLINE</th>
<th>REQUIREMENTS MANAGER</th>
<th>HQ VALIDATOR</th>
<th>ALTERNATE VALIDATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Office of Space Science and Applications</td>
<td>Maria Gallagher</td>
<td>Dr. Joseph Alexander</td>
<td>Mr. Rick Chappell</td>
</tr>
<tr>
<td>SB</td>
<td>Life Sciences</td>
<td>Shell Jones</td>
<td>Dr. Lawrence Chambers</td>
<td>Dr. Richard (Dick) Keefe</td>
</tr>
<tr>
<td>SE</td>
<td>Earth Science and Applications</td>
<td>Regina Duda</td>
<td>Mr. Ernest Lucier</td>
<td>Mr. Dixon Butler</td>
</tr>
<tr>
<td>SL</td>
<td>Solar System Exploration</td>
<td>JoAnn Nelson</td>
<td>Mr. Guenter Strobel</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>Flight Systems Division</td>
<td>TBD/John Martin</td>
<td>Dr. Phillip J. Cressy Jr.</td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Microgravity Science and Applications</td>
<td>Maria Gallagher</td>
<td>Mr. Robert Schmitz</td>
<td>Ms. Mary Kicza</td>
</tr>
<tr>
<td>SP</td>
<td>Administration and Resource Management Division</td>
<td>TBD/John Martin</td>
<td>Mr. Scott Santiago</td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>Space Physics</td>
<td>Maria Gallagher</td>
<td>Dr. James Willett</td>
<td>Mr. Louis Demas</td>
</tr>
<tr>
<td>SZ</td>
<td>Astrophysics</td>
<td>Elizabeth Feinler</td>
<td>Dr. Erwin Schmarling</td>
<td>Dr. Guenter Riegler</td>
</tr>
<tr>
<td></td>
<td>OSSA Conference Support</td>
<td>Hallie Carlson</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NSJ. Martin as of: 4/6/92
Defining a Requirement

A requirement is a scenario of science network usage. They begin as qualitative descriptions by the scientist and evolve into quantitative definitions as a product of working with a Requirements Manager.

Initial Qualitative Description:

"I am a NASA OSSA funded PI. I would like to be able to send mail to Dr. Verducci in Italy, access the Master Directory at GSFC and obtain LRS data from Galileo - can you help me?"

Derived Qualitative Parameters working with Requirements Manager:

- Locations - scientists, data
- Resources accessed, frequency accessed
- Type of computational activity performed across network - i.e., foreground vs. background and characterization, visualization, "real-time" programming, transaction query, email, file transfer, etc.)
- Additional information relating to User Services, Applications, Operations, and Security support is also derived.

Result: Completed Network Service Request
Planning Office Services

Requirements Planning

Long Range Requirements Projection
Intradiscipline Requirements Prioritization
Requirements Impact Analysis/Planning
Discipline Level MOU Development
Resource and Systems Planning
Discipline Level Overview of Req's set with HQ Validator

Requirements Management

Project Requirements Statuses
Manage Requirements Throughprocess
Communications Requirements Reviews
Work with Customer to Meet Scientific Goals
Continual User/PI Customer Contact and Feedback
Conference Support/Outreach

Requirement Processing
Requirements Processing

"Coordinating and assuring requirements are met"

NASA SCIENCE INTERNET

ALL OSSA RESEARCHERS
FLIGHT PROJECTS
CAMPAIGNS
COLLABORATORS

REQUIREMENT IDENTIFIED AND PRIORITIZED

NETWORK SERVICE REQUEST

USER SUPPORT

ANALYSIS ENGINEERING COSTING

ACQUISITION NASA (PSCH) or non-NASA

OSSA PROGRAM MANAGEMENT

IF COST, THEN HQ FUND CERTIFICATION

AVERAGE IMPLEMENTATION (12-18 MONTHS)
OSSA Requirements Processing Timeline

AVERAGE MONTHS

0  2  4  6  8  10  12  14  16  18  20

Customer Requirements Definition
NSI Validation Preparation
HQ Validation
Engineering
PSCM Implementation
User Requirements Satisfied

NASA Science Internet Project

John H. Martin
Validation Turnaround Time

AVERAGE NUMBER OF DAYS

S - 5  SB - 8  SE - 43  SL - 40  SN - 22  SS - 18  SZ - 10
Overview

I. Requirements Processes Overview

II. Future Process Evolutions

III. Conference Support Update
MOU Development Process

Program Review Cycle
- Understand and Participate in Discipline Communications Planning Process and Requirements Development
- Identify and Conceptualize Communications Architecture
- Draft and Sign OSSA Discipline MOU
- Develop Requirements Processing Priorities/Schedules
- Draft Project Specific Requirements Reference Documents

Project Review Cycle
- Revolving Document - More Frequent Updates to Meet Changing OSSA Requirements
- Longer Standing - At Discipline Level

NASA Science Internet Project
FY 92 Changes

Refine and Update NSR Process Through NSR Workshop - Look to Include Cost Weighting, and better hand-offs, QA Measures

Look to Increase User Services/NIC Requirements Definition/Tracking Effort to Incorporate into Existing NSR Process

Increase Requirements Manager's Outreach to Scientific Community

Redesign MOU Process to Develop Discipline Level MOUs

Step-up Planning Efforts with HQ Disciplines - Schedule Requirements

Hold Communications Requirements Reviews Annually

Standardize Requirements Reporting Format
Overview

I. Requirements Processes Overview

II. Future Process Evolutions

III. Conference Support Update
## FY 92 Conference Profile

<table>
<thead>
<tr>
<th>Conference Supported</th>
<th>OSSA Discipline</th>
<th>Level</th>
<th>Exhibits</th>
<th>Est. Cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division of Planetary Science (DPS)</td>
<td>SL</td>
<td>56kb</td>
<td>PDS</td>
<td>9.4K</td>
</tr>
<tr>
<td>Palo Alto, CA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Geophysical Union (AGU)</td>
<td>SE,SS</td>
<td>T1</td>
<td>MD</td>
<td>43.7K</td>
</tr>
<tr>
<td>San Francisco, CA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Astronomical Society (AAS) Winter</td>
<td>SZ</td>
<td>T1</td>
<td>GRO, HESARC, STScI, SAO, IUE, NSSDC, MD, ADC EUVE, IPAC</td>
<td>30.7K</td>
</tr>
<tr>
<td>Atlanta, GA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International Space Year (ISY - ESSIS)</td>
<td>S</td>
<td>(T1)</td>
<td>------</td>
<td>10.1K</td>
</tr>
<tr>
<td>Pasadena, CA. - JPL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunar and Planetary Society Conference (LPSC)</td>
<td>SL</td>
<td>(T1)</td>
<td>------</td>
<td>8.4K</td>
</tr>
<tr>
<td>Houston, TX. - JSC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAS Summer</td>
<td>SZ</td>
<td>T1</td>
<td>TBD est.. 5</td>
<td>TBD</td>
</tr>
<tr>
<td>Columbus, OH.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Society of Gravitational and Scientific Biologists (ASGSB)</td>
<td>SB</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

* = Cost includes NSI internal resources in addition to standard conference charges
Conference Support Updates

Conference Requirements Managed as "Typical" NSI Requirements

Conference Requirements are Validated, Documented, and Tracked

ISMB Direction for Conference Support
Support AAS, AGU, LPSC - Other Conferences Supported According to NSI Discretion and Available Resources. Funding Assistance Needed From Society

Working with Societies to Ease $ Impact of NSI Services and to Increase NSI's Available Resources

Education of Societies is the Future

NIC On-line System (NONA) Demonstration's Provided

NSI Comments Email Address Established for User Feedback to NSI (comments@nslpo.nasa.gov)

Drafted and Distributed "How to" Documentation
The NASA Science Internet Network Information Center Help Desk

Bill Yurcik
Hughes STX Corp.

April 1, 1992

Presentation to the NASA Science Internet User Working Group (NSIUWG) Conference

What is the NSI NIC Help Desk?

A centralized contact point to provide/facilitate networking information for the entire NSI community

- Respond to user requests
- Coordinate with the NSI NOC
- Coordinate with other NICs
- Reflect user feedback to NSI Project Management
- Report statistics on Help Desk Operations
Responding To User Requests

- Sharing information
- Answering questions
- Solving problems
- NSI-DECnet node administration
- Referring users to most appropriate sources
- Internal procedures to optimize our effectiveness
  (reference material, training, internal handoffs, organizing information)
- Striving to provide more personal interaction
  (increased staff coverage, telephone contact, meetings)

NSI NIC/NOC Coordination

- Coordinate response to user requests with NSI Network Operations Center (NSI NOC)
- Work with the NSI-NOC to provide more network status information to users
  e-mail announcements of network events, maps, network statistics, automated voice messages, an automated trouble ticket system accessible to users
- Work with the NSI NOC to provide network management tools to users
  a real-time graphical network management system integrating both TCP/IP and DECnet that would be accessible via NSI (read-only)
Reflect User Feedback to Project

- **NSI NIC Help Desk Input to Current NSI Projects**
  Reflecting feedback of user-oriented concerns during project development

- **"NSI New User Packet" Contents**
  Reflecting feedback from new users who contact the NSI NIC Help Desk in search of "network orientation"

- **Documentation Needs**
  Reflecting feedback from users repeatedly requesting similar information either on-line or hard copy

- **NIC Requirements Beyond Scope of Help Desk Operations**
  Reflecting feedback from users for large scale user services projects (i.e. NSI Resource Guide, directory services, library access, etc...)

Monthly NSI-NIC Help Desk Report

**OBJECTIVES:**

1. Identification of valuable information to be compiled
2. Mechanisms to transparently gather and process NSI NIC Help Desk Information
3. Development of significant statistics
4. Presentation of statistics in meaningful and visually-intuitive formats
5. Mechanisms to distribute a Monthly NSI NIC Help Desk Report to the NSI community
NSI NIC Help Desk
Future Objectives

--- WE WOULD LIKE USER PRIORITIZATION INPUT ON THE FOLLOWING ---

• NSI NIC facilitated mailing lists on special interest topics
• An Automated User Request Tracking System
  (directly accessible by users via NSI)
• Improved telephone response capabilities
• Increased hours of staff coverage
• Increased reference capabilities, on-line & hard copy
• Increased use of on-line applications in Help Desk support
• NSI NIC Help Desk Newsletter (with FAQ, FYI, news, announcements)
• Training for NSI user community
• Separate NSI User Services Meetings with open discussion

WHO YOU GONNA CALL?

NSI Network Information Center

Code 930.6
Goddard Space Flight Center
Greenbelt, MD 20771

301-286-7251
(FAX) 301-286-5152

nsihelp@nic.nsi.nasa.gov
nsinic::nsihelp
NSI NIC Possibilities

- Directory Services
  *interim solution(s)*

- Indexed Access to the NSI File Cabinet
  *NSI ARCHIE client/server*

- NSI NIC Info Server
  *based on NNSC info server, automated e-mail responses*

- On-Line Access to NASA Center Libraries
  *bibliographic search and retrieval, special databases, nationwide, full text*

- NSI Resource Guide
  *one document that pulls together NSI Resources (databases, supercomputers, e-mail syntax, FTP sites, on-line resources, NASA projects, professional groups, etc...)*

- NSI E-mail Distribution Lists on Special Topics
  *science_discipline@nic.nasa.gov, project@nic..., net_status@nic..., nslwrg@nic..., action@nic..., nsci_decm@nic..., new_tools@nic...*

- NSI Announcement/Bulletin Capability
  *info@nic.nsi.nasa.gov, on-line calendar, electronic newsletter*

- Facilitate Research Collaboration on NSINIC Host
  *Common development environment for papers, sharing software, electronic journals*

- NSI Information Tools Transfer
  *Internet information tools, how to find software tools, network management tools, data transfer tools*

- Assignment of IP Addresses for Nobile NSI Users
  *TCP/IP access through configured terminal servers*

- NSI Wide Area Information System (WAIS)
  *search and retrieval system which is question-based*
**NSI NIC Possibilities**

---

**WE WOULD LIKE USER PRIORITIZATION INPUT ON THE FOLLOWING**

- NSI NIC facilitated mailing lists on special interest topics
- An Automated User Request Tracking System
  *(directly accessible by users via NSI)*
- Improved telephone response capabilities
- Increased hours of staff coverage
- Increased reference capabilities, on-line & hard copy
- Increased use of on-line applications in Help Desk support
- NSI NIC Help Desk Newsletter *(with FAQ, FYI, news, announcements)*
- Training for NSI user community
- Separate NSI User Services Meetings with open discussion

---

**Information Tools on the Internet**

**ARCHIE**
archive server, 2 part index/search, 900 anonymous FTP sites,
1.6 M files, works w/ Gopher/WAIS/WWW
  TELNET archie.auna.net login: archie request 'help'

**Gopher**
hierarchical browsing tool, full text, multi-media, TELNET, FTP, works w/ ARCHIE/WAIS/WWW, TELNET consultant.micro.umn.edu login: gopher

**HYTELNET**
menu-based hypertext for finding resources, Unix/VMS/PC
anonymous FTP ftp.nut.nist.gov directory library

**KNOWBOT**
master directory of directory services info (whole, White pages, X.500, MCImail), model of future automated info gatherer,
TELNET nrl.reston.va.us 185

**PROSPERO**
distributed directories, virtual networked file system, 7,500 systems in 29 countries, works with ARCHIE/GOPHER/WAIS/WWW
send mail to info-prospero@isr.edu

**WAIS / SWAIS**
Query mass store databases, 238.50 client/server model,
results come back with probability, full text, multi-media
works with ARCHIE/GOPHER/PROSPERO/WWW,
TELNET quake.think.com or hub.nsc.net login: wais

**WORLD-WIDE WEB**
hypertext browsing tool for Unix and Macintosh
provides access to full text, multi-media, works w/ ARCHIE/GOPHER/WAIS
Information Tools on the Internet

Library Catalogs:

Internet-Accessible Library Catalogs and Databases

Libraries: Accessing On-Line Bibliographic Databases

Libraries: List of Contacts for Internet On-Line Bibliographic Databases

WUGATE: Gateway to the Internet Libraries and More

Campus Wide Information Systems (CWIS)

On-Line Internet Resource Guides

MERIT

NNSC (NSFNet Network Service Center)

NORTHWESTnet

Netric Information Tools on the Internet
## On-Line Internet Resource Guides

<table>
<thead>
<tr>
<th>Network</th>
<th>Description</th>
<th>Access Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Version 2.0, also menu-driven tour of resources in the guide allowing transparent access</td>
<td>TELNET nysernet.org login: nyarview password: nyarview</td>
</tr>
<tr>
<td>SURAnet</td>
<td>&quot;Information Available on the Internet: A Guide to Selected Sources&quot;</td>
<td>anonymous FTP ftp.sura.net located in directory nic</td>
</tr>
<tr>
<td>THEnet</td>
<td>&quot;User's Directory of Computer Networks&quot;</td>
<td>anonymous FTP emx.utexas.edu in directory net.directory (97,98,99)</td>
</tr>
</tbody>
</table>

## Misc Pointers to Information Tools

- RFC 120 "There's GOld In Them Thar Networks!"
- "Zen and the Art of the Internet: A Beginners Guide to the Internet" anonymous FTP ftp.cs.widener.edu directory pub/brenden zen-1.0.ps
- FTP Anonymous Servers List anonymous FTP pilot.nj.in.net directory pub/ftp-list ftp-list
- Internet Mail Distribution Lists "List of Lists" anonymous FTP ftp.niso.srl.com directory netinfo interest-groups.txt
- NETNEWS
Selected Topics from the Audience

- Conference Support
- Advertising of the NSI NIC
- Info server authentication of software
- NSI Map, NOC statistics
- How to get applications software?

WHO YOU GONNA CALL?

NSI Network Information Center

Code 930.6
Goddard Space Flight Center
Greenbelt, MD 20771

301-286-7251
(FAX) 301-286-5152

nsihelp@nic.nsi.nasa.gov
nsinic::nsihelp
NSINIC Services
Future Possibilities

C. Wrandle Barth
April 1, 1992

Requirements-Driven Support

- Potential service awareness to feed user requirement process

- Existing basic services
  - Help desk
  - New user documentation and mini-guides
  - Outreach
  - NONA
  - NSI File Cabinet

- Custom services
  - Initially provided to support special requirements
  - May evolve to become a basic service
  - Example: Electronic Postal Facilities
    
    Value-added transport-agent services that can be provided on top
    of traditional email without changing the user agent
Electronic Postal Facilities

- Remailing
- Address query; with fuzzy match
  - Example: /FN=JOHN*/LN=ROBINSON/INSTITUTION=CUNY
- Distribution lists
  - For official broadcast from few to many
  - For distribution from any to all in group
  - For closed-group discussions
  - For open-membership discussions
- File archive of distributions with ability to order part/all
- Document ordering
  - Email delivery
  - Anonymous FTP/LISTSERV style
  - Abstracts
  - Postal mail delivery
- Trouble ticket status
- Conference registration
- Message text transformation
- Other batch services from NIC

Potential Future Services

- Replicate/customize emerging services (WAIS, Archie, et al.)
- Provide utilities for session/presentation/application layers
  - Distributed systems, RPC protocols, client/server systems
  - Interim utilities for data transfer
    - Compression, error checking/correction, library utility, data conversion
- Other OSI/GOSIP applications:
  - MHS/X.400, VT, directory services, transaction processing, remote DB, FTAM, ODA, CGM/GKS, electronic data interchange, SGML
- Educate users in connectivity protocols, software
  - Client/server, among-peer protocols
  - Toolkits for protocol support
- Emerging technologies
  - X²-windows, remote visualization, interoperating databases, multimedia conferencing
CRUSH
The NSI Data Compression Utility

Edward Seiler
Hughes/STX Corporation
seiler@amarna.gsfc.nasa.gov
CRUSH
The NSI Data Compression Utility

Features:

- Includes several compression algorithms, providing a choice for particular data sets
- Decompressor automatically chooses correct algorithm
- Automatic mode tests all methods and selects the one that produces the greatest compression
- Compatible with UNIX Compress and DECUS IZ
- Source code written in C, will run on VMS and UNIX machines
- Wildcarded file specifications allowed
- VMS file characteristics (e.g. sequential organization, variable-length records) are retained through the compression/decompression
Coming soon:

- CRUSH
- Algorithms suited especially for compression of images, including the Rice algorithm, and a lossless JPEG variant
- Recognition of FITS formatted data
- Eliminate need to specify UNIX export when compressing VMS files
- Speed improvements
CRUSH
The NSI Data Compression Utility

Compression performance:

- Calgary corpus: includes a bibliography, fiction and non-fiction books, object code, electronic news, technical papers, source code in three programming languages, a terminal session transcript, and a black and white facsimile picture.
CRUSH
The NSI Data Compression Utility

Compression performance:

- Gray-scale images: A collection of ten gray scale images, including many "standard" images for comparing compression performance, were tested.
CRUSH
The NSI Data Compression Utility

Compression performance:

- Landsat Thematic Mapper images: Two seven band images of TM data, covering the Washington D.C. and New Orleans, LA areas

<table>
<thead>
<tr>
<th>Method</th>
<th>Input Bytes</th>
<th>Compressed Bytes</th>
<th>Percent Saved</th>
<th>CPU time (secs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best each file</td>
<td>3670016</td>
<td>1670823</td>
<td>54.47%</td>
<td>164.88</td>
</tr>
<tr>
<td>ADAP</td>
<td>3670016</td>
<td>1670823</td>
<td>54.47%</td>
<td>164.88</td>
</tr>
<tr>
<td>LZO</td>
<td>3670016</td>
<td>1971185</td>
<td>46.28%</td>
<td>58.53</td>
</tr>
<tr>
<td>WNC</td>
<td>3670016</td>
<td>2159046</td>
<td>41.17%</td>
<td>138.20</td>
</tr>
<tr>
<td>LZRW3A</td>
<td>3670016</td>
<td>2578671</td>
<td>29.73%</td>
<td>34.86</td>
</tr>
</tbody>
</table>
CRUSH
The NSI Data Compression Utility

Compression algorithms:

- LZC: the UNIX Compress algorithm, a dictionary-based technique. Good compression with high speed.


- ADAP: WNC encoding with an order-1 model (symbol pairs). Provides better compression than others for certain data, but is slower.

- LZRW3A: Ziv-Lempel class sliding-window algorithm designed for extremely high speed. Compression comparable to LZC.

- AUTO: tries all algorithms and encodes with the one producing the greatest compression
G. Networking Subgroup Presentations
The Program Support Communication Network (PSCN)
Program Support Communication Network

What IS: NASA Telecommunication company
- support non-spaceflight critical requirements

Services:

Teleconferencing
- VOTS
- VITS

Messaging
- Fax Store/Forward System
- E-mail

Data
- Dedicated Lines
- X.25
- PSCN Internet
- FTS2000 Agent within NASA

Current Upgrades
- X.25 Packet Switch Upgrade
- Front-End network resource manager NET IDNX 70 & 90's
- Road runner replacement
- DS-3 Ring
DECnet Phase V
Update
Phase V General Strategy

- Backwards compatibility between Phase V and Phase IV systems during the transition is the cornerstone of the transition plan:
  - Sites needn't do anything for the time being and still will keep existing connectivity. Phase V addressing will follow the existing Phase IV address structure during the transition.
- The OMNI global namespace will be utilized and supported for the Phase V transition:
  - Sites needn't join OMNI until they bring up their first Phase V system; sites, however, must join OMNI when they do bring up their first Phase V system.
- A common Phase IV address structure will be utilized to ensure backwards compatibility during the transition period. The common Phase IV prefix will be 47:0020.
- DECnet end systems (non-routing nodes) will upgrade to Phase V when they are ready to do so, independent of (sort of...) whether the DECnet area they belong to is still utilizing Phase IV routing, or is utilizing Phase V/CLNS routing:
  - Caveat: As long as the DECnet area is still using Phase IV routing, Phase V systems must be configured to ignore ISO/CLNS routing, or risk having DECnet "break".
- DECnet areas will be upgraded on an area-by-area basis from Phase IV routing to Phase V/ISO/CLNS routing. The implementation of Phase V routing is complicated by other existing ISO/CLNS support.
- There will be a limited time frame for the transition period. After that transition period ends, the transition will be declared over, and the requirement for backwards compatibility to Phase IV systems will be dropped. Remaining Phase IV systems will likely suffer from limited access, and have to utilize indirect means (poor man's routing) to access much of the network. Tentative time scale is 2 years from first customer shipment of VMS.
OMNI namespace support within ESnet (summary)

- OMNI will be a global namespace, serving all the DECnet internet community. It will be a distributed namespace with sites wanting to join the namespace assuming responsibility for management of that part of the namespace which directly supports their own node objects.

- ESnet will join the other networks (NSI-DECnet, E-HEPnet, & E-SPAN) in providing support for the top levels of the namespace that are jointly shared by everyone, and will provide access to the namespace for those sites presently belonging to the ESnet-DECnet network (using ESnet-DECnet area numbers).

- ESnet facilities will use the following general syntax for logical namespace support:

  .US.<facility>.<sub-facility> where <facility>.<sub-facility> mirrors (reverse order) existing internet names at facility level and below.

  .US.FNAL.CALVIN (CALVIN.FNAL.GOV)  .US.ANL.CTD.HOBBS (HOBBS.CTD.ANL.GOV)

- Two (for now) "master servers" in the ESnet-DECnet, which would be dedicated systems to support inter-site functions for namespace service, containing the following directories:

  <root>, '.US', and generic directories (generic Phase IV node, Backtranslation, DTS)
  Other national ('.CH', '.BR') and agency ('.US.NASA') directories as appropriate.
  Crucial replicas of site-level directories ('.US.FNAL').

- Synonym directories will be implemented at the site level. Each site will assume responsibility for providing & maintaining its own synonym directory. An information distribution mechanism (similar to existing Phase IV distribution) will be necessary to assist sites in populating their local synonym directory.

- A generic directory (.US.ESNET.NODE) will be provided to contain the node objects of sites which have not yet joined OMNI. However, once a site joins OMNI, all of its own node objects will be moved from the generic directory to the site directory and be managed by the site.
OMNI namespace support within ESnet (cont.)

- Sites are required to provide their own name server(s), when they join OMNI. The server(s) will support:
  
  Master replica of site-level directory ('.US.FNAL');
  Subdirectory structure below site level directory;
  Local synonym table (if desired).

Restrictions & recommendations on site name servers:

- At least 2 local name servers is STRONGLY recommended;
  <root>, '.US', and generic directories will not be replicated on site server(s).
  Sites may replicate another facility's site-level directory by mutual agreement.

- Access control will be managed by the creation of access control groups responsible for maintaining specific directories. The access control groups for the top levels of OMNI are clearly defined; and a model for access control groups at lower levels is specified.

- Target date for making OMNI available to the ESnet-DECnet community is 5/1/92 (but that seems somewhat optimistic...).
OMNI status

- Six countries: US, Italy, CERN, the U.K., France, FRG

- Two servers in the US:
  - FNAL (supporting <root>)
  - MSFC (NASA)

- One ESnet facility directory:
  - FNAL (with populated synonym subdirectory)

- A generic ESnet directory
  (with populated generic Phase IV node sub-directory)

- Waiting for:
  Server @ LLNL (NRERSC) to be master server.
OMNI status (continued):

- Ultimate structure of OMNI:

```
<root> -> NASA
  |   -> NASA Facility Level Directories
  |   |   -> ESNet-DECnet Facility Level Directories
  |   |   |   -> Synonym
  |   |   |   |   -> Synonym
  |   |   |   |   -> ANL
  |   |   |   |   |   -> CTD
  |   |   |   |   |   |   -> HEP
  |   |   |   |   |   |   |   -> FNAL
  |   |   |   |   |   |   |   |   -> Synonym
  |   |   |   |   |   |   |   |   |   -> univ
  |   |   |   |   |   |   |   |   |   |   -> Synonym
  |   |   |   |   |   |   |   |   |   |   |   -> ESNET
  |   |   |   |   |   |   |   |   |   |   |   |   -> Node
  |   |   |   |   |   |   |   |   |   |   |   |   |   -> NASA
  |   |   |   |   |   |   |   |   |   |   |   |   |   |   -> NASA
  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   -> NASA
``` 

- All ESnet-DECnet sites (backbone & tail sites) have facility-level directory with synonym subdirectory (and other sub-directory structure, where appropriate).
Absence of full name support for VMS means that a hierarchical structured namespace must be administered as a flat namespace.

This is technically workable, but at a significant administrative cost:

Synonym table maintenance is the primary means of administering simple name support;

Alternative means of working around the lack of full name support problem include:

- Local root abbreviation for systems with the namespace root;
- Host-based "synonyms" (system logistics);
- VMS has a "limited" (100 nodes) local (host-based) namespace capability, but either the local namespace must be the default namespace, or the namespace name must be specified;

All administrative methods of supporting simple names place the burden of that administration down on facility network namespace managers (synonym directory), local system managers (system logistics & local namespace), or the user (use addresses...). The important point is that these entities are no longer just responsible for maintaining their own part of the namespace, but also their view of the entire namespace as well.

We plan on assisting with this by setting up an information distribution for ESnet-DECnet synonyms that local sites can use to populate their synonym table. However, naming support beyond the boundaries of the ESnet-DECnet will be questionable (difficult).

There is also an architectural concern about allowing users to become dependent on simple name support, creating difficulties dropping the support once full name support is available.

The piecemeal support for full names (likely MAIL & SET HOST) does alleviate to some degree the problems with lack of full name support, but does not eliminate the problems/concerns.
The ESnet-DECnet has a rather complex DECnet routing environment:

- The ESnet backbone (multiprotocol) is large & heavily interconnected;
- The ESnet backbone sites tend to share DECnet areas across the backbone;
- The backbone uses cisco (3rd party) routers;
- Tail site connections come in many "flavors":
  - Leased lines (both DECnet-only & multiprotocol)
  - NSF regionals (CICnet & Nearnet)
  - Encapsulation (Multinet)

ESnet is already supporting ISO/CLNP:

- cisco's ISO/IGRP (ie., proprietary) as a routing protocol;
- A routing architecture with the backbone in its own routing domain (RD) & sites within their own RD (which would fragment a Phase V DECnet area shared across the backbone);

An ESnet ISO Routing task force was set up to specify OSI routing across the ESnet backbone that would support a DECnet Phase V transition. The task force has come up with two possible ways of doing that:

- Special code that would be implemented on one router per site that would "tunnel" Phase V OSI traffic across the backbone, thus joining together the fragmented area.
- Realign the RD boundaries along existing DECnet Phase IV area boundaries for the transition period.

Both options are presently being evaluated for feasibility and impact on the network.

Specific routing plans for individual ESnet DECnet areas are on hold awaiting that decision.
ESnet DECnet Phase V Documents

- ESnet-DECnet Namespace Guidelines - describes the name structure (logical namespace) to be used in the ESnet-DECnet for Phase V:
  
  available via anonymous ftp at NIC.ES.NET decnet/phase-v/dnans_guidelines.txt,
  via DECnet at ESNIC::[anonymous.decnet.phase-v]dnans_guidelines.txt

- ESnet-DECnet Policies and Procedures for Implementation of OMNI Namespace (draft) - describes implementation specifics for joining OMNI:
  
  available via anonymous ftp at HEPNET.FNAL.GOV edwg/omni.ps, or via DECnet at HEPNET::[anonymous.edwg]omni.ps

- Memo describing current recommendations on installing & configuring DECnet/Ultrix 5.0 (Phase V):
  
  available via anonymous ftp at HEPNET.FNAL.GOV edwg/phasév.ultrix, or via DECnet at HEPNET::[anonymous.edwg]phasev.ultrix

ESNIC = 41.174 / 42158
HEPNET = 42.620 / 43628

3/30/92
Summary of ESnet-DECnet Phase V Status

- Namespace planning & implementation are in "final" stages:

  ESnet DECdns Policies & Procedures for OMNI Namespace document is in second rev. of draft; the third rev. will likely be passed up to the ESCC for review & approval.

  OMNI namespace is in its initial implementation (shakedown) phase with a target date of 5/1/92 for general community access (probably a bit optimistic...).

  Lack of full name support on VMS systems makes it unclear when there will be a recommendation for sites to go ahead and bring up Phase V on VMS.

  Support for '.EDU', '.GOV', etc. is DEAD & BURIED!

- Addressing & Routing:

  The HSDCG agreed upon Phase IV compatible prefix (47:0020), and the existing Phase IV addresses will be used to create the backwards compatible address structure for the transition period.

  There is a recommendation on bringing up Phase V on Ultrix systems, and that is not to do so until OMNI is available. Addressing specifications are included for those wishing to go ahead anyway (caveat emptor...).

  Actions pertaining to Phase V routing support remain on hold pending resolution from the OSI routing task force of the Phase V/CLNS routing problem.
NASA/NSI UPDATE
DECNET/OSI PHASE V
ACTIVITIES

NSIUWG NETWORK SUBGROUP
APRIL 1, 1992

Phase V Update

New NASA Technical Group (DOT Group)
• DOT meetings - summary
• Current DOT actions
• ICCN

Phase V Testbed Activities
• MSFC/GSFC/DOE

NSI Activities
• DOE/EDWG
• HSDCG
Phase V Update

The DECnet to OSI Transition Group (DOT)
- Met twice - August 21-22, 1991 (Littleton MA) and January 30-31, 1992 (KSC, FL)
- Attended by technical reps from most centers, SPAN France and ESA reps, NASA's general wide area network providers (NSI, PSCNI)
- Focus of first meeting: "SURVIVAL TRAINING" - two day intensive bootstrap workshop on the three "ings" - Naming, Addressing, and Routing.
- Comprehensive notes and slides available (JUST ASK!)
- Results: More meetings...

- Focus of second meeting:
  - DECdns (name service) primarily, then addressing, routing
  - Dan Anderson (JSC) elected chairman (it was unanimous)
  - Next meeting at JPL in July
  - Comprehensive notes and slides available (JUST ASK!)
  - Results: 1) DECdns service supported by participant centers - will have running in 6-8 months (from Jan)

DOT ACTIONS:
1) write "cookbook" on DECdns naming and implementation
2) subgroup to examining RD boundaries in greater detail
3) work with Intercenter Council on Computer Networking (ICCN)

DOT STATUS:
1) cookbook in progress (no draft available)
2) subgroup has yet to meet
3) DOT group now officially recognized subgroup of ICCN
Phase V Update

PHASE V TESTBED ACTIVITIES

• MSFC/GSFC/Fermi National Accelerator Laboratory (FNAL/DOE)
  continue Phase V testing (see map)
  - Extensive testing of DECdns, routing on various platforms (Ultron, VMS, DR2000), interaction of IS-IS on DR2000 with Cisco CLNP

OTHER ACTIVITIES

• NSI continues collaboration with Energy DECnet Working Group
  (DECdns naming papers, general PV/OSI transition planning)
  - NASA/NSI DECdns naming paper in draft but available!! (JUST ASK)
  - NASA/DOE transition paper almost available (3 weeks - Update from DECUS April 1991 paper)

• NSI continues work with HEP-SPAN DECnet Coordination Group
  (Warren VanCamp will give summary)

→ HOW DO YOU WANT NSI/NASA TO INTERACT WITH YOU?
NASA/DOE OSI/Phase V test network
(snapshot of July, 1991)

Area 15
6SFC

Area 14
MSFC

Cisco router (ISO/IDRP)

Wanrtr: DEMSA based Phase V router "WANrouter 500"
NSI DECdns Implementation

REQUIREMENTS
LOGICAL NAMESPACE
PHYSICAL NAMESPACE
TIME SERVICES
NSI NAME SERVERS
NSI SITE SERVERS

- Single global namespace for DECnet Internet (called OMNI)
- Coordinated time service for name services.
- Use X.500 recommendations, hierarchical (tree) name structure.
- Efficient access of the namespace by users - i.e. distributed services.
- Autonomous management of sub-tree name structure.
NASA DECdns Implementation

LOGICAL NAMESPACE
- Relies on X.500 recommendations for full names:
  .US.<org>.<org-unit>...
- Recommend names be kept SHALLOW
  - Future requirements may add levels for X.500 or GOSIP compliance.
  - Names are for USERS!
- Recommend adoption of Internet name (if applicable) for DECdns names - minus the "top" level domain (GOV, EDU, etc.). e.g.
  SSL.MSFC.NASA.GOV
  MIAMI.RSMAS.MIAMI.EDU
  TCP/IP Internet names
  becomes (X.500 recommendation DECdns object):
  .US.NASA.MSFC.SSL
  .US.MIAMI.RSMAS.MIAMI
  DECnet Internet PV names

LOGICAL NAMESPACE (Continued)
- Node object directory - contains name, address, tower information for each PIV and PV system in network. Catch-all directory will be created for NSI PIV systems (.US.NASA.NSI_NODE)
- Node synonyms (short names) for NSI systems will be registered in synonym directory for NSI/NASA (.US.NASA.NODE_SYNONYM)
  Local site synonym directories may exist. Node synonym directories not shared between major network partners
- Backtranslation directories (for address to name resolution) automatically created by namespace managers and registration process.
- Hierarchical access control groups created for each level of directory structure. Allows small group access to top levels of namespace, centers access and control over own center level directories.
- What does all this look like?...
NSI DECdns Implementation

Logical Namespace Schematic for Names and Node Synonyms

```
<root>
  /
 /  \        /  \        /  \        /  \        /  \        /  \        /  \\
|   US   | CH            |   NASA   | CERN     |  RS/STAS  | MSFC     |  NSI_node | Node_Synonym | DXCISR |
\   \     |               |   \      |          |  \        |          |   \       |         |        |
  MIAMI   |               | NASA     | MIAMI    |  MIAMI    | SSL      |  LSUX01   | LSUX01   | SSL     |
        /  \     |               |           | MIAMI    | SSL      | MIAMI    |            |         |        |
       |           |               |           | MIAMI    | SSL      |            |         |        |
        |           |               |           | MIAMI    | SSL      |            |         |        |
        |           |               |           | MIAMI    | SSL      |            |         |        |
        |           |               |           | MIAMI    | SSL      |            |         |        |
        |           |               |           | MIAMI    | SSL      |            |         |        |
```

April 1, 1992 NSIUWG Network Subgroup

NSI DECdns Implementation

Logical Namespace Subtree for Backtranslations

```
<root>
  /
 /  \        /  \        /  \        /  \        /  \        /  \\
|   DNA_Ba         |   DNA_Ba         |   DNA_Ba         |   DNA_Ba         |   DNA_Ba         |   DNA_Ba         |
\   \     |               |               |               |               |               |
  %a470020  | %a47000590003400000000600  |  (Prefix directory )  |               |               |               |
        /  \     |               |               |               |               |               |
       |           |               |               |               |               |               |
       |           | %a0007        | %a0022        | %a1000        | %a0234        |               |
        /  \\
       |           | %aAA00400271C  |               |               |               |               |
        |           | link target is "US.NASA.MSFC.SSL" |
```

April 1, 1992 NSIUWG Network Subgroup
NASA DECNs Implementation

PHYSICAL NAMESPACE

- How the logical namespace structure is distributed over cooperating name servers.

- *Clearinghouses* are files containing one or more *replicas* of directories and their contents.

- Recommend at least two replicas of every directory.

- *NOT* recommended to replicate more than needed.
  - Do *not* replicate on unreliable servers.
  - Do *not* replicate in remote parts of network unless really needed.

- A few servers in global network (initially 4) will contain replicas of the root ("."), .DNA_Backtranslation, .DTSS_GlobalTimeServers.

TIME SERVICES (DECdts)

- Used by DECNs to keep namespace consistent.
  - Also provides reliable time information to all DTS clerks on network.
    (Most systems are clerks)

- Selected DECNs server system objects placed in .DTSS_GlobalTimeServers directory (noncouriers)

- Sites select local systems (couriers) to time off of noncourier systems in .DTSS_GlobalTimeServers directory. Only two per LAN recommended

- DTS clerks (rest of PV systems on LAN) receive timing from couriers on LAN.
NSI DECdns Implementation

Logical Namespace Access Control Schematic

NSI/NASA WIDE NAME SERVERS

• Replicate Important directories:

April 1, 1992 NSIUWG Network Subgroup
NASA DECdns Implementation
NASA

April 1, 1992 NSIUWG Network Subgroup
NSI DECDns Implementation

SITE NAME SERVERS:

2nd level

parent
directory
replicated
elsewhere

...site

3rd level (and below)

...NODE_SYNCHRON

..pVprefix_directory

..pVarea

parent
directory
replicated
elsewhere

..pVarea

E.g. "site" could be "MIAMI" (just below .US directory), Miami uses area 3, "pVarea" would be %X0003. "pVprefix_directory" and "pVarea" based on OSI style NSAP (assigned by OSI address authority for U. Miami.)

Addressing

ADDRESSING => GOSIP Compliance for NASA

IDP ← HO DSP ← DSP

<table>
<thead>
<tr>
<th>API</th>
<th>ID</th>
<th>DPI</th>
<th>AA</th>
<th>rsvd</th>
<th>RD</th>
<th>LA</th>
<th>ID</th>
<th>SEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

- Two AA's for NASA: 003400 (PSCN) 005900 (NSI)
- 003400 may be NASA "private"
- 005900 may be NASA "public" (advertised to Internet)

- Centers may choose to use one or other AA, or may multihome to both AAs. (Choice of AA to use does not affect reachability - that is function of routing.)

- Good overview is "Guidelines for OSI NSAP Addressing in the Internet", RFC 1173 by Colella, Gardner, Callon
Addressing

DECnet Phase IV compatibility REQUIRES
1. All systems reside same IDP+HO DSP (NSAP Prefix)
2. All Phase V systems assigned "PIV compatible address"

<table>
<thead>
<tr>
<th>IDP</th>
<th>HO DSP</th>
<th>ID</th>
<th>SEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>470020</td>
<td>0007</td>
<td>ea0004000271c</td>
<td>XX</td>
</tr>
</tbody>
</table>

- 470020 will be used in DECnet Internet (HSDCG agreement)
- Phase IV address is 7.39 in example for system SSL

If NASA adopts GOSIP, but PIV compatibility requires non-GOSIP address (although a valid NSAP), how can transition proceed?

EASY (in theory): Assign system two addresses! (multihoming)
E.g. SSL uses address as above and GOSIP Compliant address:

<table>
<thead>
<tr>
<th>IDP</th>
<th>HO DSP</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>0005</td>
<td>80</td>
</tr>
</tbody>
</table>

Routing

Intradomain and Interdomain Routing considerations:
Definitions (pertinent routing layer protocols):

- ISO 8473 (CLNP) defines packet format
- ISO 9542 (ES-IS) defines exchange of routing info between End system and intermediate system (a router)
- ISO 10589 (IS-IS) defines exchange of routing info between Intermediate systems within a Routing Domain (intradomain)
- Static Routing: tables used for exchange of routing info between Intermediate systems between Routing Domains (interdomain) IDRP in the future

Above routing protocols depend on CLNP for packet format in ISO.

IDP+HO DSP \( \Rightarrow \) defines boundary between L1 and L2 routing for IS-IS. (Called "area address") Routing domain boundaries can be set between areas, but not within an area.
Routing

**Intra-Domain Routing (IS-IS)**
- Systems may not acquire more than three area addresses (IDP+HO DSP).

```
prefix 1
prefix 2
prefix 3
prefix 4
```

Network Manager original assignment

```
prefix 1
prefix 2
prefix 3
prefix 4
```

IS-IS "union of area addresses"

This BREAKS PIV/V Compatibility.

Note: IS-IS spec default is three area addresses. Recent spec change raises maximum number of areas shared and is based on number of area addresses that will fit in a "link state packet". However, implementations are well behind.

Routing

**Inter-domain Routing**
- desire to define boundaries beyond which do not wish to share IS-IS (or other intra-domain routing protocol) information - NOT dependent on value of GOSIP "RD" field!!!

  - however, should only be set between IS's with different sets of NSAP address prefixes. THAT IS - cannot set between sites SHARING Phase IV areas (e.g. NASA site hub and University Site).

  - Other issues:
    - "Two hop problem" - static information is not propagated through an Intervening Routing Domain, therefore if primary path drops, backup path (if exists) will not automatically be used.

```
backup (not automatically used)
```

- Routing Flood Protection
General Transition Strategy

The "Five Point Plan":

1. Create single namespace for DECnet Internet (OMNI)
2. Specify transition address structure
3. Encourage ES upgrade to PV, using OMNI and address structure
4. Upgrade the routing incrementally
5. Define a timeframe to complete transition

What is "incremental" routing upgrade?
- Upgrade routing in (DECnet PIV) area one area at a time
  Upgrade all PIV L1 routers in area to PV all at once (this is a RULE)
  (but still running PIV Level 2)
- Then, can upgrade all PV routers to PV L2 routing. Requires setting
  Interphase Static Links on area boundaries between
  areas supporting PV/OSI IS-IS L2 and PIV routing protocols

Issues: Non-DEC routers (Cisco, Wellfleet, Proteon...) and VMS
  (host-based) routing (excluding cluster alias).
Issues

Goal is to preserve PIV back compatibility during transition.

1. Multihoming limitation restricts which areas may adopt more than one NSAP address.

2. Flexibility required in planning to implement routing domain boundaries during transition.

3. VMS host-based routers, non-DEC routers

Work In Progress...

New NASA/SPAN and DOE/ESnet-DECnet Transition Strategy due in three weeks on NSINIC. Look to NSINIC for other interesting (?) docs, too (like Namespace Implementation for NASA’s DECdns name servers, version 2.1)

OSI (CLNP) Status

- CLNP (8473) support available on all routers
- IS - IS (DIS 10589) supported on backbone routers
- Static routing to support connections to other AA’s
  
  ESnet (005700)
  NSFnet (FFFF00)

- RD’s available to all NSI sites
GSFC PV/OSI Future

- Allow new (production) systems to come up DECnet/OSI
- First new systems will be Ultrix and brought into GSFCOSI: NS
- New systems will be running production DECnet-Ultrix V5.0 SW
- Set up a dedicated DECdns nameserver in OMNI that hosts OMNI::us.nasa.gsfc.
- Depending timing, we may host this on a WS until dedicated platform has been procured

GSFC PV Future (contd)

- Replace WANrouter 500 (DEMSA) w/ DECnis 600
- Bring up OSI CLNP on WAN FW to talk w/WAN OSI networks
- Work w/ concept of bringing up GSFC area 15 to PV/OSI at LII, set up interphase static links to WAN OSI provider, turn off PIV on GSFC FW
- GSFC then routes only OSI (and IP) off campus in WAN
GSFC PV/OSI Experience

- 1 VMS DECnet/OSI system (FT)
- 2 Ultrix DECnet/OSI systems (FT)
- Running FT NS GSFCOSI: on DS5000/200
- WANrouter 500 (DEMSA platform) 15.1009 running PIV at LI/LII
- FTAM and VTP applications up and running btwn DEC platforms

GSFC Transition to PV/OSI

- Migrate all PIV host-based routers to dedicated routing platforms (cluster alias only exception)
- Load all DEC routing platforms w/ WANrouter SW
- Run WANrouters at PIV LI/LI routing algorithms
- Non-DEC routers capable of IS-IS (or integrated IS-IS)?
- Check interoperability of NON-DEC and DEC WAN routers
GSFC Transition to PV/OSI (contd)

- Interoperability check above area 46 or extended address?
- Cut-over to PV/OSI Link-State routing at LI (DECnet area 15)
### NSI End Sites

<table>
<thead>
<tr>
<th>Location</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGU and AAS Headquarters</td>
<td>56</td>
</tr>
<tr>
<td>Advanced Rotorcraft Technology</td>
<td>56</td>
</tr>
<tr>
<td>Aerospace Corp.</td>
<td>56</td>
</tr>
<tr>
<td>Air Force Geophysics Lab</td>
<td>56</td>
</tr>
<tr>
<td>Arizona State</td>
<td>56</td>
</tr>
<tr>
<td>Augsburg College</td>
<td>9.6</td>
</tr>
<tr>
<td>Big Bear Solar Observatory</td>
<td>56</td>
</tr>
<tr>
<td>Boston Univ.</td>
<td>9.6</td>
</tr>
<tr>
<td>Brown Univ.</td>
<td>(56)</td>
</tr>
<tr>
<td>Capitol Gallery-East</td>
<td>1536</td>
</tr>
<tr>
<td>Carmel Research Center</td>
<td>56</td>
</tr>
<tr>
<td>Carnegie Institute of Washington</td>
<td>56</td>
</tr>
<tr>
<td>Center for Aero. and Scientific Information</td>
<td>56</td>
</tr>
<tr>
<td>Centre College</td>
<td>56</td>
</tr>
<tr>
<td>Citadel College</td>
<td>56</td>
</tr>
<tr>
<td>CoBE Offsite Facility</td>
<td>1536</td>
</tr>
<tr>
<td>College of Charleston</td>
<td>56</td>
</tr>
<tr>
<td>Comsat Labs</td>
<td>56</td>
</tr>
<tr>
<td>Cornell Univ.</td>
<td>56</td>
</tr>
<tr>
<td>Dartmouth</td>
<td>9.6</td>
</tr>
</tbody>
</table>

*Network Engineering*
**NSI End Sites (cont.)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Site Code</th>
<th>Access Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryden Flight Research Facility</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Ellery Systems, Inc.</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Elore Institute</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Florida State</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>Gilmore Creek Geophysical Observatory</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Government Systems, Inc.</td>
<td>1536</td>
<td>IP</td>
</tr>
<tr>
<td>Grumman Aerospace</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>Hamden-Sydney College</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Harding Univ.</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>IUE, Computer Sciences Corp., Greentec</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Johns Hopkins Univ., Applied Physics Lab</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>Kennedy Space Center</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Langley Research Center</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Lewis Research Center</td>
<td>168</td>
<td>IP</td>
</tr>
<tr>
<td>Lockheed, Palo Alto Research Center</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Loral, ST-DADS</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Louisiana State</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>Lowell Observatory</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Lunar and Planetary Institute</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>MIT</td>
<td>9.6</td>
<td>D</td>
</tr>
</tbody>
</table>
### NSI End Sites (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine International Airport</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Mojave Base Station</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>NOAA, NIST/Space Environment Lab</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>NOAA, NODC</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>NOAA, Suttland Professional Center</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>NOAA, World Weather Building</td>
<td>1536</td>
<td>IP</td>
</tr>
<tr>
<td>National Center for Atmospheric Research (NCAR)</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>National Geodetic Survey</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>National Radio Astronomical Observatory</td>
<td>(56)</td>
<td>D</td>
</tr>
<tr>
<td>Naval Postgraduate School</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>Naval Research Lab</td>
<td>56</td>
<td>D*</td>
</tr>
<tr>
<td>New Mexico Highlands Univ.</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Northwest Research Associates</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Northwestern State, Louisiana</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Oregon State</td>
<td>56</td>
<td>D*</td>
</tr>
<tr>
<td>Owens Valley Radio Observatory</td>
<td>19.2</td>
<td>D/IP</td>
</tr>
<tr>
<td>Penn State</td>
<td>56</td>
<td>D*</td>
</tr>
<tr>
<td>Planetary Science Institute</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Rand Corp.</td>
<td>(56)</td>
<td>D</td>
</tr>
<tr>
<td>Rice Univ.</td>
<td>1536</td>
<td>D/IP</td>
</tr>
</tbody>
</table>

_Network Engineering_
<table>
<thead>
<tr>
<th>NSI End Sites (cont.)</th>
<th>IP</th>
<th>D/IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond Station</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>STX, ST Systems Corp.</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>SURAnet, FIX-East</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>SDSC, Scripps Institute</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>Service Argos, Inc.</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>Silicon Engines, Inc.</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Smithsonian Astrophysical Observatory</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Southwest Research Institute</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>SpaceTelescope Science Institute</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Stanford Univ.</td>
<td>(56)</td>
<td>D</td>
</tr>
<tr>
<td>Stennis Space Center, NORDA</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>TRW Corp.</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>U.S. Naval Observatory</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>UCLA</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>USGS, EROS</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>USGS, Flagstaff</td>
<td>56</td>
<td>D/IP</td>
</tr>
<tr>
<td>USGS, Menlo Park</td>
<td>(56)</td>
<td>D</td>
</tr>
<tr>
<td>USGS, Reston</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>USRA, Huntsville</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>USRA, Washington, D.C.</td>
<td>56</td>
<td>IP</td>
</tr>
</tbody>
</table>
### NSI End Sites (cont.)

<table>
<thead>
<tr>
<th>Location</th>
<th>Code</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. of Alabama, Huntsville</td>
<td>56</td>
<td>D</td>
<td>-1536 D/IP</td>
</tr>
<tr>
<td>Univ. of Alaska, Geophysical Inst. &amp; SAR Facility</td>
<td>56</td>
<td>D/IP</td>
<td>-1120</td>
</tr>
<tr>
<td>Univ. of Arizona</td>
<td>1536</td>
<td>D/IP</td>
<td></td>
</tr>
<tr>
<td>Univ. of California, Berkeley (SSL)</td>
<td>(56)</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Chicago</td>
<td>56</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Colorado, Boulder</td>
<td>56</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Delaware, Bartol</td>
<td>(56)</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Delaware, Lewes</td>
<td>(56)</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Iowa</td>
<td>224</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Kansas</td>
<td>56</td>
<td>D*</td>
<td></td>
</tr>
<tr>
<td>Univ. of Maryland</td>
<td>9.6</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Maryland, SAMPEX</td>
<td>(56)</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Miami</td>
<td>1536</td>
<td>D/IP</td>
<td></td>
</tr>
<tr>
<td>Univ. of Miami, ATS</td>
<td>9.6</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Michigan</td>
<td>56</td>
<td>D*</td>
<td></td>
</tr>
<tr>
<td>Univ. of Minnesota</td>
<td>56</td>
<td>D*</td>
<td></td>
</tr>
<tr>
<td>Univ. of Montana</td>
<td>56</td>
<td>IP</td>
<td></td>
</tr>
<tr>
<td>Univ. of New Hampshire</td>
<td>9.6</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Univ. of Rhode Island</td>
<td>56</td>
<td>D*</td>
<td></td>
</tr>
<tr>
<td>Univ. of South Florida</td>
<td>56</td>
<td>D*</td>
<td></td>
</tr>
</tbody>
</table>
**NSI International Connections**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Capacity</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerro Tololo Inter-American Obs., Chile</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>European Space Agency, ESOC</td>
<td>256</td>
<td>D/IP</td>
</tr>
<tr>
<td>European Space Agency, ESTEC</td>
<td>576</td>
<td>D/IP</td>
</tr>
<tr>
<td>ISAS, Japan</td>
<td>56</td>
<td>D</td>
</tr>
<tr>
<td>Inst. for Space &amp; Terr. Science, Canada</td>
<td>9.6</td>
<td>IP</td>
</tr>
<tr>
<td>McMurdo Station, Antarctica</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>National Research Council, Canada</td>
<td>9.6</td>
<td>D</td>
</tr>
<tr>
<td>Oxford Univ., UK</td>
<td>128</td>
<td>IP</td>
</tr>
<tr>
<td>Rutherford Appleton Lab, UK</td>
<td>64</td>
<td>D/IP</td>
</tr>
<tr>
<td>Sondrestrom Radar Facility, Greenland</td>
<td>56</td>
<td>IP</td>
</tr>
<tr>
<td>Univ. of London, UK</td>
<td>128</td>
<td>D/IP</td>
</tr>
</tbody>
</table>

Network Engineering  WVanCamp 7
**NSI International (PACCOM)**

NSI operates circuits for PACCOM which connect at FIX-West (ARC) to other networks

<table>
<thead>
<tr>
<th>Institution</th>
<th>Speed</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. of Hawaii</td>
<td>1536</td>
<td>D/IP</td>
</tr>
<tr>
<td>Chinese Univ. of Hong Kong</td>
<td>64</td>
<td>IP</td>
</tr>
<tr>
<td>Inst. for Supercomputer Research, Japan</td>
<td>64</td>
<td>IP</td>
</tr>
<tr>
<td>Univ. of Melbourne, Australia (AARNET)</td>
<td>512</td>
<td>IP</td>
</tr>
<tr>
<td>Univ. of Waikato, New Zealand</td>
<td>64</td>
<td>IP</td>
</tr>
</tbody>
</table>
**Introduction**

HSDCG meeting held in Bologna, Italy, 19-20 September 1991:
- NSI-DECnet
- ESnet-DECnet
- E-SPAN
- E-HEPnet

Also represented:
- Japan (HEPnet-J and TISN)
- Digital Equipment Corp

Meeting included status updates from the networks

Meeting focus was on DECnet Phase V issues
- Addressing
- Routing
- Naming (primary meeting focus)
Addressing

Phase IV address prefix has been donated to the global DECnet by CERN and use has been agreed on by HEP/SPAN

prefix = 47:0020: (areas 00-00 to 00-FF only)

Phase V systems will also multi-home to GOSIP addresses in the U.S. (other countries have other requirements)

The size of GOSIP NSAP addresses may affect the number of different areas that can be supported by multi-homing
Routing

HEP/SPAN expects static routing domain boundaries will be setup between the different networks:

NSI-DECnet
ESnet-DECnet
European SPAN
European HEPNET

Where multiple "shareable" HEP DECnet lines go from Europe to the U.S., they will be put into a single routing domain so that automatic backup can occur.

Routing will be planned for and implemented on an area-by-area basis.

Routing plans for the U.S. networks will be developed further as software becomes available from other router vendors.
Naming

Naming was the primary focus of the HSDCG meeting, since DEC is now distributing DECnet Phase V software on ULTRIX, which requires the use of DECdns naming.

All of the networks want to share a single global namespace to ensure that systems can talk to each other.

Preliminary design and review of this namespace, called "OMNI", was performed at the meeting.

DECdns provides the necessary services for the namespace.

Naming scheme is to be based on X.500 and Internet names (but there are issues still unresolved in the U.S.).
Naming Logical Structure

The general name structure follows the form:

\[ \text{.country.org.org-unit.org-unit...object} \]

where:

- \( \cdot \) = <root>
- **country** = 2 letter ISO country code (e.g., US)
- **org** = organization name (e.g., NASA)
- **org-unit** = site name (e.g., GSFC)
- **object** = namespace object, such as a nodename

An example node:

\[ \text{.US.NASA.GSFC.DFTNIC} \]
The "OMNI" Structure

root  country org  org-unit

<root>
  .US
    .NASA
      .ARC (etc.)
      .Node_Synonym
      .NASA_MGRS
      .NSI_Node
      .NASA1_CLH

    .LBL
    .LNL
    .US_MGRS
    .OMNI_MGRS
    .OMNI_CLH
    .DTSS_GlobalTimeServers
    .DNA_BackTranslation
      %X470020
      %X470005800059000000001

    .UK
    .IT
    (other countries, etc.)
The "OMNI" <root>

<root> Directory
4 Replicas (2 in U.S., 2 in Europe)
Supported on systems dedicated for nameservice
Contains clearinghouse objects of clearinghouses that replicate the <root>

Common global directories
DNA_BackTranslation (and %X470020 subdirectory)
DTSS_GlobalTimeServer
NO! DNA_Node
NO! DNA_NodeSynonym

Common global directories are replicated on the same servers which support <root>
Country-level Directories

Approved by HSDCG and implemented by <root> admin group
Utilize ISO two letter country code
Country-level server contains:
  country directory (master replica)
  backtranslation area directories in that country (master)
  organization directories (R/O replicas)
A country-level admin group must be defined to provide access and management control
and management control to all directory levels below "org"

An org-level admin group must be defined to provide access

The org-level directory contains the clearinghouse object for

site directory (master replica, possibly)

site directories (P/O replicas)

org directory (master replica)

ORG-LEVEL SERVER contains:

Implemented by country admin groups

ORG-LEVEL DIRECTORIES
Namespace Access

Access to the <root> will be strictly controlled and requires the agreement of the HSDCG representatives.

Access to country-level directories and servers is explicitly left as a national decision to country admin groups.

It is recommended that after a directory is created, the creator continues to have write access to the directory (but no lower-level directories), in order to help troubleshoot any namespace problems (e.g., after US_MGRS creates .US.NASA in the .US directory, it would continue to have write access to .US.NASA, even though NASA_MGRS would be maintaining the master replica.)
**Phase IV Synonym Table**

The Phase IV synonym table provides a method for a Phase IV application to map a 6 character nodename into a fully specified DECdns name.

There are currently conflicts between the different networks for many of the nodenames (e.g., CALVIN), which would have to be resolved to share a single synonym table.

Instead, each network will provide synonym table(s) for their own network, and together develop a mechanism for merging other network synonym tables.

NSI-DECnet will provide a single, NSI-wide synonym table, but sites (on a per-system basis) can redefine their own synonym table location if required.
<root> and country-level nameservers must use DECdns version 2.0 or later.

Each site should provide a master replica and at least one additional replica of its directories. The additional site replica can also be provided by another site, or by prior arrangement on one of the master servers.
**DECdts Time Service**

DECdts time service is required for DECdns name service.

Time service is used to ensure that DECdns name service updates are synchronized throughout the global network.

The number and location of "global" time servers will be coordinated by the HSDCG to ensure a reliable distribution throughout the network.
Current NSI Plans

Procure two "master" dedicated DECstation nameservers, to support:
- one replica of <root>
- one (or both) will contain replicas of .US
- both will contain replicas of .US.NASA (one is master)

Servers will also:
- provide DECdtv time sources
- provide (optionally) backup replicas of site directories

Evaluate procurement of additional servers as required
NASA's DECdns Nameserver

A current version of this text is available in PostScript format from the NSI File Cabinet as:

```
NASA_DECdns_IMPLEMENTATION.PS
```

in the directory:

```
[ANONYMOUS.FILES.PROTOCOLS.DE CNET.PHASE_V]
```
H. Tutorials
Vision for the NSI Online Network Aide (NONA)

Brian Lev
Hughes STX Corp.

April 2, 1992

Presentation to the NASA Science Internet User Working Group Conference

The NSI Online Network Aide (NONA)
Why Build It?

- Experience had proven that an on-line system increased the number of users who could be helped in any given period of time without over-taxing human staff.
- Rapid response needed to official assignment of NIC duties to staff at GSFC, but immediate hiring of additional staff to handle extended workload was not possible.
- Two systems already in use at GSFC for network user support (SPAN-NIC and NICOLAS) were available to serve as testbeds for NSI information and services.
- Porting of an existing system would allow near-immediate response to the increased workload.
The NSI Online Network Aide (NONA)

The First Build

- NICOLAS chosen as "template" system
  - required no new purchases, licensing, or staff training
  - guaranteed to work on existing platform(s)
- DFTNIC VAX 3250 chosen as host
  - wide variety of network links and protocols
  - already hosting NICOLAS
  - already managed by NSI USO staff
  - bypassed wait for new NSI-purchased hardware to arrive
- Emphasis on rapid installation to fill gap in user services.
- Small-scale NICOLAS "clone" with emphasis placed on NSI, as opposed to GSFC-specific, information.
- Relatively basic information server, relying heavily on NICOLAS and the old SPAN-NIC to fill gaps in content and connectivity.
- Recorded just over 900 user sessions in one year.

The NSI Online Network Aide (NONA)

Background of Current Version

- Version 2 beta installed on NSINIC MicroVAX 3300 after completion of hardware's acceptance testing.
- Fully functional "pilot" system opened for use by the NSI community in time for the December, 1991 AAS Conference.
- Recorded roughly 100 user sessions in its first month of operation; usage grew to 480 sessions in January, 1992.
- Over 740 user sessions recorded in February 1992.
- First phase of operational testing now considered as completed successfully; system now ready for additions to become true Version 2 of NONA.
  - The old version running on DFTNIC was taken offline for the last time on February 10, 1992.
The NSI Online Network Aide (NONA)
Changes from First Version

• Now running on a newer, faster host dedicated only to NSI support.
• Uses improved driver software for faster response to user input.
• Features user tracking that is both more comprehensive and more transparent.
• Driver modifications allow simpler formatting of text files.
• User messages & problem reports now routed directly into the NIC's Help Desk Email.

The NSI Online Network Aide (NONA)
What We Offer Now (Version 2 beta)

• 'Hot News' about NONA, the NSI, or other items of importance.
• Instructions on using NONA.
• Info About the NSI and Other Nets
  — What is the NSI?
  — NSI Program Objectives and Management
  — Acquiring NSI Connectivity
  — Info about the Internet and other nets (BITNET, THEnet, USENET, etc.)
• NSI Personnel for Additional Help
  — How to contact the NIC and NOC
  — Points of contact at individual NASA and ESA centers
• Help Files and Info
  — Automated Email matrix and dictionary of networking terms & NASA acronyms
  — Information & instructions for the NSI File Cabinet
• Problem Reporting/Message Box Mechanism
  — Sends flagged Email messages to the NSHELP account and notifies NSI USO staff
• Transparent "Quick Connects" to SPAN-NIC & NICOLAS
The NSI Online Network Aide (NONA)  
What We Offer Now (Version 2 beta)  

**HOW IT WORKS**

• **Menu-Driven Navigation**
  — simply choose desired option by number
  — plain English instructions for all steps
  — help for each menu available with "H" or "?"

• **Can Leave At Any Time**
  — from any menu, Q (quit) or X (exit) will log you out
  — when reading files, Q or X return you to the menu you came from

• **Forgiving Environment**
  — plain English error messages
  — available commands always on screen
  — can scroll text backwards one screen at a time
  — can refresh text displays with "R"
  — designed for VT100 "lowest common denominator"
  — designed to "fail gracefully" in worst-case scenario

---

The NSI Online Network Aide (NONA)  
The Next Step: From "2 beta" to "Version 2.0"

• **More & Better Information About NSI, such as:**
  — Improved description of levels of service and usage guidelines
  — New information about USO, OPS, ENG, and SNP groups
  — All current information updated (e.g., project charter & organization, staff, etc.)
  — Better description of how NSI differs from "The Internet"

• **More User Options, such as:**
  — White Pages interface
  — Transparent access to specific on-line resources (e.g., NSI File Cabinet, OMNET's "Lists", PI-NET, etc.)
  — Addition of NICOLAS' wide-area functions (whois, finger, nslookup, BITNET lookups)

• **Inclusion of SPAN_NIC Data Base**
  — Completes inclusion of all SPAN_NIC offerings
  — Old system will be taken off-line when done

• **More Information About Other Networks**
So far, responses on the "NONA Futures" questionnaire, items in the NONA message box, and general Email indicate that the NSI user community wants further emphasis placed on:

- expansion of the Email matrix
- more information about other networks
- more up-to-date NSI information
- wide-area lookup functions (whois, finger, et al.)
- direct access to contents of the NSI File Cabinet

Growth of NONA will be based on user requirements

Possible Additions, 6 Month Timeframe:
- New complete "branches" of SNMP and NOC information (contacts, charter, offerings, etc.)
- User registration for personalized interaction
- NSF and RPS status
- Expansion of Email matrix

Possible Additions, 12 Month Timeframe:
- New "forum" or Q&A segments à la "Ask Harry"
- Ability for users to request specific information files for delivery
- Add ARCHIE interface
- Add USB and Trouble Ticket status
- Full interactive access to NSI File Cabinet
- Improved ties to other on-line resources (e.g., ALEX)

Possible Future Additions
- Map of current NSI link status
- Continual improvement of ties to other on-line systems
- Real-time delivery of requested files
The NSI Online Network Aide (NONA)
Our Overall Goal: "Systemus Maximus"

- The following user-oriented capabilities are all considered part of an "ultimate" system:
  - Serves as "universal interface" for NSI on-line offerings (e.g., White and Yellow Pages, ALEX, etc.)
  - Recognizes and reproduces user's environment (X windows, text only, etc.)
  - Offers both "power user" (command line) and menu-driven interfaces
  - Provides for real-time contact with human operator
  - Provides a "guided tour" of itself
  - Registers users to personalize interaction and build contact data base
  - Utilizes "knowbot" or other Expert System/Artificial Intelligence approaches to help anticipate users' needs while easing access to information
  - Allows users to browse contents of the NSI File Cabinet
  - Provides on-demand delivery (via appropriate method) of all documents and information available on-line
  - Utilizes graphical displays where possible
  - Utilizes multimedia mail (voice, video, and text) for user-to-staff contacts in real time

How Do I Get to NONA?

via TCPIP: telnet nsinic.gsfc.nasa.gov
Username: NSINIC

via DECnet: SET HOST NSINIC
Username: NSINIC
WHO YOU GONNA CALL?

NSI Network Information Center

Code 930.6
Goddard Space Flight Center
Greenbelt, MD 20771

301-286-7251
(FAX) 301-286-5152

nsihelp@nic.nsi.nasa.gov
nsinic::nsihelp

The NSI Online Network Aide (NONA)
Selected Foreign User Sites, 1992

Ben Gurion University, Be'er Sheva, ISRAEL
DFVLR Oberpfaffenhofen, Weasing, GERMANY
Danish Computer Centre for Research and Education, Lyngby, DENMARK
ESA Villafranca Satellite Tracking Station, Madrid, SPAIN
ESA-ESRIN, Rome, ITALY
Eindhoven University of Technology, Eindhoven, HOLLAND
Institut d'Astrophysique de Paris, Paris, FRANCE
Japan INET, Kyoto, JAPAN
Korea Advanced Institute of Science and Technology, Seoul, KOREA
Max Planck Institut fuer Kernphysik, Heidelberg, GERMANY
Max Planck Institut fuer Plasma Physik, Garching, GERMANY
McGill University, Toronto, Ontario, CANADA
Observatoire de Paris-Meudon, Meudon, FRANCE
Rutherford Appleton Laboratory, Chilton-Dares, ENGLAND
Technion University, Haifa, ISRAEL
Tel Aviv University, Tel Aviv, ISRAEL
Universidad Nacional Autonoma de Mexico, Ciudad de Mexico, MEXICO
University Brunswick, Braunschweig, GERMANY
University of Alberta, Edmonton, Alberta, CANADA
University of New Brunswick, Saint John, New Brunswick, CANADA
University of Saskatchewan, Saskatoon, Saskatchewan, CANADA
University of Tubingen, Tubingen, GERMANY
University of Waterloo, Waterloo, Ontario, CANADA
York University, North York, Ontario, CANADA
Tutorial
on
X.500 and QUIPU

Peter Yee
Ames Research Center

April 2, 1992

Audience

- Participants in the NASA X.500 White Pages Pilot
- Want-to-participants
- Hardcore X.500 junkies

If you are not one of the above, this may be boring!
The Directory: What is X.500

- A (potentially global) distributed database.
- Optimized for data searching and listing.
- Not necessarily as consistent as a true database system.
- An international standard for provisioning of directory services.
- A floor wax and dessert toppings, all in one!

X.500 Model

<table>
<thead>
<tr>
<th>DSA</th>
<th>Directory System Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUA</td>
<td>Directory User Agent</td>
</tr>
<tr>
<td>DAP</td>
<td>Directory Access Protocol</td>
</tr>
<tr>
<td>DSP</td>
<td>Directory System Protocol</td>
</tr>
</tbody>
</table>

Image: Diagram of the X.500 Model.
X.500 Access

Referrals

Only when DUA can connect to both DSAs (network topology or protocol problems may prevent this).

Chaining

May be requested (advisory) or refused (actual) by DUA.

Application layer gateway service.

Chaining and referrals may used in combination.

Mostly transparent to the user.
What's in the Directory?

Data is organized in a Directory Information Tree:

```
C = US
  / \  /  \
O = LLNL O = NASA O = U of Mich
   / \
  DU=ARC OU=JPI
   / \  /  \
Cite: Peter Yes Cite: J. Fagan
   / \  /  \
Cite: H. Dunbar Cite: M. Pettenkofer Cite: B. Sherman
   / \  /  \
Cite: N. Myers
```

Problems:

- Fails to address directly the needs of multi-national/international organizations such as:
  - United Nations
  - European Space Agency
  - International Business Machines
- Not always an efficient way to organize data for searching.
What's in the Directory?

Entries

- Every vertex and leaf node is an entry.
- Entries are made up of attributes.
- Attributes have types and values.
- Entries have object classes which determine the attributes for the entry.
- Attributes are frequently multivalued and always ASN.1 encoded.
- Attributes and object classes have unique identifiers (OID's).

Entries (continued)

- Entries each have a Relative Distinguished Name (RDN), which differentiates them from other entries.
- The RDN is made up of selected attribute(s) from the entry - depends on the object classes.
- An entry is uniquely and globally identified by its Distinguished Name - the ordered concatenation of the RDN's for the entry, starting at the root.
  
c=US@o=NASA@ou=ARC@cn=Peter Yee
Manipulating the Directory Service

Service Primitives

- Read
- Add
- Delete
- Modify
- Compare
- Search
- ModifyRDN
Manipulating the Directory

Other Functions (DUA supplied)

- Bind
- Unbind
- Move
- Quit!

QUIPU - What's a QUIPU?

- An implementation of X.500.
- Requires the ISODE to operate.
- Supports non-standard (because there are no such standards) access control, replication, DSA maintenance, and knowledge information.
- Named for information storing strings used by the Incas.
QUIPU - Data Storage

- Entry Data Blocks (EDBs) used to hold data.
- EDBs are collections of all entries residing at a single level beneath the same point in the DIT.
- Replication works on a whole EDB (single level).
- May be copied between DSAs to enhance performance.
- Completely loaded into core memory during startup.

QUIPU - Extensions

- Replication
  - Two schemes supported through use of QuipuDSP and InternetDSP application contexts.
  - QuipuDSP copies EDBs in a single chunk.
  - InternetDSP uses bite-sized chunks to improve reliability in flaky nets.
QUIPU - Extensions

- **Access Control**
  - Directory Standards specify how to authenticate users.
  - Don't specify how to manage user access.
  - Currently only simple authentication supported.
  - Strong authentication soon (but may not be in this country).
  - QUIPU defines ACLs (Access Control Lists) for specifying which service primitives may be applied to which attributes and by whom.
  - Search ACLs limit the extent of information retrieval - prevents DIT "trawling."

QUIPU - Extensions

- **DSA Maintenance**
  - Orderly DSA shutdown.
  - DSA Information collecting.
  - Disk/Memory Synchronization.
  - Entry Locking.
  - Replication Control.
  - Data Dump.
QUIPU - Extensions

- Knowledge Information
  - Allows a QUIPU DSA to know which entries it holds.
  - Allows a QUIPU DSA to find entries it does not hold.
  - Allows a QUIPU DSA to contact other DSAs.
  - Knowledge Information is contained within the directory (neat trick!)

Mastering of Information

- Because all sibling entries are stored in a single EDB, they are all mastered by the DSA holding that EDB.
  - This is a limitation of QUIPU, but it simplifies operations greatly!
- Thus, all organizations within a country are mastered by a single DSA, for example.
  - Requires cooperative maintenance.
  - Newer versions of QUIPU allow DSA information to be mastered by the DSA itself and shadowed by the DSA above it.
  - Confusing!
Mastering of Information

- Mastered by Alpaca
- Mastered by Giant Tortoise
- Mastered by Iguana
- Mastered by Brown Headed Spider Monkey

Shadowing of Information

- Means DSA keep a copy of data that the DSA does not master.
- Done for speed and robustness.
- Typically applies to levels above the DSA in question (but could be lower).
Shadowing of Information

QUIPU - Information Storage under UNIX

- Uses UNIX directories to recreate DIT hierarchy.

- For example:
  base directory: /usr/etc/quipu/iguana
  - root of DIT stored here
    C=US: /usr/etc/quipu/iguana/c=US
    O=NASA: /usr/etc/quipu/iguana/c=US/o=NASA
    OU=LeRC: /usr/etc/quipu/iguana/c=US/o=NASA/ou=LeRC

  This can make for very long path names!

  EDB for data under each vertex of the tree stored in its corresponding UNIX directory.

  Same for EDBs containing leaf entries.
QUIPU - Information Storage under UNIX

- Remember, though, that the entry information for each vertex is found in the EDB located one directory above the vertex directory!
  - Information on ou=LeRC is found in the EDB residing in O=NASA.
  - Information about LeRC personnel is found in the EDB residing in OU=LeRC.

QUIPU - EDB Format

- 1st line: MASTER or SLAVE.
  - Indicates if EDB is original or copy.
- 2nd line: UTC timestamp
  - Used to control replication.
  - Updated every time an entry in the EDB is added/deleted/modified.
QUIPU - EDB Format

- Entries represented by consecutive attributes and separated by blank line.

- Attributes are written as:

  Type = Value

  - Type is attribute type (in string form, not usually as an OID).
  - Value is as appropriate for the attribute's syntax.
  - Special value tags of
    - {ASN} - ASN.1 encoded value in hex string format.
    - {FILE} - external file reference.
    - {CRYPT} - value is encrypted by a one-way hash function.

QUIPU - EDB Format

- First attribute is the one used to make the RDN.

- Multivalue attributes may be on separate lines or joined -- it does not matter.

- Object class attribute determines what other attributes an entry has:
  - e.g. Person must have a name (really a "common name" and surname).
  Defined in the oidtable.oc file.
QUIPU - EDB Format

Obtain software
- from uu.psl.com, via anonymous FTP
- from Peter Yee

Build software
- instructions included
- assistance available from Peter Yee

Install
- configure support files

Obtain upper level data
- ask that Peter Yee person

Obtain and convert local data
- roll your own (no standard data format available within the agency)
- sample conversion programs available from previously mentioned individual.

Running Your Own DSA
Running Your Own DSA

- Read the nice, thick QUIPU manual.
  - Really should do this first.
  - Copy included with software.
    - TeX
    - Postscript

- Take X-Tel course when available.
  - An in depth tutorial on QUIPU by its authors.
  - Currently only offered in Great Britain.
  - May be at Spring InterOp '92.

- In the meantime, visit the X.500 demo.
  - Try out different DUA's on different platforms.
  - Give Greg Brown a hard time!

Reading List

- The Directory-Overview of concepts, models and service, (ISO/IEC 9594-1, CCITT Recommendation X.500)

- The Little Black Book: Mail Bonding with OSI Directory Services,

- ISODE Manuals
  Volume 5, approx 300 pages all about QUIPU

- The Directory-Selected attribute types
  (ISO/IEC 9594-6, CCITT Recommendation X.520)

- The Directory-Selected object classes
  (ISO/IEC 9594-7, CCITT Recommendation X.521)
Support Information

PETER YEE
MS 233-18
NASA Ames Research Center
Moffett Field, CA 94035-1000
(415) 604-3812
(FTS) 464-3812

SMTP: yee@ames.arc.nasa.gov
X.400: /g=peter/s=yee/o=nasa/prmd=arc/admd=telemail/c=us/
X.500: c=US@o=National Aeronautics and Space Administration@
       ou=Ames Research Center@cn=Peter Yee
GUIDELINES FOR IMPROVING SYSTEM SECURITY ON VMS SYSTEMS

NSI User’s Working Group (NSIUWG)

April 2, 1992

Ron Tencalf
NSI Security Manager

COMMON VULNERABILITIES

• IMPROPER PASSWORD PRACTICES
  - Password=Username
  - Default Accounts
  - Trivial Passwords

• ACCOUNTING NOT RUNNING
  - VMS
  - X.25

• IMPROPER FILE/DIRECTORY PROTECTION SCHEMES
  - World Readable/Writable
  - Permits Trojan Horses, Worms

• NETWORK ABUSE
IMPROVING SYSTEM SECURITY

HACKERS ON NSI SITES

HOW THEY GET IN:

• DIAL IN
• NPSS (X.25)
• TCP/IP OR DECNET NETWORK (NSI)

TYPICAL HACKER ACTIVITY:

• TRY TO GUESS PASSWORDS
• EXPLOIT GUEST ACCOUNTS THAT ALLOW OUT OUTBOUND ACCESS
• SEARCH FOR WORLD-READABLE SYSTEM FILES

CURRENT VULNERABILITIES BEING EXPLOITED

• TFTP (Used if a node is a boot-server)
  Allows files to be read/copied w/out specifying a userid/password
  /etc/passwd

• GAINING ROOT ACCESS VIA EXPLOITING UNPATCHED BUGS

• TRIVIAL PASSWORDS
IMPROVING SYSTEM SECURITY

EQUIPMENT SECURITY

- LIMIT COMPUTER ROOM ACCESS
- LOCK SYSTEM AND WORKSTATION CONSOLES
- LOG OFF UNATTENDED TERMINALS
- LOG OFF UNATTENDED NETWORK CONNECTIONS

IMPROVING SYSTEM SECURITY

ACCOUNT MANAGEMENT

- ACCOUNT REQUEST FORMS
- ONE PERSON PER USERNAME
- DEACTIVATE ACCOUNTS UPON USER TERMINATION OR TRANSFER
- EFFECTIVE USE OF UIC-GROUPS
- ACCOUNT UAF RESTRICTIONS
  - TIME OF DAY
  - LOGIN-CLASS
  - CAPTIVE/RESTRICTED
  - DEFAULT CLI
  - CUSTOMIZED DCLTABLES
  - CPU TIME AND ACCESS TO BATCH QUEUES
IMPROVING SYSTEM SECURITY

PASSWORD SELECTION AND MANAGEMENT

• ADEQUATE LENGTH
• DISABLE PASSWORD RE-USE
• NO COMMON WORDS
• NO PROPER NAMES OR ACRONYMS
• USE NON-ALPHABETIC CHARACTERS ($, _)
• ADVOCATE PASS-PHRASES

IMPROVING SYSTEM SECURITY

SECURITY/ACCESS CONTROLS

PASSWORD ADMINISTRATION

• SYSTEM PASSWORD
• SECURE_SERVER
• SECONDARY PASSWORDS
IMPROVING SYSTEM SECURITY

SECURITY/ACCESS CONTROLS

BREAKIN DETECTION

- SYSGEN /LGI PARAMETERS
- VMS AUDIT COMMANDS

$ SET AUDIT/ENABLE=BREAKIN=ALL
$ SET AUDIT/ALARM/ENABLE=LOGIN=NETWORK
$ REPLY/ENABLE=SECURITY
$ SHOW INTRUSION

IMPROVING SYSTEM SECURITY

SECURITY/ACCESS CONTROLS

FILES, OBJECTS AND DEVICES

- UIC-BASED PROTECTION
  - DEFAULT SHOULD BE (W:NONE)

- ACCESS CONTROL LISTS
  - MONITOR ACCESS TO SENSITIVE FILES
  - ALLOW/RESTRICT ACCESS TO RESOURCES
  - CONTROL EXTENT OF ACCESS BY NETWORK USERS
EVERY NODE HAS A UNIQUE NAME AND ADDRESS CONSISTING OF AN AREA NUMBER AND A NODE NUMBER OF THE FORM:

\[ \text{AREA}. \text{NODE} \]

EX: 2.11

WHICH TRANSLATES INTO A UNIQUE INTEGER ADDRESS BY USING THE FORMULA:

\[ (\text{AREA} \times 1024) + \text{NODE} \]

EX: 2059:::

FILTERING UNKNOWN NODES

\[ \text{AREA} \quad \text{NODE} \]

\[ \text{MAX AREA} \quad \text{MAX ADDRESS} \]

\[ 0 \quad 0 \]

\[ 1023 \quad 63 \]
CONTROLLING NODE ACCESS WITH NCP

NCP> SET NODE EAGLE ACCESS BOTH
    MYNODE  →  EAGLE

NCP> SET NODE EAGLE ACCESS INCOMING
    MYNODE  →  EAGLE

NCP> SET NODE EAGLE ACCESS OUTGOING
    MYNODE  →  EAGLE

NCP> SET NODE EAGLE ACCESS NONE
    MYNODE  →  EAGLE

$ TYPE REMOTE "USER PASSWORD": FILE.EXT
.
.
.
$ TYPE REMOTE::FILE.EXT
.
.
.
$DIR REMOTE::
.
.
.
$COPY «FILE» REMOTE::

LOCAL NODE  REMOTE NODE

[DECNET] [USER]
### NETSERVER$TIMEOUT

- **Length of time "server" processes live after object termination**

**RECOMMENDATION**

```
$DEFINE/SYSTEM/EXEC NETSERVER$TIMEOUT "0000 00:00:00:00.01"
  * Each network connection in its own NETSERVER.LOG
  * VMS Accounting Record for EACH Network Access
  * Process creation each time a network object invoked
```
NETSERVER.COM

- Invoked each time a new "server" process starts up
- Services incoming network connections for an object
- Waits for NETSERVER$TIMEOUT or 25 Connections
  - Multiple Connections per NETSERVER.LOG
- Purges NETSERVER.LOG

RECOMMENDATION:
- Comment out the line that Purges NETSERVER.LOG
  (This change not supported by DEC)

SYSSSYSTEM:NETSERVER.COM

:.
$ IF PERMANENT_NETSERVER_COUNTERLT.25 THEN GOTO LOOP
$ PERMANENT_NETSERVER_COUNTER = 0
$ SET NOON
$ DEASSIGN SYMOUTPUT
$ DEFINE SYMOUTPUT NETSERVER.LOG
$ WRITE SYMOUTPUT "NETSERVER.LOG - NEW VERSION CREATED \"PITIME\""
$ SET ON
$ GOTO LOOP
$ !
$ !FIRST TIME THROUGH, PURGE OLD LOGS.
$ !ALSO, SEE IF THERE ARE ANY PERMANENT NETSERVER SLOTS OPEN...
$ !
$ STARTUP_NETSERVER:
$ STARTUP_FLAG = "N"
$ IF PSEARCH ("SYSILogin:NETSERVERLOG") NE "" THEN:
$  PURGE / KEEP 3 SYSILogin:NETSERVER.LOG
:.
PROTECT NETSERVER.LOG

- Deters unauthorized browsing/deletion of NETSERVER.LOG
- Impossible to completely "cover one's tracks"
- Suggest (S:RWD,O,G,W)

NETSERVER.LOG PROTECTION

[- NETSERVER.LOG protected (S:RWD, O:RWED, G,RE, W) -]

DELETED ROBIN : NETSERVER.**
%DELETE-W:FNITDEL, error deleting ROBIN : DECNETS : [FAL] NETSERVER.LOG, 39:RS-FLK, file currently locked by another user
%DELETE-I:FLDEL, ROBIN : DECNETS : [FAL] NETSERVER.LOG, 38 deleted (8 blocks)
%DELETE-I:TOTAL, 1 file deleted (8 blocks)

TYPE ROBIN : NETSERVER.LOG

Connect request received at 9-MAY-1982 13:20:29.18
from remote process LARK : "DETCATI" for object SYSSYSPOOL : [SYSEX]FAL.COM
NETSERVER.LOG PROTECTION
(Cont.)

FAL V04-000 started execution on 9-MAY-1990 13:50:39.57
with SYSSNET = LARK : "0=TENCATI " and
with FAL$LOG = 1
Requested file access operation: Open File
Specified file: DECNETS : [FAL]NETSERVER.LOG; 39
DAP status code of 4030 generated
Requested file access operation: Erase File
Specified file: DECNETS : [FAL]NETSERVER.LOG; 39
DAP status code of 4030 generated
Requested file access operation: Open File
Specified file: DECNETS : [FAL]NETSERVER.LOG; 39
Resultant file: DECNETS : [FAL]NETSERVER.LOG; 38
File access was terminated with DLT bit set on close

USING FAL$LOG TO ENHANCE AUDITS

- UNDOCUMENTED FEATURE (Debugging?)
- Inserts extended information into NETSERVER.LOG
- Bit-mask (Best defined as a character string):
  
  Bit 0  - Enables logging of Filename(s)
  Bit 1  - Enables generation of throughput statistics
  Bit 2  - Enables logging of DAP messages
  Bit 3  - Enables logging of xmit and recv AST completions
  Bit 4  - Enables logging of xmit and recv QIO requests
  Bit 5  - Reserved
  Bit 6  - Disables DAP message blocking
  Bit 7  - Disables DAP CRC error checking
  Bit 8 - 31 Reserved

Examples:

$DEFINE/SYS/EXEC FAL$LOG 1
dl
$DEFINE/SYS/EXEC FAL$LOG "3(DISABLE=8"
        (Disables "poor man's routing")
NETSERVER.LOG PROTECTION
(Recommended Setting)

[- NETSERVER.LOG protected (S:RWED, O,C,W) -]

$ DELETE ROBIN::NETSERVER.LOG

Error deleting ROBIN::DECNETS:[FAL]NETSERVER.LOG:69
Insufficient privilege or file protection violation

STYPE ROBIN::NETSERVER.LOG

Connect request received at 9-MAY-1990 16:02:07.51
from remote process LARK::"0:TENCATI"
for object "SYSSYSROOT: [SYSEX]FAL.COM"

FAL V4.6-00 started execution on 9-MAY-1990 16:02:07.95
with SYSSNET = LARK::"0:TENCATI" and
with FALLOG = 1

Requested file access operation: Open file
Specified file: DECNETS:[FAL]NETSERVER.LOG:69
DAP status code of 0665 generated

DEFAULT DECNET ACCESS

$ DIR ROBIN::

Directory ROBIN::DECNETS:[FAL]

LOGIN.COM:32767 NETSERVER.LOG.2 NETSERVER.LOG:1 NODEINFO.LIS:32767
SPANLOG.COM:32767 STC.BAK:32767 STC048.A:32767

Total of 7 files

$ TYPE ROBIN::NETSERVER.LOG

Connect request received at 3-MAY-1990 14:18:45.19
from remote process LARK::"0:TENCATI"
for object "SYSSYSROOT: [SYSEX]FAL.COM"

[- Additional Information Provided by FALLOG -]

FAL V4.6-00 started execution on 3-MAY-1990 14:18:45.19
with SYSSNET = LARK::"0:TENCATI" and
with FALLOG = 1

Requested file access operation: Directory List
Specified file::
Resultant files:

FAL terminated execution on 3-MAY-1990 14:18:47.16
POOR MAN'S ROUTING

$ DIR ROBIN : : LARK : : **:**
Directory ROBIN : : LARK : : [DECNET]
DTR.LOG;53 EXENET.COM;1 FAL.LOG;80 LOGIN.COM;3
MIRROR.LOG;4 NETSERVER.LOG;1575 NETSERVER.LOG;1574
NETSERVER.LOG;92 NTM.LOG;157 NETSERVER.LOG;1573
NETSERVER.LOG;1575 NM.NET;17 TMPCLE.LOG;3
Total of 13 files.

$ TYPE LARK : : NETSERVER.LOG

Connect request received at 9-MAY-1990 13:19:31:44
from remote process ROBIN : : '0=DECNET
for object 'SYS$SYSROOT : [SYSEX]FAL.COM'

(From LARK):

$DIR ROBIN : : EAGLE : : **:**
-RM$-F-NOD, Error in node name

$TYPE ROBIN : : NETSERVER.LOG

Connect request received at 9-MAY-1990 13:19:31:44
from remote process LARK : : '0=TENCATI
for object 'SYS$SYSROOT : [SYSEX]FAL.COM'

FAL V4.6-00 started execution on 9-MAY-1990 13:19:31:44
with SYS$NET = LARK : : '0=TENCATI
with FAL$LOG = l/DISABLE=8

Request file access operation: Directory List
Specified file: EAGLE : : **:**
DAP status code of 4088 generated
SELECTED DECNET/DAP STATUS CODES

<table>
<thead>
<tr>
<th>DAP CODE</th>
<th>Corresponding VMS Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>401D</td>
<td>Error in Device Name or Inappropriate Device...</td>
</tr>
<tr>
<td>401E</td>
<td>Error in Directory Name</td>
</tr>
<tr>
<td>4020</td>
<td>Directory Not Found</td>
</tr>
<tr>
<td>4030</td>
<td>File Locked by Another User</td>
</tr>
<tr>
<td>4032</td>
<td>File Not Found</td>
</tr>
<tr>
<td>4055</td>
<td>Insufficient Privilege or File Protection Violation</td>
</tr>
<tr>
<td>4086</td>
<td>Invalid Channel (Poor Man's Routing Attempted/Disabled)</td>
</tr>
<tr>
<td>4097</td>
<td>Syntax Error in Filename</td>
</tr>
<tr>
<td>1007</td>
<td>Related to Sending Mail Across Node</td>
</tr>
<tr>
<td>1009</td>
<td></td>
</tr>
<tr>
<td>5D60</td>
<td></td>
</tr>
</tbody>
</table>

Success: "File Access was Terminated with No Bits Set on Close"
Deleted: "File Access was Terminated with DLT Bit Set on Close"
SHOWSYS.COM:

$ DEFINE SYS$OUTPUT SYS$NET
$ SHOW SYSTEM
$ EXIT

$ TYPE EAGLE: "0=SHOWSYS"
- Requires that the task object be present

NCP> DEFINE OBJECT SHOWSYS NUMBER 140
FILE ddcu:[DIR]SHOWSYS.COM USER FRED PASS password

$ TYPE EAGLE: "140=
- Does not use the task object

USING SEPARATE OBJECT USERID'S

- Each object gets its own VMS accounting record

- Objects can be assigned identifiers for use in ACL's

- Removal of userid/password from Executor database

- Define each object with NCP:
  Example:
  NCP>DEFINE OBJECT FAL USER FAL OBJ PASSWORD XYZZY
  NCP>DEFINE OBJECT MAIL USER NETUSER PASSWORD PONEYEXPRESS

- A configuration option under V3.2 and higher
DECNET OBJECT DATABASE

Known Object Volatile Summary as of 2-MAY-1989 20:21:13

<table>
<thead>
<tr>
<th>Object</th>
<th>Number</th>
<th>File/PID</th>
<th>User Id</th>
<th>Password</th>
</tr>
</thead>
<tbody>
<tr>
<td>$MOM</td>
<td>0</td>
<td>SYSSYSTEM:MOM.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>$NICONFIG</td>
<td>0</td>
<td>SYSSYSTEM:NICONFIG.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>$TASK</td>
<td>0</td>
<td>SYSSYSTEM:TASKLOG.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>$SMISERVER</td>
<td>0</td>
<td>2020008C</td>
<td>NET_NML</td>
<td>RESTRICTACCESS</td>
</tr>
<tr>
<td>TASK</td>
<td>0</td>
<td>SYSSYSTEM:MANAGER:TASKLOG.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>FAL</td>
<td>17</td>
<td>SYSSYSTEM:FAL.COM</td>
<td>FAL</td>
<td>FAL_USE_PWD</td>
</tr>
<tr>
<td>HLD</td>
<td>16</td>
<td>SYSSYSTEM:HLD.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>NML</td>
<td>19</td>
<td>SYSSYSTEM:NML.COM</td>
<td>NET_NML</td>
<td>RESTRICTACCESS</td>
</tr>
<tr>
<td>REMACP</td>
<td>23</td>
<td>20200094</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>MIRROR</td>
<td>25</td>
<td>SYSSYSTEM:MIRROR.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>EVL</td>
<td>26</td>
<td>20200092</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAIL</td>
<td>27</td>
<td>SYSSYSTEM:MAIL_SERVER.EXE</td>
<td>NETMAIL</td>
<td>BILL_COLLECTOR</td>
</tr>
<tr>
<td>PHONE</td>
<td>29</td>
<td>SYSSYSTEM:PHONE.COM</td>
<td>PHONE</td>
<td>BUSY$SIGNAL</td>
</tr>
<tr>
<td>DOMF</td>
<td>30</td>
<td>SYSSYSTEM:DOMF.COM</td>
<td>DECNETUSER</td>
<td>DEFAULT_PWD</td>
</tr>
<tr>
<td>CTERM</td>
<td>42</td>
<td>20200094</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPMBREMOTE</td>
<td>51</td>
<td>SYSSYSTEM:SPMBREMOTE.COM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DTR</td>
<td>63</td>
<td>SYSSYSTEM:DTR.COM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINGER</td>
<td>117</td>
<td>FINGER@DIRECTORY:FINGER.EX</td>
<td>NET_FINGER</td>
<td>ALL$THUMBS</td>
</tr>
</tbody>
</table>

CONNECTION SUMMARY

(INBOUND REQUEST)

USE EXPLICIT ACCESS STRING

Else

USE DEFAULT OR SPECIFIED PROXY

Else

USE OBJECT-LEVEL USERID/PASSWORD

Else

USE EXECUTOR DEFAULT ACCESS INFO

Else

"Login Information Invalid at Remote Node"

Local Login Failure Record
SAMPLE UAF RECORD

Username: DECNET
Account: NETWORK
CLI: DCL
LGICMD: NIL
Login Flags: Directly Locked Restricted
Primary days: Mon Tue Wed Thu Fri
Secondary Days: Sat Sun
Primary: 0000000000111111111111112222
Day Hours: 012345678901234567890123
Secondary: 0000000000111111111111112222
Day Hours: 012345678901234567890123
Network: accessFull access accessFull access
Batch: No Access
Local: No Access
Dialog: No Access
Remote: No Access
Expiration: (none)
Prevlogin: 180 00:00
Last Login: 4-NOV-1988 12:41 (interactive), 14-SEP-1988 11:00 (non-interactive)
Maxjobs: 0
Maxprocs: 0
Maxdetach: 0
Perm: 0
Prl: 0
Pre: 4
Quepre: 0
CPU: 0 00:01:00

Authorized Privileges:
- [DECNET]
- [NETMAIL]
- [FINGER]
- [PHONE]
- [LOGFILES]

Default Privileges:
- TMPMBX NETMBX

Every Network object should have a separate UserId with the above configuration. (Unique UIC's)
LOGGING NETWORK CONNECTIONS

- Provides hardcopy proof of connection
- Easier monitoring of DECNET activity
- Suggested Implementations:
  - \$SET AUDIT/ALARM/ENABLE=LOGIN=NETWORK
    (Extractable with SECAUDIT.COM)
  - Make an LGICMD file each object "user" runs:
    \$User  = F8Logical("SYSREM_ID")
    \$Node  = F8Logical("SYSREM_NODE")
    \$Request/To = Network -
    "Network Connect From Node "Node"User="User"
    \$Exit

NETWORK AUDIT TRAILS

\$ SET AUDIT/ALARM/ENABLE=LOGIN=NETWORK

%%%%%%%%%%%%%%%% OPCOM 3-MAY-1990 10:25:00.51 %%%%%%%%%%%%%%%%%
Security Alarm on MYNODE / Network Login
Time:    03-MAY-1990 10:25:00.46
PID:     00001F65
User Name: EAGLE
Source:  5.143 EAGLE-TENCATI

UAP > MODIFY NET_FAL/LGICMD=NET_LOG.COM
NCP> SET OBJECT FAL USER NET_FAL PASSWORD <password>

%%%%%%%%%%%%%%%% OPCOM 3-MAY-1990 10:25:03.74 %%%%%%%%%%%%%%%%%
Message from user NET_FAL on MYNODE
FAL_15390, Network Connect From Node: EAGLE, Username: TENCATI
Sample Output From NETLOG.COM

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>Remote Node</th>
<th>Remote Userid</th>
<th>Connect Time</th>
<th>Local Username</th>
<th>Record Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-MAY-86</td>
<td>07:53:42</td>
<td>HAMLET</td>
<td>2080012C</td>
<td>00:00:35</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>07:53:54</td>
<td>WRIF</td>
<td>DUNKERT</td>
<td>00:00:53</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>07:53:27</td>
<td>MARVAX</td>
<td>DECENT</td>
<td>00:00:27</td>
<td>FAL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:00:31</td>
<td>MARVAX</td>
<td>DECENT</td>
<td>00:00:41</td>
<td>FAL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>07:56:03</td>
<td>FLAG2</td>
<td>000000422</td>
<td>00:06:07</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:02:59</td>
<td>JPL, RAG</td>
<td>OLSEN</td>
<td>00:01:09</td>
<td>OLSEN&lt;Login&gt;</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:03:25</td>
<td>MARVAX</td>
<td>DECENT</td>
<td>00:01:02</td>
<td>FAL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:05:25</td>
<td>MARVAX</td>
<td>DECENT</td>
<td>00:01:28</td>
<td>FAL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:28:38</td>
<td>UCMBO</td>
<td>21000004A</td>
<td>00:00:28</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:36:50</td>
<td>LAMPS</td>
<td>KWAIGHTT</td>
<td>00:00:19</td>
<td>PHONE</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:36:40</td>
<td>CASS91</td>
<td>000000110</td>
<td>00:04:29</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>08:46:08</td>
<td>JPL, MAD</td>
<td>PAULSON</td>
<td>00:00:18</td>
<td>PHONE</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:04:45</td>
<td>LOCK</td>
<td>HACK</td>
<td>00:00:28</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:06:09</td>
<td>LOCK</td>
<td>HACK</td>
<td>00:03:12</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:12:20</td>
<td>DIRAC2</td>
<td>KERR</td>
<td>00:02:58</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:15:24</td>
<td>ASD</td>
<td>LEHMAN</td>
<td>00:00:21</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:19:14</td>
<td>EROSA</td>
<td>SYSTEM</td>
<td>00:00:18</td>
<td>PHONE</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:20:56</td>
<td>JPL, RAG</td>
<td>SYSTEM</td>
<td>00:00:53</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:21:26</td>
<td>HAMLET</td>
<td>2080412B</td>
<td>00:00:28</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:31:19</td>
<td>SWRI</td>
<td>00000078C</td>
<td>00:00:34</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:46:21</td>
<td>JPL, SP</td>
<td>BGOLOSTEIN</td>
<td>00:03:44</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>09:31:57</td>
<td>CYCLOP</td>
<td>000001D2C</td>
<td>00:30:32</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>11:52:39</td>
<td>NSSDCA</td>
<td>CROMP</td>
<td>00:00:44</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
<tr>
<td>10-MAY-86</td>
<td>15:23:39</td>
<td>LHEAVY</td>
<td>0000004AA</td>
<td>00:00:46</td>
<td>NETMAIL</td>
<td>Mail</td>
</tr>
</tbody>
</table>

IMPROVING SYSTEM SECURITY

IMPROVING SECURITY - GENERAL

- USE PASS-PHRASES
- REQUIRE PASSWORDS ON ALL ACCOUNTS
- ONE ACCOUNT PER USERNAME
- GENERATE AUDIT TRAIL (ACCOUNTING) DATA - REVIEW DAILY
- INSTALL PATCHES AS THEY BECOME AVAILABLE
- RUN SECURITY "TOOLKIT" SOFTWARE
  UNIX: "COPS" VMS: "SPAN TOOLKIT"
- REPORT INCIDENTS WHEN THEY HAPPEN
IMPROVING SYSTEM SECURITY

IMPROVING SECURITY - VMS

- NO TASK OBJECT
- SEPARATE USER IDS FOR DECNET OBJECTS
- USE NETSERVER_TIMEOUT AND FALLOG TO ENHANCE AUDIT TRAILS
- USE ACCESS CONTROL LISTS
- RESTRICT FTP TO PARTICULAR DIRECTORY
- USE PSI_SECURITY TO FILTER X.25 CONNECTS TO FROM VALID DTE'S ONLY

INCIDENT HANDLING

- DO NOT REPORT NSI/NASA INCIDENTS TO THE "CERT"
- USERS SHOULD REPORT ANY ANOMALY TO THEIR SYSTEM ADMINISTRATOR
- SYSTEM ADMINISTRATORS SHOULD REPORT ANY SECURITY INCIDENT TO THEIR DPI-CSO
- IF INCIDENT INVOLVES AN EXTERNAL SITE, REPORT IT ALSO TO NSI-SECURITY OFFICE, SECURITY@NSINC.GSFC.NASA.GOV
- NSI SECURITY OFFICE ISSUES SECURITY BULLETINS TO NSI COMMUNITY VIA ROUTING CENTER MANAGERS AND NASA AIS CONTACTS
IMPROVING SYSTEM SECURITY

SECURITY MANAGEMENT TOOLS

- NSI SECURITY BULLETINS
- PASSWORD MONITORING/COMPLIANCE SOFTWARE
- DECNET CONNECTION SUMMARY REPORT GENERATOR
- PSI ACCOUNTING
- PSI CONNECTION/USER SUMMARY REPORT GENERATOR
- SPAN TOOLKIT
- LLNL SPI/VMS TOOLKIT
Major purposes of this presentation

- To familiarize you with some of the major security problems in UNIX
- To acquaint you with methods of making your UNIX system more secure, regardless of whether you are a user or system manager
About the security of the UNIX operating system

- UNIX was designed for use in "trusted" computing environments
- As UNIX has moved towards becoming a de facto standard, it is being used more in sensitive and classified computing environments
- The UNIX kernel is secure, but the applications/utilities are often not
- UNIX contains many security features, but they usually must be enabled
- As new features are added to UNIX, security has become more difficult to control

What really is the problem?

- FACT - 90 percent or more of the intrusions into UNIX systems would never occur if two widespread problems were corrected
  - Weak passwords
  - Unpatched vulnerabilities
Other causes of security problems

- Improper permissions (especially file permissions)
- Improper system configuration
- Use of programs and functions that compromise security
- Lack of security maintenance activity
- Inadequate network security architecture

Some dangers of an attacker obtaining root privileges

With root privileges on a system an attacker can
- Create new accounts
- Disable any account
- Read, write to, or delete any file on that system, regardless of any protections placed on that file
- Intercept and read anyone's e-mail
- Install trojan horse programs on that system
- Delete any system accounting files (/etc/utemp, /etc/wtemp, usr/admin/lastlog)
Some dangers of an attacker obtaining root privileges (continued)

- Modify data (e.g., change value of pi to 3.4)
- Kill any process that is running
- Login to any other system that trusts the compromised host without using a password, and do the same!
Passwords

More UNIX incidents start with because of poor or nonexistent passwords than any other cause!

Evidence of password problems

- In *The Cuckoo's Egg*
- During the 1988 Internet worm attack
- Intrusions into U.S. UNIX systems from Germany, England, Australia, The Netherlands, etc. from 1987 - present
- Intrusions into U.S. UNIX systems from overseas during Operation Desert Shield/Desert Storm
Evidence of password problems
(continued)

- Klein's study in 1990 showed that of a total of 15,000 passwords in password files from 50 sites:
  - 3% could be found by a password cracking program within 10 minutes
  - 21% could be cracked by this program in 1 week
  - Approximately two-thirds of systems involved in study could be compromised by at least one bad password

How attackers obtain passwords

- By guessing
- By cracking password files
- From bulletin boards
- From e-mail messages and files in compromised accounts
- By social engineering—"con jobs" on unsuspecting users to obtain passwords
"Joe" accounts

Accounts with the same user name and password

User = jabstar
Password = jabstar

Weak (easy-to-guess) passwords

- Simple variations (e.g., rnjones, jonesrn, rjones, ronjones) or reversals of a username
- Any word found in the English dictionary
- Popular car makes
- First names
- Computer (and other) slang (e.g., guru, wizard, etc.)
- Yiddish or Chinese words
- Simple letter iterations (e.g., ababab)
Frequently found default passwords

- root
- diag
- sysdiag
- sundiag
- maint
- sync

Unpassworded accounts

- Some accounts have no password at all
  - Examples: root* and uucp
  - Frequent reason: convenience of users
  - Easy target for attack
- If there is no password for modem dial-ins, once an attacker has the dial-in number a system is subject to multiple attacks involving different accounts

* Some but not all UNIX vendors ship systems with an unpassworded root account
Choosing a sound password

- Requires some inconvenience on the user's part

- Recommended methods
  - Short word + control character + short word unrelated to first, e.g., tie&shirt
  - Mnemonic method—using first letter of each word in an easily remembered phrase, e.g., mctotsiol (my Country tis of thee...sweet land of liberty)

- Avoid using any password less than 7 - 8 characters in length

Checking for easily guessed passwords

- Proactive approach—when the password is set
  - Replace the procedure for changing the password to check for easily guessed passwords
  - Establish policy for setting the initial password to something not easily guessed

- Retroactive approach—at regular intervals
  - Run a password checker on your system's passwords
  - Prepare a policy for finding and changing easily guessed passwords
Checking for easily guessed passwords (continued)

- Install password filtering tool (proactive)
  - npasswd (anonymous ftp to emx.utexas.edu)
  - passwd+ (contact Matt.Bishop@dartmouth.edu)
  - Commercially available tools

OR

- Use password checking tool (retroactive)
  - COPS (ftp to cs.purdue.edu)
  - CRACK (ftp to wuarchive.wustl.edu—in vol. 25)
  - SPI (Security Profile Inspector) – send e-mail to
tencatl@nssdca.gsfc.nasa.gov

Password aging

Requiring users to change their password on a regular basis has some benefits and drawbacks:

- Can flag and remove dormant accounts
- Limits the utility of a stolen password

BUT

- Can drive users to choose weak passwords, since the user now has to invent and remember new passwords more frequently
Password aging (continued)

- In some UNIX systems password aging can be set by editing `/etc/passwd`
  
  root:abcdefgijklmnop:0:Whammie:/bin/csh

  value (in weeks) for password expiration

- Some commercial security packages have password aging

- In "secure" SunOS systems, modify passwd.adjunct in `/etc/security`

Eliminating accessible password files

"Secure" versions of UNIX have shadow password files (i.e., encrypted passwords are stored in a non-accessible file)

  root:*:28:1::Whammie:/bin/csh

  login process

  `.security`, `/etc/security` or `/usr/etc/security`
Social engineering

OmniCore is experimenting in online - high resolution graphics display on the UNIX BSD 4.3 system and its derivatives. But, we need your help in testing our new product - TurboTetris. So, if you are not too busy, please try out the tetris game in your machine's /tmp directory. Just type:

/tmp/tetris

Because of the graphics handling and screen-reinitialization, you will be prompted to log on again. Please do so, and use your real password. Thanks for your support. You'll be hearing from us soon!

OmniCore

UNIX Security

Overview
Password Management
File Protection
System Configuration
Vulnerabilities
A Final Note
File protections

- File protections determine who may
  - Read/write to and/or execute a file
  - List, create and search directories
- An attacker may not need to obtain root privileges or break into your account to get what s/he wants from your account if your file protections are not set properly

File access modes

$ ls -Ig anyfile

- rwxr-xr-x 1 gene sys 2 May 1 1991 anyfile
  - owner—read, write, and execute allowed
  - group—read, write and execute allowed
  - other—read and write access but no execute allowed
- file type—- shows this is a file
Directory access modes

```
$ ls -ldg mydir
```

- **File type:** d shows this is a directory
- **Owner:** list, create and search access
- **Group:** list, create and search access
- **Others:** list and create but no search access

```
drwxrwxrwx 1 gene sys 512 May 1 1991 mydir
```

The "bottom line" of file protection

- Anyone with access to your system can
  - Read/copy any of your world-readable files
  - Alter/delete any of your world-writable files
  - Run any of your world-executable programs
  - Plant trojan horse programs in your world-writable directories in your path

- Threats to the system itself
  - World-writable binaries and system directories allow an attacker to modify the system
  - Readable restricted system files allow an attacker to discover other trusted computers or other privileged information
Setting the proper file permissions

• In octal method of setting file permissions
  4 = read (or list in the case of directories)
  2 = write (or to add/delete files from a directory)
  1 = execute (or to cd into a directory)
  so 761 = owner read-write-execute, group read-write, and world execute only for a file

• To change permissions so that you can read-write-execute, but group or world cannot read-write-execute
  $ chmod 700 anyfile

Setting the proper file permissions (continued)

OR (symbolic method)
  $ chmod og-rwx anyfile  (group and world now have no read-write-execute access)

• To recursively remove all read access for group and world recursively through your directory structure:
  $ chmod -R og-r  (BSD systems only)
  OR
  $ find . -exec chmod og-r {} \;

1-29
Recommended file permissions

• For user files and directories:
  - Any file containing a password: mode X00
  - Hidden files: writable only by owner
  - Directories: writable only by owner, with all files contained therein owned by user
  - If you are not sure, try mode 700 or 711 initially for executable files and 600 or 644 for non-executable files

Recommended file permissions (continued)

• In general, only root needs to have write permission for system files
• System files should be owned by system users
• root directories (e.g., bin, dev, etc, mnt, usr, etc.) should not have add/delete access by world
• World should not be able to read-write to memory, devices, spool directories, etc.
Recommended file permissions (continued)

- netrc (contains login and initialization information for use by ftp's auto-login process) - should be readable only by owner
- /usr/adm/utmp or /usr/adm/wtmp - mode 600 or 644
- /var/adm/acct or /var/adm/pacct - mode 600
- syslog, authlog, or similar files - mode 664 or 644 (recommended directory mode is 700 or 755)

umask

- umask (in /etc/profile or .cshrc file) sets a mask on permissions for files and directories you create
- sets limit on maximum permission values (octal)
- 7 minus umask value = maximum sum of access permissions for each bit, e.g., mask value of 4 allows write (2) and execute (1) only

$ umask (displays umask creation mask)
$ umask 126 (prevents owner from execute, group from read-execute and world from read-write access)
$ umask 077 (prevents group and world from read-write-execute access)
UIDs for processes

- **UID** - user identification number
- If a process needs to read, write or execute a certain file, the associated UID must have the appropriate access permissions.
- **Real UID** - the UID of the user who executes the process.
- **Effective UID** - the UID under which the process runs (with the same access permissions as the owner of any accessed file).
- **Example** - If user rcarr executes a setuid file owned by gene, the real UID will be rcarr's, but the effective UID will be gene's.

GID}s for processes

- **GID** - group identification number.
- **Real GID** - the GID of the group that executes a process.
- **Effective GID** - the GID under which the process runs (with associated access permissions and privileges).
SUID permission

SUID - Set user ID

- When SUID permission is set, all processes created from program will have effective UID of the owner of program
- Effective UID may be different from real UID
- chmod command used to set SUID permission
  $ chmod u+s anyfile OR chmod 4XXX anyfile (sets SUID permission)
  $ ls -ig anyfile
    - rw-rw-r-x 1 gene sys 2 May 1 1991 anyfile
      the s replaces the x to show that the SUID permission is set

SGID permission

SGID - Set group ID

- When SGID permission is set, all processes created from program will have effective UID of the group associated with program
- Effective GID may be different from real GID
- chmod command used to set SGID permission
  $ chmod g+s anyfile OR chmod 2XXX anyfile (sets SGID permission)
  $ ls -ig anyfile
    - rwxr-xr-x 1 gene sys 2 May 1 1991 anyfile
      the s replaces the x to show that the SGID permission is set
The sticky bit

- If the sticky bit on a directory is set, only the owner of files in that directory can remove or rename those files
  - Applies to SunOS and some other BSD systems
  - Useful especially for /tmp directories (normally world-writable)

```
$ chmod 1XXX mydir OR $ chmod o+t
$ ls -ldg mydir
  drwxr-xr-x 1 gene sys 512 May 1 1991 mydir
```

this replaces the x to show that the sticky bit is set

setuid root files planted by intruder

- Designed to allow root privileges to intruder upon reentry into system
- Often are hidden* (e.g., .xx, .., etc)
- setuid root program might be /bin/sh
- To find setuid root files:
  ```
  $ find / -user root -perm -4000 -print
  ```

* - Hidden files begin with a period
Recommendations for setuid

- setuid root scripts
  - Your vendor can inform you which scripts need to run as root — other setuid root scripts should not be allowed
  - All setuid root programs should be in systems directories and should not be world readable-writable
  - /usr/bin/uusend and /usr/lib/ex3.7preserve should not be setuid root in SunOS systems

- All setuid to user programs should be known to user

- setuid files generally require only execute access
  
  $ chmod 4711 any_setuid_file

UNIX Security

Overview
Password Management
File Protection
System Configuration
Vulnerabilities
A Final Note
Ownership

• /etc should be owned by root, not bin

$ ls -lf /bin

```bash
drwxr-xr-x 4 bin system 3584 Jun 4 11:05 etc/   (this is bad!)
```

$ chown root /etc (now bin is owned by root)

• /dev/mem, /dev/kmem and /dev/drum
  - Should be owned by root and group kmem
  - Mode 640 recommended

$ ls -lF /dev/mem

```bash
drwxr-xr-x 4 root kmem 4096 Aug 8 13:54 dev/mem  (this is good)
```

• All devices (except terminals*) should be owned by root
  * - Should be owned by user until user logs out—then should be owned by root again

sendmail

• alias, alias.dir and alias.pag in sendmail
  - Should also be owned by root
  - Should not be world writable

• Remove decode alias from /etc/aliases or /usr/lib/aliases
System integrity

- Inspect system programs, network daemons, and access control programs for trojan horse programs
  - telnet
  - /bin/login
  - tftp
  - su
  - cron**
  - at**

$ sum /bin/login

OR run integrity checking tool such as COPS

* - Use checksum program kept offline
** - Any file referenced by cron and/or at should not be world-writable, either

Trusted hosts files

- Ensure integrity of trusted hosts files (i.e., hosts.equiv, hosts.lpd and .rhosts files)
  - Inspect names of systems (e.g., unauthorized or not in your domain)
  - + in these files allows universal access
  - Files should not be world-writable
tftp

- Secure tftp (trivial file transfer protocol)
  - Disable tftp unless it is necessary (e.g., for diskless servers)

$ get /etc/motd

- To disable tftp: delete or comment out tftp entry in /etc/inetd.conf
- If you run tftp, run the most recent version (Berkeley version 5.60) and run it "secure" (-s option in inetd.conf in SunOS)

anonymous ftp

- Secure anonymous ftp (file transfer protocol)
  - (If possible) - have dedicated anonymous ftp server
  - Asterisk out password fields in ~ftp/etc/passwd
  - Allow only group access in ~ftp/etc/group
  - Directory protections: 755 (generally)
  - netrc (contains login and initialization information for use by ftp's auto-login process) - should be readable only by owner
Account management

- Disable* unnecessary default accounts (e.g., sync)
- For disabled accounts, change login shell from /bin/sh to /bin/false
  
  sys:*:2,2::/:/bin/false
- Ensure that password file does not contain entries such as :0:0:
- Recommendation—avoid:
  - Guest accounts**
  - Group accounts***

* - Replace the password with an asterisk
** - If guest accounts must be used, assign a non-trivial password, and disable account immediately after guest user leaves
*** - If multiple users are to have root privileges, assign multiple accounts with UID=0

Other recommendations for system configuration

- /etc/exports
  - Should specify only hostnames or netgroups allowed to mount partitions
  - access= must not be empty, or any host may mount file system
  - After editing, enter
    
    # exportfs -a
    
    (to ensure that changes are put into effect)

- /etc/netgroup
  - Should specify only hostnames or netgroups allowed to mount partitions
  - Host and user fields must not be empty
UNIX Security

Overview
Password Management
File Protections
System Configuration
Vulnerabilities
A Final Note

About UNIX vulnerabilities

- Older versions of UNIX generally contain more vulnerabilities
- Your vendor can help you learn which specific vulnerabilities apply to the particular flavor and version of UNIX that you run
- Patches may have undesirable side effects, depending on configuration
UNIX vulnerabilities can be exploited several basic ways

- Authentication bypass or back doors
- Compromise of passwords
- Unauthorized use of functions/privileges
- Disabling of protections

sendmail vulnerabilities

- Hole 1 — an attacker can gain root privileges and execute commands on a remote system
  - Exploited by Morris Worm
  - Fixed in recent versions of major UNIX operating systems (e.g., BSD, SunOS, ULTRIX, etc.)
- Hole 2 — when used with .rhosts can allow attacker to gain access to a system without password
  - Present in SunOS 4.0.3, but fixed in version 4.1 (BugID 1028173)
  - Fixed in recent BSD sendmail releases (5.61 - 5.65)
  - Allows serious damage to be done to systems, especially if used in connection with .rhosts files
sendmail vulnerabilities (continued)

- Hole 3 — an attacker can use this hole to overwrite critical system files (i.e., /etc/passwd, crontab)
- Other holes in older versions of UNIX, including decode, which allows users to create any file to which daemon has access

finger vulnerabilities

- Hole 1 — allows a symbolic link to privileged files when finger is run setuid to root
  - Fixed in SunOS 4.0.3 (BugID 1015128) and BSD 4.3 Tahoe
  - Exploited by Morris Worm
- Hole 2 — allows an attacker to flood the input buffer with finger requests and subsequently gain unauthorized root privileges
  - Workaround — remove setuid from finger
  - Patch available from most vendors
finger vulnerabilities (continued)

- finger is often used by an attacker to find other account names and home directories – can be used in connection with other vulnerabilities

ftp vulnerabilities

- Hole 1 – allows unauthorized root access when anonymous ftp is enabled on older UNIX systems
  - Patch available
  - Allows user to modify any file in system (including /etc/passwd)
- Hole 2 – allows unauthorized file access (e.g., /etc/passwd)
  - Patch available
Other frequently exploited UNIX vulnerabilities

- tftp – permits an attacker to remotely read any world readable file (including password file)
  - Patch available (tftp -d to specify a directory to chroot into)
  - Workaround: disable function or replace with tftpbootd
- /bin/mail – on ULTRIX systems, makes it possible for an attacker to create a shell with EUID=0 (root)
- On Sun systems, FSIRAND function is predictable, allowing an unauthorized user to mount file systems remotely

Other frequently exploited UNIX vulnerabilities (continued)

- rcp (remote copy) – allows remote copying of user readable files.
  - Workaround available
  - Patch available
- nis (network information service) and nfs (network file system) – many vulnerabilities
- dump/restore – runs as root and can allow unauthorized user to overwrite system files
Other recommended strategies

- Make backups—minimum of once every month
- Read system logs daily, checking especially for
  - Unsuccessful login attempts
  - su's to other accounts (especially root)
  - Unusual messages from daemons that log to the syslog file
- Be on the alert for unexplained changes in file sizes/dates, number of links to files, unsuccessful login attempts, etc.
- Encrypt sensitive files (but don't use Crypt!)
Scenario for the "big fall"

- lack of system maintenance
- unpatched vulnerabilities
- configuration problems
- improper permissions
- unpassworded accounts
- weak passwords

The Internet

- RSCS
- OSI (in the future)
- Decnet
- European SFAN
- NASA Science Internet
- Esnet
- TCP/IP
- NSFnet
- Milnet
- SCinet
- Internet
HOW DO I SEND EMAIL TO Whatshisname?
(Actually, how to find someones E-mail address)

OR

How I spend too much of my time

By David M. Stern

Presentation to NASA Science Internet User Working Group
Spring 1992
Users often have difficulty in finding a proper Email address they can use to communicate with a colleague. This talk looks at tricks and techniques in discovering a user's account and hostname in the DECnet, BITnet, X.29 and TCP/IP world with heavy emphasis on TCP/IP. Various Internet-wide resources and commonly available utilities (both VMS and UNIX) will be discussed.
There are basically three techniques one can use to determine a user's email address:

* Poor Mans Networking (phone him and ask)

* Search commonly available databases

* Use Network utilities
Many sites have locally available online flat-files that users may perusing.

eg The Space Data Computing Division Cluster has the Goddard phonebook online at

SDCDCL::PUB_PROD:[PHONEBOOK]PHONEBOOK.DAT

**EXAMPLE:**

c search sdcocl::pub_prod:[phonebook]phonebook.dat stern
66079 STERN DAVID M HSTX 930.4 28 W205J
68292 STERN DAVID P DR. 695.0 2 143
71736 STERN RICHARD ARICH CSC 832. 2N161 119

But these online files often don't contain email addresses. More importantly most remote users wouldn't know about such local services.

searching commonly available databases or flatfiles

To find a BITnet machine:

Search the host table that is periodically distributed to BITnet sites.
On a VMS machine running Joiner software, it is located in JAN_ROOT:[SYS]:JANROUTES.JCP and is world-readable. In fact, you need not be a BITnet site to search this file. You can peruse it remotely. Thus if a hostname is 6 or fewer alphanumeric characters, it may be a BITnet node

**EXAMPLE:**

c search dftnic::jan_root:[sys]:janroutes.jcp slac

DEFINE SLACESA /ROUTE=SCFMVS !BITNET US
DEFINE SLACRPCR /ROUTE=SCFMVS !BITNET US
DEFINE SLACPHYS /ROUTE=SCFMVS !BITNET US
DEFINE SLACSCS /ROUTE=SCFMVS !BITNET US
DEFINE SLACSLC /ROUTE=SCFMVS !BITNET US
DEFINE SLACSLD /ROUTE=SCFMVS !BITNET US
DEFINE SLACSRV2 /ROUTE=SCFMVS !BITNET US
DEFINE SLACTBF /ROUTE=SCFMVS !BITNET US
DEFINE SLACTPC /ROUTE=SCFMVS !BITNET US
DEFINE SLACTPCS /ROUTE=SCFMVS !BITNET US
DEFINE SLACTWGM /ROUTE=SCFMVS !BITNET US
DEFINE SLACVM /ROUTE=SCFMVS !BITNET US
DEFINE SLACVX /ROUTE=SCFMVS !BITNET US
But how do you find out if someone is running Joiner software?
You can remotely translate a logical using the following technique:

\texttt{SMail NL: DFTNIC::JAN_ROOT}

This forces VMS on the remote machine to internally interpret the
logical \texttt{jan_root} and parrot back to you its equivalence in the error
message.
This same technique can be used to see if a machine is running multinet,
PMDF, DEC-PSI etc

\textbf{EXAMPLE:}

c mail nl: dftnic::jan_root
%MAIL-E-USERSPEC, invalid user specification ':[SYS3.JANDFTNIC.]

Compare this to the attempted translation of a logical that does NOT
exist on the remote machine DFTNIC. Note the error message
regurgitates the logical EXACTLY as you entered it.

c mail nl: dftnic::gobblede_guk
%MAIL-E-NOSUCHUSR, no such user GOBBLEDE_GUK at node DFTNIC

To find a VMS X.25 machine:

If you are trying to reach an X.25 site, you have DEC's PSI software
and your systems manager has been kind enough to define logicals to
equate easily remembered names with machine DTE numbers, the PSI
table will list at least those DTE's that HAVE been defined.

This will only work locally. You can NOT remotely translate a PSI
logical. Likewise you can't randomly browse another machines
psi$dte_table. So if you're not a PSI site, you're SOL.

NB. Because of security considerations, Sprintnet won't translate a
number for you)

\textbf{EXAMPLE:}

c show log/table=psi$dte_table ssl "SSL" = "311032100160" (PSI$DTE_TABLE)

You don't need to give it a full name; wildcards are allowed.
Further, you don't need to remember that ridiculous logical table
name:

c show log/table=*psi* *venus* (PSI$DTE_TABLE)
"KDDVENUS" = "440881786124"
To find a DECnet machine:

First, let's assume it's in the NSI address space. If your local NCP database is up to date, try searching it ($MCR NCP SH NODE string)
Otherwise: $SEARCH NSINIC::NSI_DECNET.COM string

This file lists all registered NSI-DECnet nodes. Again, if the nodename is 6 or fewer alphanumeric characters, it may be an NSI-DECnet node.

**EXAMPLE:**

c $ see nsinic::nsi_decnet.com zar
DEFINE NODE 5.864  NAME MIZAR
DEFINE NODE 5.900  NAME ZARDOZ
DEFINE NODE 33.38  NAME MIZAR2

UNIX users can grab this file from the EAST gateway.
ftp nsinic.gsfc.nasa.gov.
cd [nsinic.general_info]
get using_east_gateway.dat

**PERHAPS ITS A HEPNET, EUROPEAN-SPAN, EUROPEAN-HEPNET, CANADIAN-SPAN, CANADIAN-HEPNET OR THENET NODE**

The above nets share the same address space. A name may be multiply defined in two or more networks. Some areas are not defined in all of the above nets.

The same previously mentioned technique can still be used. You just need to know where to look. NSI_DECNET.COM has the following "gateways" defined

<table>
<thead>
<tr>
<th>Machine</th>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNAL</td>
<td>(Fermi Lab in HEPnet)</td>
<td>42.1</td>
</tr>
<tr>
<td>ECD1</td>
<td>(European SPAN)</td>
<td>28.1</td>
</tr>
<tr>
<td>CANOTT</td>
<td>(Canadian SPAN)</td>
<td>18.100</td>
</tr>
<tr>
<td>THENIC</td>
<td>(Texas Higher Education Network)</td>
<td>25.213</td>
</tr>
</tbody>
</table>

The following machines are undefined in NSI_DECNET.COM

<table>
<thead>
<tr>
<th>Machine</th>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEPCAN</td>
<td>(Canadian HEPnet)</td>
<td>18.1001</td>
</tr>
<tr>
<td>VXCEPN</td>
<td>(European HEPnet)</td>
<td>22.190</td>
</tr>
</tbody>
</table>

So all you need to do is query one (or all) of the above regarding a nodename.

Note that you need to know (or guess) the full machine name. You cannot search on a partial string. Still, if you're only trying to identify on which network a known host resides, this method will suffice.

Once you decide on what net the machine resides, you can poor-mans-route email thru the appropriate gateway

**EXAMPLE**

`$mail data.txt fnal::marie::smith`
Bear in mind that nodenames are NOT necessarily unique to any of the previously mentioned DECnet networks.

**EXAMPLE:**

```
$ echo ncp tell fnal sh node marie

  Node    State  Active  Delay  Circuit  Next node
  43 355 (MARIE)  BNA-0  42.33 (FNALRE)

$ echo ncp sh node marie

  Node    State  Active  Delay  Circuit  Next node
  5 779 (MARIE)  SVA-0  15.1019 (WAN1)
```

You can also use X.500 White pages service:

If the user is a member of any government agency, they have automatically been registered in X.500 white pages. Unfortunately it's not the most user-friendly device and can be painfully slow if you don't know the organization the user belongs to. Further, it uses fuzzy logic for the search (this can be both good and bad). Finally, it might not even list their e-mail address (if they don't have an X.500 address). Nevertheless, users need not update this information themselves. Supposedly this is done automatically.

```
wp - graphics for vt100 OR display back to an Xwindow
fred - a more user-friendly front end
sd - for experts only
```
EXAMPLE:

Fred> whois -org nasa stern -full
(...Some entries not displayed for brevity...)

Try @c=US@o=National Aeronautics and Space Administration ...
Robert Stern (5)

NASA Johnson Space Center
Houston, TX 77058

Mailbox information:
c=usa,admin=telemail,prmd=jsc,org=nasa,ou=life,gn=robert,sn=stern,i=m

Locality: Houston, Texas

Name: Robert Stern, Johnson Space Center, National Aeronautics and Space Administration, US (5)
Modified: Tue Sep 24 21:17:48 1991 by: Manager, National Aeronautics and Space Administration, US (7)
(Partial results only--not all DSAs could be reached)
fred> whois 2
Richard Dunbar (2)  +1 301-286-9430
  aka: Richard Alan Dunbar
  aka: Richard A. Dunbar
  aka: Rick Dunbar

Jack of all trades
Goddard Space Flight Center
  Code 630.4
  Greenbelt, MD 20771

Mailbox information:
  internet: rdunbar@dftsrv.gsfc.nasa.gov
  uucp: bdf!rdunbar
  c=usa,ad=telemail,prmd=gsfc,org=nasa,ou=STX/Code630.4,gn=Richard,sn=dunbar

Locality: Greenbelt, Maryland
Drinks: Captain Morgan's and Coke

Handle: @c=US@a=National Aeronautics and Space Administration@ou=Goddard Space Flight Center@cn=Richard Dunbar (2)
Hmmm.... Got anything better?

YES

NETWORK UTILITIES
BITNET

If you are on a BITnet machine, you can send a test message/command to the user you intend to email to. Likewise, you can use the finger utility to verify that a machine name is legitimate and even get a listing of user currently logged on.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Username} & \text{Program} & \text{Login} & \text{CPU Time} & \text{TTY} \\
\hline
\text{JHUVM} & \text{Name} & 08:54 & 37.5 & \text{LTA702} \\
\text{JHUVM} & \text{GGA} & 14:26 & 2.6 & \text{RTA3} \\
\text{JHUVM} & \text{EBOLTZ} & 13:13 & 17.1 & \text{NTY4} \\
\text{JHUVM} & \text{JOHNHARR} & 14:01 & 8.0 & \text{TZA6672} \\
\text{JHUVM} & \text{CAE_005} & 14:27 & 1.4 & \text{TZA6731} \\
\text{JHUVM} & \text{ADM_ACWS} & 13:35 & 214.6 & \text{TZA6613} \\
\text{JHUVM} & \text{EVH5150} & 13:14 & 133.4 & \text{TZA6547} \\
\text{JHUVM} & \text{JU1972} & 14:28 & 4.1 & \text{TZA6732} \\
\hline
\end{array}
\]

... (output deleted for brevity) ....

But not all BITnet machines enable the finger utility.

The following machine is an IBM. It is a valid BITnet host, just doesn't run finger.

\[
\begin{array}{|c|}
\hline
\text{send @huvms finger} \\
\hline
\end{array}
\]

\[
\begin{array}{|c|}
\hline
\text{INVALID COMMAND FINGER} \\
\hline
\end{array}
\]

\[
\begin{array}{|c|}
\hline
\text{send jan_root:/sys/anroutes.jcp huvms} \\
\text{DEFINE JHUVM /ROUTE=SCFMVS 1 BITNET US} \\
\text{DEFINE JHUVM /ROUTE=SCFMVS 1 BITNET US} \\
\hline
\end{array}
\]
Limitations:

You must be a bitnet site. Furthermore, using the finger to identify a
username on a valid bitnet host will only work if the user is
currently logged on. Finally, illegal names aren't actually identified
as such.

EXAMPLE:

$ mail
MAIL> set::system
To: A2
CC: A2
Exit

MAIL> send gobbledygobble@jhuvm "test"
(469)

(GOBLEDE NOT LOGGED ON)
Limitations:

Just because an email address is valid, it isn't necessarily the address you want. eg Is Pat Gary DFTNIC::GARY or DFTNIC::PGARY? Both are valid. (Of course, this is always true. Just something to keep in mind)
Sometimes a machine is down. To get around this, you can use a feature of multinet to queue it up.

**EXAMPLE:**

```
$ mail
MAIL> s
To: ssp1::system
%MAIL-E-LOGLINK, error creating network link to node SSSP1
- SYSTEM-F-NOSUCHNODE, remote node not currently reachable

MAIL> s
To: smtp%"ssp1::system"
CC: 
Subj: Sample of queueing up DECnet mail for later delivery
```

**FINGER**

The same technique used to discover a legitimate username on a particular BITnet machine may also be used in the IP world.

**EXAMPLE:**

```
$ finger @nsipo.nasa.gov
```

<table>
<thead>
<tr>
<th>User</th>
<th>Real Name</th>
<th>What</th>
<th>Idle</th>
<th>TTY</th>
<th>Host</th>
<th>Console Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>aschen</td>
<td>Anne Chen</td>
<td></td>
<td>0:02</td>
<td></td>
<td>*p7 nsipo.ar</td>
<td>(cumulus.arc.nasa</td>
</tr>
<tr>
<td>bosco</td>
<td>Kathy J. Bosovich</td>
<td></td>
<td>0:30</td>
<td></td>
<td>*co zeus.arc</td>
<td>unknown</td>
</tr>
<tr>
<td>chen</td>
<td>Anni Chen</td>
<td></td>
<td>0:18</td>
<td></td>
<td>*co jadde.ar</td>
<td>unknown</td>
</tr>
<tr>
<td>defrenza</td>
<td>Michael DeFrenza</td>
<td></td>
<td>0:14</td>
<td></td>
<td>*co wonderla</td>
<td>unknown</td>
</tr>
<tr>
<td>feinler</td>
<td>Jake Feinler</td>
<td></td>
<td></td>
<td></td>
<td>*pa nsipo.ar</td>
<td>(sophie.arc.nasa</td>
</tr>
<tr>
<td>hallie</td>
<td>Hallie Carlson</td>
<td></td>
<td></td>
<td></td>
<td>*co spot.arc</td>
<td>unknown</td>
</tr>
<tr>
<td>howe</td>
<td>Greg Howe</td>
<td></td>
<td>0:02</td>
<td></td>
<td>*p1 eudoxa.a</td>
<td>(:0.0)</td>
</tr>
<tr>
<td>joanie</td>
<td>Joan C. Thompson</td>
<td></td>
<td>15:59</td>
<td></td>
<td>*p2 jehovah.</td>
<td>(:0.0)</td>
</tr>
<tr>
<td>jones</td>
<td>Wm Pritchard Jones</td>
<td></td>
<td>22:15</td>
<td></td>
<td>*pd nsipo.ar</td>
<td>(warlord.arc.nasa</td>
</tr>
<tr>
<td>kamedze</td>
<td>Jeanine Kamedze</td>
<td></td>
<td>23:49</td>
<td></td>
<td>*co volcano.</td>
<td>unknown</td>
</tr>
<tr>
<td>leon</td>
<td>Mark Leon</td>
<td></td>
<td>0:24</td>
<td></td>
<td>*p9 dscs.arc</td>
<td>(fltsatcom.arc.nasa</td>
</tr>
<tr>
<td>maria</td>
<td>Maria L. Gallagher</td>
<td></td>
<td>0:50</td>
<td></td>
<td>*co discover</td>
<td>unknown</td>
</tr>
<tr>
<td>mckernan</td>
<td>Daniel S. McKernan</td>
<td></td>
<td>2:20</td>
<td></td>
<td>p1 noc.arc.</td>
<td>(noc.arc.nasa.go</td>
</tr>
<tr>
<td>wade</td>
<td>A. Lee Wade</td>
<td></td>
<td>0:03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wiersma</td>
<td>Al Wiersma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PING

Like the previously mentioned VMSMAIL verification technique, PING can be used to verify a hostname and insure that the machine is currently available.

**EXAMPLE:**

```plaintext
$ mu ping nsipo.nasa.gov
PING NSIPO.NASA.GOV (128.102.18.20): 56 data bytes
64 bytes from 128.102.18.20: icmp_seq=0 time=360 ms
64 bytes from 128.102.18.20: icmp_seq=2 time=290 ms
```

TRACEROUTE

Occasionally, you may come across a domain name that you don't recognize. Using TRACEROUTE and a little geography, one can often figure out physically where (at what local site) a machine resides.

**EXAMPLE:**

```plaintext
$ mu trace gdsnet.grumman.com
traceroute to GDSNET.GRUMMAN.COM (134.223.87.7), 30 hops max, 38 byte packets
1 nsi-gw1 (128.183.10.40) 20 ms 10 ms 10 ms
2 SURA.NSN.NASA.GOV (128.161.40.38) 30 ms 10 ms 10 ms
3 nss-fix.sura.net (192.80.214.254) 40 ms 20 ms 30 ms
4 Ithaca.NY.NSS.NSF.NET (129.140.74.9) 60 ms 60 ms 60 ms
5 Ithaca.NY.NSS.NSF.NET (129.140.10.16) 60 ms 60 ms 60 ms
6 cornell.syr.pop.psi.net (38.145.10.1) 60 ms 90 ms 70 ms
7 syrpop.albany.pop.psi.net (38.145.20.2) 120 ms 90 ms 70 ms
8 albpop.nyc2.pop.psi.net (38.145.80.1) 80 ms 80 ms 70 ms
9 nyc_C2.lan.nyc2.pop.psi.net (38.145.218.3) 130 ms 80 ms 80 ms
10 nyc1.grumman.psi.net (38.145.18.2) 100 ms 160 ms 100 ms
11 ... ...
12 ... ...
13 ... ...
14 ... ...
15 ... ...
16 ... ...
17 ... ...
18 ... ...
19 ... ...
20 ... ...
21 gdsnet.grumman.com (134.223.87.7) 110 ms ! 100 ms ! 110 ms

Limitation: On VMS machines running multinet, this is a privileged command. (Your systems manager may opt to install the command with privs...)
```
WHOIS

WHOIS is probably the single-most valuable utility for looking up email addresses. (After all, its sole purpose is to return a legitimate email address.) This utility comes packaged with most TCP/IP products. It is based on the WHOIS lookup capability at the NIC.DDN.MIL.

**EXAMPLES:**

<table>
<thead>
<tr>
<th>WHOIS Command</th>
<th>Description</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>whois stern</code></td>
<td>Sternal, Richard (RS1441)</td>
<td><a href="mailto:nsaparip@NOSC.MIL">nsaparip@NOSC.MIL</a> (841) 865-6344</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Alan (AS2235)</td>
<td>STERN%<a href="mailto:RISVAX@CCNMR.MIT.EDU">RISVAX@CCNMR.MIT.EDU</a> 617-497-4604</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Alan (AS2236)</td>
<td><a href="mailto:sternrisvax@ccnmr.mit.edu">sternrisvax@ccnmr.mit.edu</a> 617 497-4604</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Allen M. (AMS49)</td>
<td><a href="mailto:STERRA@RUCKER-SAFETY.ARMY.MIL">STERRA@RUCKER-SAFETY.ARMY.MIL</a> (DSN) 856-2826</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Andre (AS127)</td>
<td><a href="mailto:stern@PRG.OXFORD.AC.UK">stern@PRG.OXFORD.AC.UK</a></td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Catherine (CS231)</td>
<td><a href="mailto:cster@APG-EMH5.APG.ARMY.MIL">cster@APG-EMH5.APG.ARMY.MIL</a> (301) 671-2208 (DSN) 584-2208</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Damon E. (DES83)</td>
<td><a href="mailto:destern@ODS-HOST1.ARMY.MIL">destern@ODS-HOST1.ARMY.MIL</a> 011-966-3-439-4279</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, David M. (DMS75)</td>
<td><a href="mailto:STERN@DFTNIC.GSFC.NASA.GOV">STERN@DFTNIC.GSFC.NASA.GOV</a> (301) 286-6079</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Eric S. (ES221)</td>
<td><a href="mailto:SFAE-CM-FM@MONMOUTH-EMH3.ARMY.MIL">SFAE-CM-FM@MONMOUTH-EMH3.ARMY.MIL</a> (908) 532-0263</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Fred (FS67)</td>
<td><a href="mailto:STERN1@CCF.NRL.NAVY.MIL">STERN1@CCF.NRL.NAVY.MIL</a> (319) 353-4892</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Fredrick M. (FMS8)</td>
<td>(DSN) 675-2393 805-385-2393</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Hal (HS71)</td>
<td>(617) 890-2888</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Jack (JS855)</td>
<td><a href="mailto:EAID-IB-EE@CASEY-EMH1.ARMY.MIL">EAID-IB-EE@CASEY-EMH1.ARMY.MIL</a> (DSN) 730-5238</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Les (LS233)</td>
<td><a href="mailto:TAMMC200@OBL-LINK.EUCOM.MIL">TAMMC200@OBL-LINK.EUCOM.MIL</a> 06332-86-6538 (DSN) 494-6538</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Neil H. (NHS2)</td>
<td><a href="mailto:nstern@PICA.ARMY.MIL">nstern@PICA.ARMY.MIL</a> (201) 724-6363 (DSN) 880-6363</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Richard (RS144)</td>
<td><a href="mailto:nsaparip@NOSC.MIL">nsaparip@NOSC.MIL</a> (814) 865-6344</td>
</tr>
<tr>
<td><code>whois stern</code></td>
<td>Stern, Robert (RS713)</td>
<td><a href="mailto:fastkorea@BELVOIR-EMH.ARMY.MIL">fastkorea@BELVOIR-EMH.ARMY.MIL</a> (703) 664-5482</td>
</tr>
</tbody>
</table>

To single out one record, look it up with "lxxx", where xxx is the handle, shown in parenthesis following the name, which comes first.
You can also find out whois is responsible for a particular network using either the Class B address mask or the network name.

**EXAMPLE:**

```plaintext
$ whois 128.161.0.0
NASA Ames Research Center (NET-NSN-NET) Moffett Field, CA 94035
Netname: NSN-NET Netnumber: 128.161.0.0
Coordinator: Medin, Milo (MSM1)
MEDIN@NSIPONASA.GOV
(415) 604-6440 (FTS) 484-6440

Domain System inverse mapping provided by:
NSIPONASA.GOV 128.102.18.20
ORION.ARC.NASA.GOV 128.102.18.10

Record last updated on 03-Jan-91.
```

To see this host record with registered users, repeat the command with a star ("*" before the name; or, use "]" to show JUST the registered users.

**EXAMPLE:**

```
$ whois nih.gov
National Institutes of Health (NIH-DOM)
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894

Domain Name: NIH.GOV
Administrative Contact, Technical Contact, Zone
Contact: Aronson, Jules P. (JA1)
ARONSON@MCS.NLM.NIH.GOV
(301) 496-9300 (FTS) 496-9300

Record last updated on 02-Aug-91.
```

Domain servers in listed order:
LHC.NLM.NIH.GOV 130.14.1.128 UUCP-GW-1.PA.DEC.COM
16.1.0.18 RAY.NLM.NIH.GOV 130.14.20.2 SUN1.NLM.NIH.GOV
130.14.20.30 NS.NIH.GOV 128.231.128.251 DX1.NIH.GOV
128.231.64.1

To see this host record with registered users, repeat the command with a star ("*" before the name; or, use "]" to show JUST the registered users.

Further capabilities are allowed if you telnet nic.ddn.mil

**Limitations:** A user needs to register at the NIC in the first place. He/she is also responsible for keeping the information current. To register,

ftp nic.ddn.mil
get /netinfo/user-template.txt
NSLOOKUP

NSLOOKUP allows you to convert IP numbers to names, convert mx records, dump all nodes a nameserver knows about and more.

If you know a partial host name or know their domain and think you'd recognize the hostname if you saw it, find a nameserver in that domain and dump all nodes.

But first, it may be useful to have a list of all domain names. Flip to NSINIC, drop down to [nsinic.tcp-ip.docs] and grab DOMAIN-INFO.TXT (or get it from NIC.DDN.MIL, or DECNnet copy it from:

NSINIC::DISK:NSINIC::ANONYMOUS.FILES.NSINIC.TCP-IP.DOCS]DOMAIN-INFO.TXT

You may also find the companion document, US-DOMAIN.TXT, (in the same directory) useful.

[ NETINFO:DOMAIN-INFO.TXT ]

DDN NIC DOMAIN SUMMARY 11-Dec-89

[NSI NIC note: Each of the "domains" referred to in the following list is the last part of a full name Internet address; for example, GOV is the domain for the address "nsinic.gsfc.nasa.gov" and COM is the domain for "stx.com".]

AT
No known domains under this top level domain. (AUSTRIA)

...... (parts of this document removed for brevity) ......

CA
No known domains under this top level domain. (CANADA)

...... (parts of this document removed for brevity) ......
Finding a GnuSun node called GDSomething

$ nslookup
Default Server: chiusr.gsc.nasa.gov
Address: 128.193.10.134

> set queryType=ns

> grumman.com
Nome
server = NS.PSINET
Address: 128.193.10.134

Non-authoritative answer:
name server = NS2.PSINET
Address: 192.33.4.10

Authoritative answers can be found from:
gumman.com
ns.server = NS2.PSINET
Address: 192.33.4.10

Non-authoritative answer:
name server = NS.PSINET
Address: 128.193.10.134

Authoritative answers can be found from:
gumman.com
ns.server = NS2.PSINET
Address: 192.33.4.10

$ exit
BUT WHAT IF THE DOMAIN IS TOO NEW TO BE IN THIS LISTING?

$mu nslookup/typ=soa wisc.edu
Default Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

WISC.EDU
  origin = cs.wisc.edu
  mail addr = hostmaster.cs.wisc.edu
  serial = 920304
  refresh = 28800 (8 hours)
  retry = 14400 (4 hours)
  expire = 3600000 (41 days 16 hours)
  minimum ttl = 86400 (1 day)
Other neat things you can do with NSLOOKUP

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSLOOKUP / TYPE = A</td>
<td>address (default)</td>
</tr>
<tr>
<td>ANY</td>
<td>any and all info</td>
</tr>
<tr>
<td>CNAME</td>
<td>Canonical name (alias)</td>
</tr>
<tr>
<td>HINFO</td>
<td>Host information eg machine type</td>
</tr>
<tr>
<td>MX</td>
<td>Mail exchange record</td>
</tr>
<tr>
<td>NS</td>
<td>Name server</td>
</tr>
<tr>
<td>PTR</td>
<td>back-translate number to name</td>
</tr>
<tr>
<td>SOA</td>
<td>Start of authority</td>
</tr>
<tr>
<td>WKS</td>
<td>Well known services</td>
</tr>
</tbody>
</table>

If you can't translate a hostname, you might want to query one of the seven Internet ROOT SERVERS

NS.NIC.DDN.MIL
KAVA.NISC.SRI.COM
AOS.BRL.MIL
C.NYSER.NET
TERP.UMD.EDU
NS.NASA.GOV
NIC.NORDU.NET
$ mu nslookup
Default Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

> server ns.nasa.gov
Default Server: ns.nasa.gov
Addresses: 128.102.16.10, 192.52.195.10

> ls ca.
[ns.nasa.gov]
| CA          | server = RELAY.CDN.NET.CA |
| RELAY.CDN.NET | 192.73.5.1          |
| CA          | server = NSC.NSF.NET |
| NSC.NSF.NET | 128.89.1.178         |
| CA          | server = CLOUSO.CRM.CA |
| CLOUSO.CRM.CA | 192.26.210.1     |
| CA          | server = UGW.UTCS.UTORONTO.CA |
| UGW.UTCS.UTORONTO.CA | 128.100.102.3 |
| UGW.UTCS.UTORONTO.CA | 128.100.100.3 |
| GPU.UTCS.UTORONTO.CA | 128.100.100.1 |
| UGW.UTCS.UTORONTO.CA | 128.100.102.3 |
| UGW.UTCS.UTORONTO.CA | 128.100.100.3 |
| NEAT.CS.UTORONTO | 128.100.1.65  |
| VAN-BC.WIMSEY.BC | 192.48.234.1   |
| NS.LSUC.ON | 142.57.1.1         |
| GATEWAY.BNR | 192.58.194.71       |
| CLOUSO.CRM | 192.26.210.1        |
| BLACKADDER.CIS.MCMASTER | 130.113.0.62 |
| BALDRIC.CIS.MCMASTER | 130.113.0.63 |
| RELAY.CDN.NET | 192.73.5.1         |
| CLYDE.CONCORDIA | 132.205.1.1      |

But sometimes the address you're given doesn't seem like a legitimate hostname

Perhaps it's an MX record. That is, mail destined for that host is sent thru a "Mail exchanger" or gateway that forwards it appropriately.

$ mu trace bypass.dnet.nasa.gov
r2vuva$dia2:[sys0.syscommon.][multinet]multinet_traceroute.exe:2:
unknown host BYPASS.DNET.NASA.GOV

$ mu nslookup/ty=mx bypass.dnet.nasa.gov
Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

Non-authoritative answer:
BYPASS.DNET.NASA.GOV preference = 0, mail exchanger =
east.gsfc.nasa.gov
east.gsfc.nasa.gov internet address = 128.183.104.4

$ mu nslookup/ty=mx nasamail.nasa.gov
Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

NASAMAIL.NASA.GOV preference = 5, mail exchanger =
gemini.arc.nasa.gov
NASAMAIL.NASA.GOV preference = 10, mail exchanger =
homer.arc.nasa.gov
gemini.arc.nasa.gov internet address = 128.102.18.6
The safest way to use NSLOOKUP is probably with the /type=any qualifier.

**EXAMPLE:**

```bash
$ mu nslookup/ty=any nasamail.nasa.gov
Server: dtsrv.gsfc.nasa.gov
Address: 128.183.10.134

Non-authoritative answer:
NSAMAIL.NASA.GOV preference = 5, mail exchanger =
gemini.arc.nasa.gov
NSAMAIL.NASA.GOV preference = 10, mail exchanger =
homer.arc.nasa.gov

Authoritative answers can be found from:
nasa.gov nameserver = NS.NASA.GOV
nasa.gov nameserver = CRAYON.NAS.NASA.GOV
nasa.gov nameserver = ORION.ARC.NASA.GOV
nasa.gov nameserver = JPL-MIL.JPL.NASA.GOV
gemini.arc.nasa.gov internet address = 128.102.18.6
homer.arc.nasa.gov internet address = 128.102.18.66
NS.NASA.GOV internet address = 128.102.16.10
NS.NASA.GOV internet address = 192.52.195.10
CRAYON.NAS.NASA.GOV internet address = 129.99.23.6
ORION.ARC.NASA.GOV internet address = 128.102.18.10
ORION.ARC.NASA.GOV internet address = 128.102.128.2
JPL-MIL.JPL.NASA.GOV internet address = 128.149.1.101
JPL-MIL.JPL.NASA.GOV internet address = 128.149.4.1
JPL-MIL.JPL.NASA.GOV internet address = 128.149.28.2
```

But unless you know how to read this, you may come down with a bad case of information overload.

Additionally, type=mx only interprets the address *STYLE*, not the hostname itself.

**EXAMPLE:**

```bash
$ mu nslookup/ty=mx mumble.dnet.nasa.gov
Server: dtsrv.gsfc.nasa.gov
Address: 128.183.10.134

Non-authoritative answer:
MUMBLE.DNET.NASA.GOV preference = 0, mail exchanger =
east.gsfc.nasa.gov
east.gsfc.nasa.gov internet address = 128.183.104.4

Note that nowhere in the above example does it mention that this is not a valid address. So type=mx needs to be used in conjunction with a straight nslookup or SMTP to determine the address.
```
NSLOOKUP can also be used to back-translate a number to a node

**EXAMPLE:**

```
$ MU NSLOOKUP/TYP=PTR 128.102.18.10
Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134
10.18.102.128.in-addrarpa name = orion.arc.nasa.gov
```

SMTP

We all take mail for granted. The front ends (mailers) we use often hide what happens on the lower levels. Using the lower levels of Simple Mail Transfer Protocol (SMTP), one can verify an address, expand a mail distribution list and more.

In the following example, the syntax used is for VMS machine running multinet. Other variations of TCP/IP require the syntax "TELNET host 25"

**EXAMPLE:**

```
$telnet/port=25 nsisrv
Trying... Connected to NSISRV.GSFC.NASA.GOV
EXPNU ADFTO
220 nsisrv.gsfc.nasa.gov Sendmail 5.57/Utix3.0-C ready at Tue, 25 Feb 92 13:45:30 -0500
250-Javad Boroumand <javad>
250-Yonsook Enloe <yonsook>
250<yurcik@dftnic.gsfc.nasa.gov>
250<lencati@dftnic.gsfc.nasa.gov>
250<stern@dftnic.gsfc.nasa.gov>
250<seilers@amarna.gsfc.nasa.gov>
250-Scott W. Rogers <rogers>
250-lev@dftnic.gsfc.nasa.gov>
250-lang@dftnic.gsfc.nasa.gov>
250<jamii@lego.gsfc.nasa.gov>
250<jackson@dftnic.gsfc.nasa.gov>
250<pigary@dftnic.gsfc.nasa.gov>
250<rdunbar@lego.gsfc.nasa.gov>
250-Bill Fink <bill@wizard.gsfc.nasa.gov>
250<bennet@dftnic.gsfc.nasa.gov>
250<rdunbar@lego.gsfc.nasa.gov>
VRFY RICK
550 rick... User unknown: No such file or directory
VRFY RDUNBAR
250 Rick Dunbar <rdunbar@lego.gsfc.nasa.gov>
QUIT
```
Now let's put it all together. The following example verifies the address molner@telly.on.ca

**EXAMPLE:**

```
e mu ping telly.on.ca
e mu nslookup/ty=mx telly.on.ca
```

```
Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

TELLY.ON.CA preference = 10, mail exchanger =
gpu.utcs.utoronto.ca
gpu.utcs.utoronto.ca internet address = 128.100.100.1
gpu.utcs.utoronto.ca internet address = 128.100.102.1
NSINIC e mu nslookup/type=wks gpu.utcs.utoronto.ca
Server: dftsrv.gsfc.nasa.gov
Address: 128.183.10.134

Non-authoritative answer:

```
GPU.UTCS.UTORONTO.CA
inet address = 128.100.100.1, protocol = tcp
smtp
```

NSINIC e finger molnar@gpu.utcs.utoronto.ca
Login name: molnar
Group: UTCS/Systems
Office: MP350, x-8853 Home phone: Send E-mail
CAN: 1992 PIN: 17958 TDD: uzf
Directory: /home/gpu/u1/molnar Shell: /bin/tcsh
New mail received Mon Mar 3 06:28:54 1992;
unread since Mon Mar 3 06:28:57 1992

Signature:

Tom Molnar
Unix Systems Group, University of Toronto Computing Services

NSINIC e telnet/port=25 gpu.utcs.utoronto.ca
Trying... Connected to GPU.UTCS.UTORONTO.CA, a SUN4/490 running
SUNOS4.1.1.

220 gpu.utcs.utoronto.ca Server SMTP ready at Wed, 26 Feb 1992
09:36:34 -0500
exph molnar
250-local delivery for Tom Molnar <molnar>
quilt
TCP/IP Tutorial

John McMahon
TGV, Inc.

Due to size and copyright considerations, Mr. McMahon's tutorial materials will be made available upon request to the NSI NIC.
IV. Exhibit Summaries
Third Annual NSIUWG Conference  
NSI Networking in the Nineties  
EXHIBITORS

(All exhibits are located in the Annapolis Room on the lobby level. Exhibitors will be available from 1:30 to 5:00 Tuesday through Thursday and 10:00 to noon on Friday.)

NASA Science Internet User Support Office

Members of the NSI User Support office will inform NSI users of the various services available to them as a result of being a member of the NSI user community.

NASA Science Internet Network Operations Center

Members of the NASA Science Internet Operations staff will demonstrate real time monitoring capabilities of the NSI/NOC located at the NASA Ames Research Center.

NASA Center for Computational Studies

The NCCS provides computational services and tools in a data rich environment to scientists supported by NASA's Office of Space Sciences and Applications. Programs include a computational physics group and a scientific visualization laboratory. Resources include: Cray Y-MP 8/464, Convex 220, MasPar MP-1, Ultra network, and associated mass data storage and delivery systems.

TAE Plus

TAE is a software development tool.

GDAAC

NCDS and PLDS The Earth Observing Systems Goddard Distributed Active Archive Center represents global change disciplines through its baseline systems: The NASA Climate Data System and Pilot Land Data System. The Goddard DAAC is developing innovative data management systems to handle the tremendous volume of data expected in the EOS era.

EOSDIS IMS Version

The EOSDIS IMS Version 0 Inventory Interoperability Proof of Concept Demonstration is a cooperative effort between the IMS system level coordination/development team and the distributed DAAC software development teams. This software demonstrates the capability to access heterogeneous distributed inventories of scientific metadata.

MASTER DIRECTORY

The Master Directory is a free on-line data information service. It is a multidisciplinary and multi-agency information service.
**Title and Subtitle:**
The Third Annual NASA Science Internet User Working Group Conference

**Authors:**
Brian S. Lev and J. Patrick Gary, Editors

**Performing Organization Name(s) and Address(es):**
NASA Goddard Space Flight Center
Greenbelt, MD 20771

**Sponsoring/Monitoring Agency Name(s) and Address(es):**
National Aeronautics and Space Administration
Washington, DC 20546-0001

**Supplementary Notes:**
Brian Lev, Hughes STX Corp., Lanham, MD; J. Patrick Gary, Head, Code 933, Goddard Space Flight Center, Greenbelt, MD; meeting held March 30 - April 3, 1992 at the Greenbelt Marriott Hotel, Greenbelt, MD.

**Distribution/Availability Statement:**
Unclassified - Unlimited
Subject Category 82

**Abstract:**
The NASA Science Internet (NSI) User Support Office (USO) sponsored the Third Annual NSI User Working Group (NSIUGW) Conference March 30 through April 3, 1992, in Greenbelt, MD. Approximately 130 NSI users attended to learn more about the NSI, hear from projects which use NSI, and receive updates about new networking technologies and services. This report contains material relevant to the conference; copies of the agenda, meeting summaries, presentations, and descriptions of exhibitors.

Plenary sessions featured a variety of speakers, including NSI project management, scientists, and NSI user project managers whose projects and applications effectively use NSI, and notable citizens of the larger Internet community. The conference also included exhibits of advanced networking applications; tutorials on internetworking, computer security, and networking technologies; and user subgroup meetings on the future direction of the conference, networking, and user services and applications.

**Subject Terms:**
Networking, Applications, Policy, Conference, Computers, Engineering, Security

**Security Classification of Report:**
Unclassified