



FINAL REPORT FOR AWARD # 9729500

David L Shealy ; *U of Alabama Birmingham*
High Performance Connection for Research Universities in Alabama

Participant Individuals:

CoPrincipal Investigator(s) : Stan A McClellan; Jill Gemmill; Priscilla A Hancock
Technician, programmer(s) : Landis B Manderson
Senior personnel(s) : Joyce W Iannuzzi; Sheila M Sanders; David Brown
Technician, programmer(s) : Craig White; John Watters
Senior personnel(s) : David Cordes
Technician, programmer(s) : Doug McLean; Clayton Bell
Senior personnel(s) : Stephen A Szygenda; Henry Panion; Mike Carson; Donald B
Twieg; Robert M Hyatt; Walter H Johnson; Andrew E Pollard
Technician, programmer(s) : Shane Merritt
Senior personnel(s) : Maurice Mitchell
Undergraduate student(s) : Rodney Hasty; Evan Rowe
Senior personnel(s) : Kenn McCracken
Undergraduate student(s) : Robert Cummings

Participants' Detail

Partner Organizations:

University of Alabama in Huntsville: Financial Support; In-kind Support; Facilities;
Collaborative Research

The University of Alabama in Huntsville (UAH) is a partner in establishing a regional gigaPOP. This project was awarded supplementary funding from EPSCoR, which has been used to establish a high speed connection between The University of Alabama at Birmingham (UAB) and UAH. (UAH is also a HPC awardee; we are working together to obtain maximum benefit from our high performance connections.)

Southeastern Universities Research Association: Financial Support; Facilities;
Collaborative Research

The Southeastern Universities Research Association's (SURA) Southern Crossroads Initiative (SoX) provides us with a gigaPoP connecting Alabama high performance sites with the Abilene network backbone. SURA has provided occasional subsidies to support the SOX operations. SURA is also funding other activities such as the Video Development Initiative (ViDe) that have contributed to obtaining maximum benefit from our use of the HPNs.

Alabama Supercomputer Authority: In-kind Support; Facilities; Collaborative Research; Personnel Exchanges

The Alabama Supercomputer Authority manages the Alabama Research and Education Network (AREN), Alabama's state funded research and education network. AREN staff have assisted UAB in reviewing equipment selections and configuration, and in discussing Network Operations Center (NOC) services specifications. Through an agreement between the Gulf Central GigaPoP (GCG) and AREN, GCG provides bandwidth to AREN for in-state research/education traffic for all education entities, in exchange for AREN providing NOC services for GCG. As a result of this agreement, AREN upgraded its state backbone from being T1 based to one based on DS3 circuits.

University of Alabama Tuscaloosa: Financial Support; In-kind Support; Facilities; Collaborative Research

The University of Alabama (Tuscaloosa) is a partner in developing the regional gigaPOP and is a subcontractor on this HPC grant.

ITC^DeltaCom: In-kind Support; Facilities; Collaborative Research

ITC^Deltacom entered an agreement with The University of Alabama, University of Alabama at Birmingham, and University of Alabama in Huntsville; this agreement provides OC3 circuits among these three institutions and 2 X OC3 circuits from Alabama to the SOX GigaPoP. The agreement makes these circuits extremely affordable due to this corporate support.

University of South Alabama: Financial Support; Facilities; Collaborative Research

The University of South Alabama is a participant in the Gulf Central GigaPoP and is working to upgrade its campus network infrastructure and to access the high performance national backbone.

Tuskegee University: Financial Support; Facilities; Collaborative Research

Tuskegee University is a participant in the Gulf Central GigaPoP and is working to upgrade its campus network infrastructure and to access the high performance national backbone.

Alabama A&M University: Financial Support; Facilities; Collaborative Research

Alabama A&M University is a participant in the Gulf Central GigaPoP and is working to upgrade its campus network infrastructure and to access the high performance national backbone.

Auburn University: Financial Support; Facilities; Collaborative Research

Auburn University is a participant in the Gulf Central GigaPoP and is working to upgrade its campus network infrastructure.

University Corporation for Advanced Internet Development: Financial Support; Facilities; Collaborative Research

The University Corporation for Advanced Internet Development (UCAID) operates the Abilene network; UCAID provided financial and technical support for the world's first internet virtual recording studio session organized by UAB Professor of Music Dr. Henry Panion.

Cisco Systems, Inc.: In-kind Support

Cisco provided an equipment grant to NSF-HPC funded institutions, including UA and UAB. Dr. McClellan was awarded an additional \$100K equipment grant from Cisco to help establish the UAB Engineering Quality of Service Laboratory.

Other collaborators:

1. Ron Hutchins, Director of Engineering, GCATT, Georgia Tech. Technical and administrative issues related to activating our link to vBNS, Abilene, and the SURA Southern Cross Roads (SoX).
2. Gordon D. Wishon, Associate VP for Information Technology, Georgia Tech. Management, funding, policy issues related to starting an Internet2 gigaPOP.
3. ViDe Video Development initiative, Large Scale Video Network Prototype project (member listed at www.vide.net include affiliates from Georgia Tech, Rutgers, SURFnet, Australian Research Network, CANARIE, Univ. of Tennessee, Indiana University, Ohio State, etc.
4. Southeastern Universities Research Association (SURA)
5. University Corporation for Advanced Internet Development (UCAID) - Both UAB and UA were founding members of UCAID and have collaborated in a number of ways with other I2-affiliates.

Activities and findings:

Research and Education Activities:

The project 'High Performance Connections for Alabama Research Universities' proposed establishment of an initial connection in the State of Alabama to the NSF sponsored very high-speed Backbone Network Service (vBNS).

Objectives of the original proposal were:

- (1) To deploy sufficient network infrastructure, organizational expertise, and high-speed, advanced networking expertise to support advanced telecommunication intensive research and education applications.
- (2) To upgrade UA and UAB campus networking infrastructure to support high speed connectivity in all areas of the universities.
- (3) To establish a wide-area network capability within Alabama to support aggregation of vBNS-class traffic for cost-effective connection to national high performance networks.

Results:

The research team succeeded in turning each of these objectives into reality.

Objective (1): As will be documented below, the meritorious research projects received high speed connections from their labs to the national backbones.

Objective (2): Both campus network infrastructures have been significantly upgraded. In the case of UAB, the campus has gone from FDDI ring and shared ethernet to a gigabit backbone (gigabit connections to each building); 100Mb/sec and 10Mb/sec switched ethernet connections have replaced shared connections; these changes came about through a \$20 million network infrastructure project approved by the UAB President and UA System Board of Trustees. As this 5-year network upgrade project enters its final year, any researcher or educator anywhere on campus can easily and affordably order the type network connection needed to support their application's requirements. The UA campus has undergone a similar upgrade to gigabit ethernet backbone and switched ethernet architecture.

Objective (3) In cooperation with other research institutions in the State of Alabama, an entity known as the Gulf Central GigaPoP (GCG) has been established. By leveraging funds from this grant with other funded grants, university funds, corporate contributions, and in-kind contributions the seven research universities in Alabama each have a minimum of DS3 connectivity for research traffic (in addition to whatever commodity connections they have as well), with OC3 or greater connectivity for each of the large research institutions. This high performance state backbone is now in the process of being leveraged to connect all of K-20 education to the high performance backbone. See <http://www.gulfcentralgigapop.net>

Findings:

Here we summarize the original meritorious research projects and how their needs were met during the course of the funded project.

During the previously mentioned network infrastructure upgrade project at UAB, priority was given to buildings housing meritorious applications; in other words, first the researchers were asked about their need for immediate improvements, otherwise their building was moved to the top of the network upgrade project list so that most meritorious applications were taken care of during the first 18 months of this project.

Meritorious Project Status Summary:

(1) NSF MINT Center (UA): The Center for Materials for Information Technology is a multidisciplinary research program focusing on new materials for advanced data storage. A major emphasis is on materials for magnetic heads and media, key components in high performance information storage systems. Twenty-two faculty from seven academic programs including Chemical Engineering, Chemistry, Electrical Engineering, Materials Science, Mathematics, Metallurgical and

Materials Engineering, and Physics work together to provide students with a broad training in materials performed in a team environment. Research carried out in cooperation with industrial partners prepares students for exciting careers in a rapidly expanding field. The mission of the Center is to perform world-class research, educate students, and serve as a resource and communication channel for the information storage industry. Research programs range from the basic scientific study of thin films prepared by molecular beam epitaxy to the engineering technology of tape web coating. Basic science, supported by strong materials preparation and characterization facilities, is focused on future opportunities for materials breakthroughs. Promising results are transferred to our industry partners through collaborative research programs. An infrastructure of exchange visits and visitors, seminars, workshops, industrial internships, and research reviews facilitate a dynamic atmosphere for information growth.

The MINT Center received switched 10/100 Mbps Ethernet access early in the project for all personnel in this research area. A Gigabit Ethernet uplinks to the campus border router was provided. This router connects to the OC-3 link to the GCG and then on to SoX via a dual OC3 link where Abilene connects.

(2) Virus Capsid Assembly (UAB - Prevelige) allowed connections to a structural prediction program that was running on a Connection Machine at MIT. The code on the connection machine was ported to Pentium PCs where it ran just fine. Investigator was happy with a 100 Mb/sec network connection paid for by this project.

(3) Remote Design of Inhibitors (UAB - DeLucas/Carson): This building was the first to be fully rewired in November 1998 (paid by Health Service Foundation : part of matching funds for this grant) The grant purchased 2 high performance network cards for their SGI Origin server. This work continues. Carson gave a talk at an Internet2 annual meeting on his work during a Life Sciences track.

(4) Multisite Brain Visualization (UAB Dobbins/Gamlin/Tweig) : This project was housed in two separate buildings; after wiring & network upgrades, laser confocal microscope facilities & stored images became accessible to colleagues across the UAB campus.

(5) Pediatric Cardiology (UAB- Johnson): switched network connections were provided to make H.323 videoconferencing technology possible, and we also looked at 10Mb/sec Litton cameras. Physician was interested in remote diagnosis of infant cardiology exams; however, low bandwidth to healthcare facilities of greatest interest to this researcher discouraged him from pursuing telemedicine approaches until commercial bandwidth is available. Johnson presented his research interest at a SURA Advanced Network Applications workshop in 1997.

(6) Remote Astronomy (UA Keel): The astronomers at UA received switched 10/100 Mbps Ethernet connections with Gigabit Ethernet uplinks to the campus core and boundary router. The following quote from Dr. William Keel on FEB 21, 2000, summarizes their experiences with the upgraded network: 'I just had a chance to use our new and vastly improved Internet connection for one of the applications that

went into the original proposal. Over the weekend I was working with some collaborators at the telescope on Kitt peak, near Tucson. The detector was a CCD array of 8192x8192 16-bit pixels, 135 Mbytes every time the shutter opens. To general astonishment, I could keep up with the data for 10-minute exposures. Quite reliably (within a few percent from Friday night to this morning), it took 13 minutes per file to pull these over. As far as I can tell, this is about the raw speed of the link from the mountaintop to Tucson, at which point my guess is that it jumps on I2 from that 'other' U of A to here.'

(7) Medical Videoscope (UAB Guthrie) - PI/neurosurgeon became involved in building a software company (Imageon) to market other of his technical developments and he dropped interest in this particular project. Guthrie presented his research interest at a SURA Advanced Network Applications workshop in 1997.

(8) ATM Network Stress Testing (UAB School of Engineering/McClellan) : this grant purchased \$60K of Newbridge ATM network equipment, including devices for connecting other buildings. School of Engineering and Communications Services agreed on an implementation involving two ATM domains, a configuration Newbridge did not yet support. There were difficulties implementing this solution, and no one wanted to add other buildings to a situation that was problematic. Eventually most of engineering moved off ATM to gigabit Ethernet; CTER's ATM network is still running. The research faculty enhanced the network research facility through a \$100K equipment grant from CISCO, associated with this project, and through collaboration with the BellSouth Technology Research Center (BTAC) in Birmingham. Two undergraduate students supported by an REU supplement to this grant working on this collaboration at the BTAC facility. McClellan presented his research at several Alabama IEEE meetings.

(9) Mobile Network Test-bed (UA): Unfortunately, the researcher that requested assistance with this test-bed left UA early in the project and no one else at UA was interested in pursuing this idea at this time.

(10) Distributed Parallel Processing (UAB- Hyatt): The Computer Science and Physics areas were rewired and had switched ethernet connections provided. Additional funds have been used to acquire several Beowulf computer clusters for use by UAB researchers. Access to and use of these computing resources has been made possible by higher speed network connections.

(11) Cardiac Tissue Simulation (UAB Pollard) Network infrastructure for this facility was upgraded; Pollard at first wanted a high speed connection to the State Supercomputer, which became available, but he in time migrated towards heavy use of campus Beowulf computing clusters for his research. Pollard was scheduled to present his research at the Fall 2001 Internet2 meeting.

(12) Molecular Physics Simulation (UAB Kawai) - The Computer Science and Physics areas were rewired and had switched Ethernet connections provided. Additional funds have been used to acquire several Beowulf computer clusters for use by UAB researchers. Access to and use of these computing resources has been made possible by higher speed

network connections.

(13) History of Medicine Project (UAB) - Unfortunately, the chief investigator in this project left UAB early in this project.

(14) Distance Learning Project - Unfortunately the person mainly responsible for distance learning left for another university; there have been some interesting pilot efforts but serious last-mile issues in Alabama make Distance Learning a low-bandwidth effort for now. Development of the state research/education backbone network have made new collaborations in K-12 education possible, wherever a local school system has bandwidth to support high quality audio/video materials.

(15) Music Technology Project (UAB Panion) - Building wiring and Ethernet switches were upgraded; department now capable of various resolution streaming media originating from their recording studios. Panion organized the first Internet Virtual Recording Studio production at an annual Internet2 meeting.

(16) Medical School Distance Teaching (UAB Smith) - Purchased new CISCO switch for this project and 100MB ethernet cards to upgrade a web server providing very high resolution pathology images and education.

Findings:

(A) At first we expected some applications to need ATM quality of service; however, that is not the direction the campus architecture took, and investigators report that they are satisfied with the switched Ethernet solution provided.

(B) The proposal called for a Project Management Board comprised of administrative, faculty, and technical people and with some focus to supporting applications. This approach worked quite well; the approach was expanded at UAB by formation of an Internet2 Applications Working Group, a faculty/staff advisory body that both informed schools and departments about what Internet2 was and what it enabled, and that also brought concerns and ideas back to the project management team.

Training and Development:

1. Technical staff continue to attend NLANR/vBNS joint engineering workshops. UA, UAB, and UAH have been represented at almost every one of these workshops, and when physical attendance was impossible virtual attendance via Internet2 supported multicast and H.323 was utilized.

2. Representatives from UAB attended the NLANR Network Performance Measurements conference in June 1999

3. UAB helped to organize and sponsor the SURF Advanced Network Applications Workshop in September, 1999, attended by 165 people.

4. Through the ViDe Video Development Initiative Workshops, we have received technical training and support in managing videoconferencing

services. Representatives from UA, UAB, and UAH have attended this workshop every year. Jill Gemmill (co-PI) currently chairs the ViDe group.

5. The University of Alabama's chief network technician has attended several Cisco training sessions dealing with router configuration and troubleshooting. Since all of the router and switch equipment utilized in the University's new network infrastructure will be Cisco equipment, this training has been, and will continue to be, very beneficial.

Outreach Activities:

1. 'Dynamics of the Networked Academy - University Panel,' sponsored by Mississippi State University Information Technologies Oversight Committee, SURA, and UCAID, Starkville, MS, September 9-11, 1998.
2. 'Alabama's Internet2 and Advanced Networking Infrastructure' Dave Cordes, UA; David Shealy, UAB; Sara Graves, UAH; David McGirt, ITC^DeltaCom, Alabama EPSCoR Conference, Feb, 1999.
3. 'Internet2: The Alabama Connection', IEEE Region 3 General Meeting, Birmingham, AL, Stan McClellan (Feb. 1999).
4. 'Standards Based Delivery of IP Multicast to the Desktop : A Progress Report' Jill Gemmill, Southeastern Universities Research Association (SURA) Networked Video Workshop (March 3-4, 1999)
5. Presentation at Virtual Laboratories Workshop, Research Triangle Park, NC, David Shealy, April 15, 1999.
6. 'Internet2: What is it? Why would you use it? How would you use it?', Jill Gemmill, UAB Information Technology Day (May 6, 1999)
7. 'Report from the SURA Advanced Network Applications Workshop', U.S. National Committee for the International Union of Biochemistry and Molecular Biology, Jill Gemmill (September 23, 1999)
8. 'Applications over Differentiated Services in the Next Generation Internet', S.McClellan, M.Stricklen, B.Cummings, BellSouth Telecommunications Innovations Showcase, Oct. 1999.
9. 'Information Technology, the Next Generation Internet, and Medicine', UAB School of Health Related Professions, Stan McClellan Oct. 1999.
10. 'Diagnostic-Quality Network Video with MPEG2', UAB Pediatric Cardiology, Oct.1999.
11. 'Quality of Service', S.McClellan, SURA Workshop on Advanced Applications, Sept. 1999.
12. 'Demonstration of QoS Technologies: ATM, Diffserv, 802.1p/q, et.al.', S.McClellan, M.Stricklen, B.CUmmings, S.Chataut, SURA

Workshop on Advanced Applications, Sept. 1999.

13. 'Importance of Clinical Trials in Network-Based Medicine', S.McClellan, SURA Workshop on Advanced Applications, Sept. 1999.

14. 'Internet2: The Alabama Connection', S.McClellan, IEEE Region 3 General Meeting, Birmingham, AL, Feb. 1999.

15. David L. Shealy was a Member of NSF Committee of Visitors during Summer 2000 for the purpose of reviewing the Advanced Networking & Infrastructure Research Programs (ANIR) during the past 3 years. Invited participant in AAAS National Workshop on Developing Guidance for NSF Advanced Networking Infrastructure Support, February 22-23, 1999.

16. Alabama's Internet2 and Advanced Networking Infrastructure Initiative. Alabama State EPSCoR Conference, Auburn, Alabama. Spring 1999.

17. Alabama's Internet2 and Advanced Networking Infrastructure Initiative. The University of Alabama Board of Trustees, Spring 1999.

18. Poster session presentation on Alabama's Internet2 Project. 1999 National EPSCoR Conference, Perdido Beach, Alabama, Dave Cordes Fall 1999.

19. Internet2: Status of the Gulf Central GigaPoP and Networking at EPSCoR Schools. Alabama State EPSCoR Conference, Montgomery, Alabama, Jill Gemmill, Spring 2000.

20. 'IP Multicast', UAB School of Engineering, Jill Gemmill (May 2000).

21. 'High Resolution Internet Videoconferencing Systems', UAB Information Technology Days, Jill Gemmill, (April 2000)

22. 'H.323 Videoconferencing', NIH General Clinical Research Centers Annual National Meeting, Jill Gemmill, (March 10, 2000)

23. D.L. Shealy presented invited opening presentation entitled 'Theory of geometrical methods for design of laser beam shaping systems' to the first international Laser Beam Shaping Conference 4095, SPIE International Symposium on Optical Science and Technology, San Diego, 2 August 2000.

24. 'NSF EPSCOR : The Internet2 Project in Alabama', Alabama EPSCOR NanoTechnology Conference, Dave Cordes, (January 19, 2001)

25. 'NSF EPSCOR: The Internet2 Project In Alabama', SURA/ViDe Digital Video Workshop, Jill Gemmill/Dave Cordes (March 20, 2001)

26. 'Internet2 and 'Tele-Collaboration'', Alabama EPSCoR Steering Committee, AAAS, and Centers of Excellence PI's. Jill Gemmill, May 2001.

27. 'Blind Men Feeling the Elephant: Managing Network Application Performance. Standards, Tools, and Challenges'. World Conference on

Integrated Design and Process Technology, Workshop on Transdisciplinary Education and Research, Jill Gemmill, (June 2001)

28. 'Internet2 Brings New Opportunities to Bio/Medical Informatics'. UAB Health Informatics Seminar, Jill Gemmill, July 17, 2001.

29. 'Gulf Central GigaPoP: Alabama's High Performance Network for Research and Education'. Alabama Higher Education Network Infrastructure Summit, Jill Gemmill, (July 26, 2001)

30. David L. Shealy presented the invited talk entitled 'Geometrical methods for laser beam shaping,' Laser Materials Processing Session 11: Laser Beam Shaping, Quality & Transmission, 20th International Congress on Applications of Lasers & Electro-Optics, Jacksonville, 18 October, 2001.

31. 'Internet2 Brings New Opportunities'. UAB Department of Surgery,, Jill Gemmill, (January 7, 2002)

32. 'H.323 Videoconferencing', (Jill Gemmill, Doug Pearson, Indiana University and Tyler Johnson, University of North Carolina). Presentation to NLANR Techs Workshop January 2002

33. 'IP Flow Analysis of UAB's Internet2 Utilization: What Campuses Want to Know about End-to-End Performance'. Internet2 End-to-End Performance Workshop, Jill Gemmill, January 2002.

Journal Publications:

M.Stricklen, B.Cummings, S.McClellan, "Linux and the Next Generation Internet: a Diffserv Testbed", *Linux Journal*, vol. 72, (2000), p. ?. Published

Y.L. Liang, S. McClellan, K. Burst, "Issues and techniques in network-based distributed healthcare: Quality of service and bandwidth", *Proc. Fifth World Conf. on Integrated Design & Process Technology*, vol. , (2000), p. ?. Published

S. McClellan, G. Grimes, K. Burst, "Issues and techniques in network-based distributed healthcare: Advanced network technology", *Proc. Fifth World Conf. on Integrated Design & Process Technology*, vol. , (2000), p. ?. Published

S. Chataut, S. McClellan, J. Gemmill, "Tools for application performance management", *Proc. Integrated Design & Process Technology*, vol. , (2000), p. ?. Published

Jiang Lan, Jill Gemmill, "The Networking Revolution for the New Millennium: Internet2 and Its Educational Implications", *International Journal of Educational Telecommunications*, vol. 6, (2000), p. 179. Published

Jill Gemmill, "Blind Men Feeling the Elephant - Managing Application Network Performance: Standards, Tools and and Challenges", *Integrated Design and Process Technology*, vol. 1, (2001), p. 64. Published

Jill Gemmill, "IP Flow Analysis of UAB's Internet2 Utilization", *Technical Report 2001-11-ECE-017, Department of Electrical and Computer Engineering, University of Alabama at Birmingham.* , vol. 2001-11, (2001), p. ?. Published

Jill Gemmill, Clair W. Goldsmith, Murat Tanik, Gregg L. Vaughn, David L. Shealy, "UAB's Internet2 Utilization: A Case Study Using IP Flow Analysis", *Proceedings of the Society for Integrated Design and Process Technology*, vol. , (2002), p. . Accepted

N.C. Evans and D.L. Shealy, "Design of a gradient-index beam shaping system via a genetic algorithm optimization method", *Proceedings SPIE*, vol. 4095, (2000), p. 26. Published

Book(s) of other one-time publications(s):

Y.L. Ling, "Performance Analysis of Telepathology in an ATM Network" , bibl. University of Alabama at Birmingham, (1998). *Thesis* Published

Jill Gemmill, "UAB Internet2 Web Site" , bibl. <http://www.uab.edu/internet2/>, (1998). *web site* Published

S.McClellan, "Applications over Differentiated Services in the Next Generation Internet" , bibl. Bellsouth Science & Technology Innovations Showcase, (1999). *Conference* Published

S.McClellan, "Quality of Service & Telemedicine" , bibl. SURA Workshop on Advanced Applications, (1999). *Conference* Published

S.McClellan, M.Stricklen, B.Cummings, S.Chataut, "Demonstration of QOS Technologies: ATM, Diffserv, 802.1p/q, et.al." , bibl. SURA Workshop on Advanced Applications, (1999). *Conference Demonstration* Published

David L Shealy, "Laser Beam Shaping Theory and Techniques" , bibl. Marcel Dekker, New York, pp. 163-213 (Chapter 4), 215-248 (Chapter 5), 313-348 (Chapter 8). , (2000). *Book* Published
of Collection: Fred M. Dickey and Scott C. Holswade, "Laser Beam Shaping Theory and Techniques"

Other Specific Products:

Funded Research Grant

The University of Alabama has made presentations to NASA and Army

personnel in Huntsville in hopes of developing research grants with these federal agencies. As a result of those meetings, The University of Alabama has obtained and completed a planning contract with the Army Missile Command (AMCOM) to obtain their involvement in Internet2 research. All three University of Alabama System universities were involved. The planning contract was conducted July 1 - September 30, 1998 and brought in approximately \$95,000 to the universities. Results of this research project will be distributed through AMCOM.

Internet Dissemination:

<http://www.uab.edu/internet2/> <http://internet2.ua.edu/> <http://www.gcgpop.net/>

The first site summarizes UAB's activities in implementing this award. The meritorious research applications and other applications requiring high performance network connections are described at this location. Publications and research findings will also be posted.

The second URL summarizes UA's Internet2 activities.

The third URL describes the Gulf Central GigaPoP

Contributions:

Contributions within Discipline:

The process of building, operating, and utilizing high performance networks represents development of an important information science and technology infrastructure within Alabama.

Contributions to Other Disciplines:

The availability of high performance networks is changing how courses are being taught and how research is being done in many fields on our campuses, such as, biochemistry, physics, materials science, medicine, nursing, electrical & computer engineering, computer science, biomedical engineering, astronomy, and music. Higher bandwidth networks enable real-time, remote control of medical and scientific instruments, graphic visualization of large dataset generated at remote supercomputer, large database analysis, and collaboration using digital video. Multimedia is now becoming viable for use in web-assisted instruction, collaborations, and conference attendance.

After UA connectivity to Internet2 link through the GCG, SoX, and Abilene, an astronomer recently indicated that he was able to successfully collaborate with some colleagues at Kitt Peak with excellent results. Quoting Dr. William C. Keel, Professor of Astronomy at the University of Alabama:

'I just had a chance to use our new and vastly improved Internet connection for one of the applications that went into the original proposal. Over the weekend I was working with some collaborators at the telescope on Kitt Peak, near Tucson, The detector was a CCD array

of 8192x8192 16-bit pixels, 135 Mbytes every time the shutter opens. To general astonishment, I could keep up with the data for 10-minute exposures. Quite reliably (within a few percent from Friday night to this morning), it took 13 minutes per file to pull these over. As far as I can tell, this is about the raw speed of the link from the mountaintop to Tucson, at which point my guess is that it jumps on I2 from that 'other' U of A to here.'

Contributions to Education and Human Resources:

Widespread interest in web-assisted instruction/distance education was documented through the High Performan