



2006  
Outstanding Program Awards  
Application

Program Title: Third Frontier Network

Check one:  Individual State Award  Partnership or State/Private Entity

NASCA Member State: Ohio

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► **Deadline: March 1, 2006**

The application package must be received no later than March 1, 2006 for consideration.

Submit nominations electronically to NASCA Staff at [nasca@csg.org](mailto:nasca@csg.org). Or mail a CD or disk to: NASCA, c/o Council of State Governments, 2760 Research Park Dr., PO Box 11910, Lexington, KY 40578-1910. All submissions must be submitted electronically including copies of the justification and executive summary.

## **NASCA Award Application**

### **Third Frontier Network**

- a. Indicate Individual State Award or Partnership between state and private entity.

#### *Individual State Award*

- b. Executive Summary of program

The Third Frontier Network (TFN) is a statewide telecommunications network created by the Ohio Board of Regents and currently being used by P-12 and higher education. Developed through the purchase of dark (“unused”) optical fiber from private telecommunications providers and the use of the latest in optical networking technologies, the TFN provides the state’s educational networks a significant increase in network capacity at the same cost as their previous networks. More than just providing Ohio a means of getting greater value with state funds, the TFN offers the means to support greater collaboration among Ohio’s education organizations. Through that collaboration, the network supports sharing of resources in a way that can radically expand the capabilities of Ohio’s education organizations and improve the educational, economic development or other services they provide to Ohio communities. The design of the network will allow the TFN to offer the same advantages to other statewide networks.

- c. Describe the program and relative significance to the improvement of the operation and/or efficiency of state government.

#### **About the Third Frontier Network**

The Third Frontier Network is an optical network created initially to link Ohio’s higher education institutions with each other, K-12 schools, public broadcasting stations, and government labs as well as with the hospitals, businesses and economic development organizations with which they collaborate on research, education or health care programs. The TFN project was initiated by the Ohio Board of Regents and was built and managed by OARnet. OARnet is the networking division of the Ohio Supercomputer Center (OSC) and acts as the Internet Service Provider for Ohio’s higher education community. It is operated as a consortium of higher education institutions and is funded partly by state appropriations through the Regents and partly through member fees.

The TFN is made up of more than 1600 route miles of fiber optic cables that reach into every region of Ohio [see the accompanying map.] These fiber optic cables were purchased from private telecommunications

companies. This fiber is the “backbone” of the Third Frontier Network. Eighty-eight Ohio universities and colleges are connected to the TFN at the network Points of Presence (POPs) located around Ohio. All of OARnet’s member institutions use the TFN and more than 41 have high-speed broadband (greater than 45 Mbps) connections to the network. The network is used to provide them with a range of services, including access to the national research networks such as Internet2, access to the commercial Internet, connections among institutions to support collaborative projects, and support for videoconferencing.

The network became operational in 2004 after two years of development. Since that time eTech Ohio and the Ohio Department of Education, the two state agencies responsible for providing the network to link K-12 schools and public broadcasting organizations, have become partners in the TFN project. They have started moving their network over to the Third Frontier Network and the first K-12 organizations switched to the network in February 2006.

### **Significance of the Third Frontier Network**

The Third Frontier Network is a significant national example of innovation in meeting higher education’s need for greater network capacity “bandwidth.” The Ohio Board of Regents and OARnet have used the latest in networking technologies and industry practices for purchasing fiber to create a new economic structure for its network that makes it possible to offer greater capacity at a fixed cost.

The TFN has done so in a way that can bring the benefit of greater capacity to not just a few research institutions, but to all of Ohio’s higher education institutions and can offer the same capacity and advantageous financial structure to other statewide public sector organizations. More than just an example of technical or administrative innovation, the development of the network is an innovative example of how these financial and technical choices support greater collaboration among public sector organizations that can dramatically change their capacity to offer education, economic development, or other crucial services.

The innovations and benefits of the Third Frontier Network are explained through the following history of the network.

#### *The Issue*

The creation of the Third Frontier Network began in 2001 as a result of the Regents’ development of the Ohio Plan: an initiative for research-based economic development. The committee considering this plan considered Ohio’s widely distributed investment in higher education and determined that if Ohio was to support world-class research, it would have to be easy for faculty to work with colleagues located at other institutions. They envisioned that “a researcher in Athens should be

able to work with a colleague in Cleveland as if they were located next to each other.”

This analysis led them to review the higher education network that OARnet was then operating. They determined that network would be insufficient to support the level of collaboration the committee believed was necessary. The Ohio Plan committee saw that greater collaboration among researchers would require the ability to share a growing amount of visual information – from microscope images to video conferences and computer generated visualizations of scientific data. They also saw that the amount of network bandwidth needed for these images would continue to grow. At that time, a typical video conference used 384 Kbps (Kilobits per second)<sup>1</sup> of bandwidth; high-definition video conferencing would be used in the near future and was likely to require much greater bandwidth – around 6 Mbps (Megabits per second). As a result of their review of the existing network, the committee determined that OARnet’s network did not have sufficient bandwidth to support exchange of these materials. Given the financial structure of the current network, simply purchasing additional and higher quality bandwidth would result in dramatic increases in the cost of its operations.

When the committee members reached this conclusion, they also determined that the need for greater capacity was not restricted to researchers or research institutions. All of Ohio’s higher education institutions needed the ability to expand collaboration. Even if smaller institutions did not generate a lot of high bandwidth content, they were likely to receive such content from other organizations. For example, they might receive high-definition video broadcasts of courses from larger institutions. And high quality images and other bandwidth intensive materials have just as much value in many areas of technical education as in academic research.

#### *The Solution*

These conclusions led Ohio to seek innovative solutions to respond to its need to provide greater bandwidth while not increasing the cost of telecommunications services. A group was created to consider the technical and financial options that were available. This group chose to meet higher education’s needs by procuring a “dark” optical fiber network. It was believed that this type of a network would be able to provide the much greater amount of bandwidth needed to support expanded collaboration among institutions without requiring an increase in funding.

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<sup>1</sup> Network capacity, also called bandwidth, is measured in bits per second (bps). One bit is 1/8<sup>th</sup> of a byte the measure of capacity for most other forms of computer equipment. Bandwidth is typically expressed in thousands of bits per second, Kilobits per second (Kbps), millions of bits per second, Megabits per second (Mbps), or billions of bits per second, Gigabits (Gbps).

Most regional and national telecommunications networks are now built using optical fiber. Optical networks offer a greater amount of bandwidth than networks created using other forms of cabling, (for example the copper wire used to connect an office PC to a local area network). For long distance circuits, non-optical connections can provide only 45 Mbps while optical fiber can support 10 Gbps and higher – a much bigger pipeline to transfer visual and complex data. Optical fiber has the added advantage of making it possible to use Dense Wave Division Multiplexing (DWDM). This is a technology that makes it possible to operate multiple networks simultaneously on one fiber. Each network using the single fiber operates on a different wavelength of light. These multiple networks do not divide the capacity of the fiber. They can each have a capacity of up to 10 Gbps.

The capacity of an optical fiber is not static. It continues to increase as the electronics used to send light over the network are improved. These improved electronics can radically expand the capacity of a network because they support both faster transmission of data (from 10 Gbps to greater rates of bandwidth of 40 Gbps and higher) and support simultaneous operation of a greater number of networks on one fiber (today's limit is 32 and soon will expand to 64). These new electronics provide not only expanded capacity, they also cause a decrease in the price of older types of DWDM equipment, allowing an incremental increase in capacity at lower and lower costs.

Telecommunications services are traditionally purchased by leasing circuits with a fixed bandwidth between two points. There is then a monthly charge for this leased circuit. With a leased optical circuit, the private telecommunications carrier gets the benefit of the added capacity produced by better electronics. They have historically sold the added capacity to other customers and typically did not reduce the cost of service by a significant amount.

The customer has an alternative when they purchase the fiber, called dark fiber, from a telecommunications company. This “dark fiber” is unused fiber optical cable without the electronics needed to send light over the fiber. Dark fiber is usually purchased through a 20-year capitalized lease called an Indefeasible Right of Use which gives the customer exclusive use of the fiber. When purchased in this way, it is up to the purchaser to obtain the needed electronics and add them to the fiber. The customer can purchase new equipment as often as needed to increase the capacity of the network and receives the benefit of the increased capacity or lower costs made possible by improved or lower cost electronics. Dark fiber thus creates a different financial structure for the purchaser. Instead of a monthly cost for services, the customer pays a one-time cost for the fiber infrastructure and for new equipment to light the fiber then pays only a small monthly fee for the maintenance of the fiber.

The Board of Regents and OARnet were highly innovative when they chose to create an optical network through the purchase of dark fiber and the use of DWDM equipment. These decisions would provide a network that offers greater bandwidth and an ability to upgrade to a greater capacity whenever OARnet chose to do so at a one-time cost that would likely decrease as equipment becomes cheaper.

It also was realized that this network could support more than just the higher education community. Since fiber optic cables can simultaneously support multiple independent networks, the dark fiber could be used to support multiple statewide public sector networks at the same time, e.g. the P-12 or state government networks. For this reason, representatives of those networks were involved in the group that managed the process of purchasing dark fiber.

The Board of Regents obtained start-up financing for the TFN project by allocating \$5 million in state capital funds for equipment and obtaining a seven-year loan to cover the cost of purchasing the fiber. The Regents annual operating funds for OARnet were committed to the repayment of this loan. With this funding in place, OARnet and the Regents purchased more than 1600 route miles of fiber from several telecommunications companies. Fortunately, this purchase coincided with the “Dot.Com” crash when many telecommunications companies, (some reorganizing in bankruptcy), were willing to sell their fiber at much lower prices than during the “Dot.Com” boom.

#### *Current Status*

Ohio has led other states by creating an optical network that takes advantage of the technical (DWDM) and economic advantages (dark fiber) of a fiber network and by ensuring that the network extends into every region of the state, not just major research centers. Other states, in comparison, have not used the same technology, thereby limiting the capacity of their fiber, or have focused on connecting only major research universities. But the significance of the Third Frontier Network is not limited to these financial and technical advantages. It is especially significant because of its potential to radically transform the capabilities of Ohio’s public sector organizations.

Networks can transform organizations when they are used to create novel approaches to resource sharing and collaboration. For example, OhioLINK is a statewide library consortium of Ohio’s universities and colleges that was created to operate over Ohio’s previous higher education network. It permits universities and colleges to share books and other library materials. Students and faculty from any OhioLINK member institution can request materials from any other member institution and the materials will be delivered to their campus within a few days. Many of the OhioLINK member institutions have small library collections, but considered together, they can offer a collection of around 22 million items, roughly the size of Harvard University’s renowned

library. Thus, the network was used effectively to transform these small institutions' libraries into a preeminent research university library.

The Third Frontier Network now makes it possible to share new types of resources and again transform the capacity of Ohio's universities and colleges. Specialized resources at particular institutions can be made accessible over the network. Two examples can demonstrate this potential:

First, Ohio State University (OSU) has a state-of-the-art electron microscope used to help develop and examine primary metals. A company located in Canton that is working with Ohio State on metals research would like access to this instrument. That company is located next to a community college with a high-speed connection to the Third Frontier Network. The OSU research institute can locate a set of controls for the instrument, costing approximately \$30,000, at the community college where they can be accessed by the company to operate the microscope. The TFN provides sufficient bandwidth to remotely operate the instrument in real-time and to carry the highly detailed images from the instrument at OSU to the corporate research partners in Canton. In effect, the network has been used to transform the capabilities of this local college, making it perhaps one of the only community colleges in the country able to serve the specialized needs of its local industry with access to an advanced electron microscope.

A second less-technical example, but an application important to the improvement of the state's P-12 schools, is the collaboration between the University of Toledo and the Toledo Public Schools. The teacher education program at the University of Toledo will be working with teachers to improve math and science education in their local schools using the TFN. The professors will be able to see classes, instruct teachers and share resources over the network. The TFN will thus have transformed the professional development capacity of the Toledo Public Schools and the education received by graduate students at the University of Toledo.

The network can have this same transformational power in many other areas of research, education, and economic development and for other parts of the public-sector.

- d. Provide calculation of actual savings in short and/or long term: if applicable

At the time OARnet decided to switch from its old network to the Third Frontier Network, its backbone network was primarily made up of OC-12 circuits. These circuits had a bandwidth of approximately 620 Mbps. With the Third Frontier Network, OARnet gained an OC-48 backbone

with a bandwidth of 2.4 Gbps (2.4 Gbps = 2400 Mbps), roughly a four-fold increase in capacity. The cost of migrating to the new network was \$18.5 million. This transition was accomplished through a one-time special allocation of \$5 million. Otherwise the network has been supported through OARnet's usual operating and capital budget allocations and user fees of approximately \$12 million per year which were used in part to secure a seven year \$7 million loan that helped to cover the start-up costs of the network. Thus the network has provided a 75% reduction in the unit cost for OARnet while providing an increase in bandwidth of 1.8 Gbps.

When OARnet issued its RFP for dark fiber, it allowed vendors to propose traditional leased services as an alternative to dark fiber. This RFP and subsequent interactions with vendors have demonstrated that OARnet would not have been able to obtain a comparable decrease in the unit cost of bandwidth by purchasing leased circuits. In fact, circuits with equivalent bandwidth were not available in every region of Ohio, or at least not without significant additional costs. Thus, the network has provided savings for higher education and Ohio's public sector when compared to the increased cost of a network created by leasing circuits. Because these services were not available everywhere in the state, it is difficult to put an exact value on these savings. With flat budgets, it also would not have been possible for OARnet or the higher education institutions to afford the greater expenses for leased circuits. Had dark fiber not been purchased, OARnet could not have met the continued demand for additional and expanded services.

- e. Describe quantitative benefits realized by service recipients, taxpaying, and/or state agencies

As was described in the response to Item D above, the Third Frontier Network has resulted in a dramatically lower unit cost of network connectivity allowing for the provision of much greater amounts of bandwidth during a time when state financial support for higher education has been flat or declining. It also has offered Ohio's universities and colleges a second form of savings because OARnet has been able to restructure its service fees. Prior to the creation of the TFN, OARnet could not distinguish traffic from universities and colleges using commercial Internet, e.g. Amazon.com and iTunes, from network traffic that stayed within the Third Frontier Network among educational sites. The new network allows OARnet to differentiate between these two types of traffic and to charge a lower rate for in-state traffic than for out-of-state traffic, thereby decreasing the incremental cost of greater collaboration and information-sharing among higher education institutions.

- f. Describe applicability of use by other state, local and/or federal government.

The technologies chosen for the Third Frontier Network, optical fiber and Dense Wave Division Multiplexing (DWDM) allow the TFN to be used by many other organizations than higher education or K-12 schools. There are two other state organizations looking to replace their current networks with new statewide networks: the Office of Information Technology (the information technology service organization for state government), and the Supreme Court (which wants to create a statewide court network). Both of these organizations have expressed considerable interest in using the Third Frontier Network as the foundation for their networks.

The TFN also has applicability to local government. As the network is extended around Ohio, it is connected with local fiber optic networks. As an extension to these local networks, there is the opportunity for local governments to use the TFN. The local governments with fiber networks are also looking to use the TFN to support their economic development plans. For example, one Ohio community, New Philadelphia, wants to connect to the TFN so they can make its bandwidth and the resources of the higher education community available to the future occupants of its technology park. In Springfield, access to the Third Frontier Network was the rationale for the development of a high-technology park and has had an influence in attracting major information technology companies to the development.

The federal government also will benefit from the TFN. The network will be connected to NASA Glenn and Wright Patterson Air Force Base during the next year to support their collaboration with Ohio's universities on aerospace and materials research. These collaborative research programs are expected to help strengthen the ability of those centers to compete for major roles in NASA and Department of Defense programs. The Third Frontier Network was cited in the Base Realignment and Closure Commission as one of the reasons to consolidate Air Force Research Laboratory's Human Effectiveness Directorate operations from other bases to Wright Patterson in Dayton. Finally, negotiations are underway to support connecting the TFN to the Department of Energy's Teragrid network. This connection is to be made to support Department of Energy sponsored research sites.

# TFN: All Sites with Metro Rings

