Testbed for Satellite and Terrestrial Interoperability (TSTI)
A FY98 Program Product of 632-50-50 Communications - Terrestrial

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Workshop

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Objective
Develop and demonstrate high degree of interoperability between satellite- and terrestrial-based networks
- Develop and evaluate enhancements to protocols such as ATM and TCP/IP
- Test and demonstrate new interface equipment hardware and software
- Utilize and showcase ACTS performance, especially its high data rate capabilities
- Extend HPCC network research program in Large Scale Networks
- Open to U.S. satellite and terrestrial communications carriers, equipment suppliers, and network providers
Specific Technical Objectives

Facilitate and conduct research and evaluations of new computer networking protocols and related technologies which improve the interoperability of satellite and terrestrial networks, e.g.,

- TCP: large windows (RFC 1323), SACK (RFC 2018), XTP (RFC 1453)
- IP: TAG (cisco), flow (lpsilon), multi-protocol label switch (IETF), RSVP, multicasting, IPv6
- ATM: MPOA, PNNI, available bit rate traffic management
ACTS Experiment #118
622 Mbps Network Tests Between ATDNet and MAGIC Via ACTS
PI's: J. Patrick Gary/NASA GSFC & Gary Minden/DARPA

2.0 Network Test Suites for the ATDNet-ACTS-MAGIC Network (AAMnet)

- 2.1 Assessment of Satellite Links on ATM Signaling (Co-I: Rich Verjinski/Fore @ NRL)
- 2.2 Tuning TCP over High Speed Satellite Links (Co-I: Pat Gary/GSFC)
- 2.3 Evaluation of ATM Flow Control and Traffic Monitoring Techniques in a 622 Mbps Hybrid Satellite/Terrestrial Network (Co-I: Victor Frost/KU)
- 2.4 Demonstration and Evaluation of Everyday Internet Applications across the AAMnet at 622 Mbps (Co-I: Pat Gary/GSFC)
- 2.5 Demonstration and Evaluation of TerraVision/ISS Operating over the AAMnet (Co-I: Jay Feuquay/HSTX @ EDC)
- 2.6 Multimedia Telemedicine Applications Operating over the AAMnet (Co-I: Kenneth Kemper/NIH)
- 2.7 Telemedicine-enabling R&D Testbed Experiments Operating over the AAMnet (Co-I: Pat Gary/GSFC)
- 2.8 Demonstration and Evaluation of Effects of Hybrid Satellite/Terrestrial Networks on ATM Signalling (Co-I: Tom von Deak/LeRC)
- 2.9 Native ATM Application Programmer Interface Testbed for Cluster-based Computing (Co-I: Pat Dowd/NSA & UMD)
- 2.10 ARIES / ACTS 622 Mbps Experiment (David R. Beering/Amoco)
- 2.11 Multiplatform Evaluation of TCP/IP over ATM Interoperability Issues in a Hybrid Satellite Environment (Co-I: Mike Gill/ NLM)
- 2.12 Testbedding of New Applications at 622 Mbps (Co-I: Pat Gary/GSFC)
- 2.13 Demonstration and Evaluation of TerraVision/ISS Operating over the AAMnet (Co-I: Jay Feuquay/HSTX @ EDC)
- 2.14 Assessment of Effects of Hybrid Satellite/Terrestrial Networks on ATM Signalling (Co-I: Tom von Deak/LeRC)

ACTS-ATDNet-MAGIC NETWORK (AAMNET) Topology Overview
ATDNet with Multiwavelength Optical Network (MONET)- the system of the future

Department of Defense:

ATDnet++ ... A fully switched Wavelength Division Networking Testbed

Proposed late 1999-2000: Mixture of wavelength interchange & wavelength select devices
Testbed for Satellite and Terrestrial Interoperability Infrastructure at NASA Goddard Space Flight Center

Collaborations/End Sites with GSFC/930
In TSTI-based Evaluations - Present

Applications | Sat./Terr. Carriers | Academia | Federal
---|---|---|---
DGCM | ACTS Exp. #92 | UCLA | GSFC/910, JPL
Telemedicine | AAMnet/#118g | [SFU] | NLM
Teleradiology | AAMnet/#118f | [WashU] | NIH
TerraVision | AAMnet/#118e | | EDC, LeRC
Teleradiology | ATDNet-ACTS/#110 | UHI, GUMC | [TAMC]
GLIN | ATDNet, Comsat/Intelsat | UMD(Balti.County) | LOC
Trans-Pacific DL | ATDNet, Comsat/Intelsat, ACTS/NREN, MPT/CRL | LOC, NLM, [Smithsonian,] National Library of Japan |
Collaborations/End Sites with GSFC/930
In TSTI-based Evaluations - Present

<table>
<thead>
<tr>
<th>Technology</th>
<th>Industry</th>
<th>Academia</th>
<th>Federal</th>
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<tbody>
<tr>
<td>TCP LFN (RFC 1323)</td>
<td>PSC</td>
<td>KU</td>
<td>LeRC, JPL</td>
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<tr>
<td>TCP SACK (RFC 2018)</td>
<td>Mentat</td>
<td>UCLA</td>
<td>GSFC/505 &amp; 540</td>
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<tr>
<td>XTP (RFC 1453)</td>
<td></td>
<td>Concordia U. (Quebec)</td>
<td>Sandia N.L.</td>
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<tr>
<td>IP/TAG Switching</td>
<td>Ipsilon, Cisco</td>
<td>GSFC/505, ARC</td>
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<tr>
<td>(IETF MPLS WG)</td>
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<tr>
<td>IPv6/RSVP</td>
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<tr>
<td>ATM Transport Drivers</td>
<td>UMD(College Park) NSA</td>
<td>GSFC/505</td>
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<tr>
<td>ATM OC-3c Firewall</td>
<td>STK/NSC, SPOCK</td>
<td>NSA</td>
<td></td>
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<tr>
<td>ATM OC-12c Encryption</td>
<td>SECANT, SPOCK</td>
<td>NSA</td>
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- Recent Major Accomplishments
  - Enabled first use of ACTS high data rate capabilities by GUMC, KU, NIH, and NLM
  - Monthly highlights online at http://everest.gsfc.nasa.gov/month.html
  - LeRC set ACTS highwater throughput performance
    - 520 Mbps memory-to-memory
    - 320 Mbps aggregate (3 streams) tape-to-tape
  - Protocol performance baselining by GSFC
    - TCP, TCP-SACK, XTP
    - BER: 0, 10E-11, 10E-10, 10E-9, 10E-8, 10E-7, 10E-6, 10E-5
    - Delay: 0, 5, 71, 540 ms
Satellite Conditions (RTT = 540 ms)
Demonstrate and evaluate use of high performance satellite communications and advanced data communications protocols to enable interactive digital library data access between the U.S. Library of Congress, the National Library of Japan, and other digital library sites at 155 Mbps.

- The satellite links demonstrate effective use of geostationary satellite-based communications in the Global Information Infrastructure.
- The data communications protocols will include both standard protocols with recently specified options for performance enhancements and experimental protocols designed for improved performance.
- Access will include interactive searches and retrievals of new on-line digital library data, and will promote an understanding of the need for ready access to these data.
Trans-Pacific Digital Library Experiment

**U.S.-led Applications**

- Law Library of the Library of Congress
  - Global Legal Information Network

- NASA Goddard Space Flight Center
  - Trans-Pacific Access to GLOBE Visualizations in Real Time

- NIH National Library of Medicine
  - Multi-Lingual Digital Anatomical Data Base

- USDA National Agricultural Laboratory
  - Plant Genome Databases

![Configuration of Networks for Trans-Pacific Digital Library Experiment](image)
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- Major Milestones
  - FY98: TSTI development and instrumentation; Support for PI & Co-I's at GSFC, KU, LeRC, NIH, and NLM in 622 Mbps Network Tests between ATDNet and MAGIC via ACTS (Exp. #118) and for others (e.g., GUMC and GiBN Trans-Pacific Digital Library Experiment)
  - FY99: Complete evaluations of IP switching and ATM traffic management 4.0 explicit rate control in ABR; Enable/expand testbed for use by other GiBN projects and Satellite Alliance USA
  - FY00: Initiate evaluations of IP RSVP and ATM QoS parameters
  - FY01: Complete evaluations of IP RSVP and ATM QoS parameters

ESDCD On-Going Network Projects
More Info

- AAMNet: ADTNet-ACTS-MAGIC Network (622 Mbps)
- ATDNet: Advanced Technology Demonstration Network
  - http://www.atd.net/
- GiBN DLE: Global Information Broadband Network Dig. Lib. Exp.
  - http://dlt.gsfc.nasa.gov/gibn/
- GLIN: Global Legal Information System
  - http://lcweb2.loc.gov/law/GLINv1/GLIN.html
- HECN: High End Computer Networking (for HPCC/ESS)
  - http://everest.gsfc.nasa.gov/
- TSTI: Testbed for Satellite and Terrestrial Interoperability
  - http://everest.gsfc.nasa.gov/TSTI/TSTI.html