

## MOST COLLEGES AND UNIVERSITIES OBTAIN BANDWIDTH THROUGH STATE AND REGIONAL CONSORTIA

by Leslie Christovich

According to the National Science Foundation's (NSF's) biennial Survey of Science and Engineering Research Facilities, research-performing colleges and universities<sup>1</sup> continue to enhance their networking and computational resources, two key components of their cyberinfrastructure.<sup>2</sup> Cyberinfrastructure is playing an increasingly important role in the conduct of science and engineering (S&E) research and significantly changing S&E research methods. According to the NSF Advisory Panel on Cyberinfrastructure, these advances are not simply changing the conduct of science, but are revolutionizing it (NSF 2003).

### Networking

For FY 2005, 43% of academic institutions reported the total of their commodity internet (Internet1)<sup>3</sup> and Abilene (Internet2) bandwidth to be greater than 155 megabits (table 1). As a point of reference, high-speed internet connections available to residential customers in the United States generally range between 1 and 6

megabits. Twenty-one percent of the institutions reported bandwidth of 1 gigabit or greater. The percent with a total bandwidth of 1 gigabit or faster is estimated to increase about 9 percentage points in FY 2006 to 30%.

The majority of institutions (63%) obtained at least some of this bandwidth from a consortium in FY 2005. Sixty-eight percent anticipated doing so in FY 2006. While institutions reported a variety of consortia, many are state and/or regional research and education networks. For example, some of the many consortia include the Corporation for Education Initiatives in California (CENIC); the Merit Network (which provides services to research and education institutions primarily in Michigan); the New York State Education and Research Network (NYSERNet); and the Metropolitan Research and Education Network (MREN), originally developed by a group of both academic and nonacademic Midwestern organizations.

Institutions reported connections to several high-performance networks, including Abilene, a high-performance network dedicated to research led by a consortium of universities, governments, and private industry. In FY 2005, 69% of institutions were connected to Abilene (table 2), an increase from the 65% with a connection in FY 2003 (NSF 2006). By FY 2006, 74% of all institutions anticipated having a connection. Thirty-two percent of those anticipating Abilene connections in FY 2006 also anticipated Abilene bandwidth of 1 gigabit or faster (not shown in table).

<sup>1</sup> The NSF Survey of Science and Engineering Research Facilities also collects data from nonprofit biomedical research institutions (hospitals and research organizations) receiving research funds from the National Institutes of Health, as well as from academic institutions. Although networking capabilities at universities are reported here, networking at biomedical institutions is not.

<sup>2</sup> The NSF survey collects information both on institutions' physical "bricks and mortar" infrastructure and cyberinfrastructure. In the cyberinfrastructure section of the survey, respondents were asked to identify all of their networking resources, regardless of whether these resources were used for research.

<sup>3</sup> Commodity internet is the general public, multiuse network often called the "Internet."



TABLE 1. Total bandwidth to commodity internet (Internet1) and Abilene (Internet2), by type of institution: FY 2005 and FY 2006 (estimated)  
(Percent distribution)

Speed	FY 2005			FY 2006		
	All academic	Public	Private	All academic	Public	Private
All bandwidths	100	100	100	100	100	100
None	0	0	0	0	0	0
Less than 1.6 mb	2	2	2	1	1	1
1.6 to 9 mb	3	2	5	2	2	4
10 mb	1	1	2	*	1	0
11 to 45 mb	23	20	29	18	14	26
46 to 99 mb	16	17	14	13	12	15
100 mb	3	3	2	4	4	2
101 to 155 mb	9	11	5	10	11	9
156 to 622 mb	18	18	19	17	17	16
623 to 999 mb	3	4	2	4	5	3
1 to 2.5 gb	15	16	14	20	22	16
2.6 to 9 gb	4	5	2	5	8	1
10 gb	*	*	0	1	1	1
More than 10 gb	2	2	3	4	4	4
Other	*	0	1	*	0	1
Number of institutions	449	301	148	449	301	148

\* = greater than 0, but less than 0.5%.

mb = megabits per second.

gb = gigabits per second.

NOTES: Abilene is a high-performance backbone network that enables the development of advanced internet applications and the deployment of leading-edge network services to member colleges, universities, and research laboratories across the country.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Science and Engineering Research Facilities, Fiscal Year 2005.

Institutions of higher education may also be connected to the National LambdaRail, a national fiber optic infrastructure supporting multiple networks for the research community. In just one year the number of institutions connected to the National LambdaRail was expected to increase by 21 percentage points, from 10% with connections in FY 2005 to 31% in FY 2006. In addition, about 13% of the institutions anticipated being connected to at least one federal government high-performance network, such as NASA's Research and Engineering Network (NREN) or the Department of Energy's Energy Sciences Network (ESnet), by FY 2006. A number of institutions are or will be connected to more than one high-performance network.

Concurrent with increasing bandwidth to external networks such as the Internet1, Abilene, or National

LambdaRail, institutions also are increasing their internal network speeds. In FY 2003, the highest speed from one desktop to another was 100 megabits at 64% of the institutions, while the highest speed was 1 gigabit to 2.5 gigabits at 33% of the institutions. By FY 2005, 54% of institutions reported their highest desktop to desktop speeds to be one gigabit or faster. In FY 2003, no institution had a speed greater than 2.5 gigabits, but 4% had speeds at least this fast in FY 2005. Over 14% estimated that their highest desktop to desktop speed would be at least this fast in FY 2006.

One indicator of potential expansion of networking capacity is the amount of dark fiber owned by institutions. Dark fiber is unused fiber within fiber optic cables that have already been laid. They are therefore available for future use. At the end of FY 2005, 29% of the institu-

TABLE 2. Institutions with high-performance network connections, by type of institution: FY 2005 and FY 2006 (estimated) (Percent)

Type of institution	Abilene	National LambdaRail	Federal government research network	Other
At end of FY 2005				
All academic	69	10	11	6
Doctorate granting	82	11	13	15
Nondoctorate granting	38	7	6	6
Public	73	11	12	14
Private	58	8	9	9
At end of FY 2006 (estimated)				
All academic	74	31	13	6
Doctorate granting	86	40	15	18
Nondoctorate granting	44	11	7	7
Public	78	36	14	16
Private	65	21	11	11

NOTE: Abilene is a high-performance backbone network that enables the development of advanced internet applications and the deployment of leading-edge network services to member colleges, universities, and research laboratories across the country.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Science and Engineering Research Facilities, Fiscal Year 2005.

tions owned dark fiber to their internet service provider (ISP), and 85% owned dark fiber between their buildings.

Another important component of internal networking cyberinfrastructure is desktop port speed. In FY 2005, 83% of the institutions reported that the greatest proportion of their desktop ports had a speed of 100 megabits, up from 72% of institutions in FY 2003. Another 3% reported that the largest proportion of their ports was 1 gigabit or faster in FY 2005. Six percent estimated that the highest proportion of their ports would be at 1 gigabit or faster in FY 2006.

Although used less frequently for research purposes than hardwire connections, research-performing colleges and universities continued to expand their wireless coverage. In FY 2003, 14% of academic institutions had greater than half of their building area covered by wireless (table 3); in FY 2005, 34% had similar coverage. Ten percent had greater than 90% coverage in FY 2005. Fifty-six percent of the institutions estimated that

greater than 50% of their buildings would have wireless coverage by FY 2006.

### High-Performance Computing

Scientific computation is another key component of cyberinfrastructure, particularly high-performance computing. In FY 2005, almost two-thirds (62%) of academic institutions reported having at least one high-performance computing<sup>4</sup> system located at their institutions. Seventy-eight percent of the institutions with high-performance computing reported more than one system. These systems may be located in specific schools and departments, however, and therefore may not be accessible to all potential researchers. Forty-four percent of the institutions with high-performance computing indicated that none of these systems were generally available to all of their faculty, and 50% indicated that at least one of the systems at their institutions was generally available to all faculty.

TABLE 3. Wireless connections by building area coverage at academic institutions: FY 2003, FY 2005, and FY 2006 (estimated) (Percent distribution)

Building area coverage (%)	FY 2003	FY 2005	FY 2006
Total	100	100	100
None	4	2	*
≤10	43	15	3
11-20	20	16	8
21-30	11	15	12
31-40	5	9	12
41-50	4	9	9
51-60	2	5	8
61-70	2	6	8
71-80	3	7	10
81-90	1	6	8
91-100	6	10	22
Number of institutions	424	449	449

\* = greater than 0, but less than 0.5%.

NOTE: Details may not add to 100% due to rounding.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Science and Engineering Research Facilities, Fiscal Years 2003 and 2005.

<sup>4</sup> On the survey, high-performance computing was defined as a computing system that performs at the fastest rate currently available, manipulating a very large amount of data in a short time. High-performance computing includes large capacity mainframe computers. It also includes the use of parallel processing to spread a computational problem over multiple computers.

### Data Notes

The data presented in this *InfoBrief* were obtained from a census of 452 colleges and universities that grant degrees in science or engineering and that expended at least \$1 million in research and development funds in FY 2004. Each academic institution's level of expenditures was obtained from the NSF's FY 2004 Survey of Research and Development Expenditures at Universities and Colleges.

The FY 2005 Survey of Science and Engineering Research Facilities detailed statistical tables are available at <http://www.nsf.gov/statistics/nsf07325/>. Current survey data for individual institutions are available from the Computer-Aided Science Policy Analysis and Research (WebCASPAR) database system, a Web tool for retrieval and analysis of statistical data on science and engineering resources (<http://webcaspar.nsf.gov>).

### References

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