

# **Report of the Internet2 Campus Expectations Task Force (CETF)**

## **Executive Summary**

Since the creation of Internet2 in 1996, the question of what it means to be a member of the community served by the organization has not been reexamined until now. Charged by the Internet2 Applications Strategy and Network Planning and Policy Advisory Councils, a Campus Expectations Task Force (CETF) was created to examine this question.

The CETF began its work by considering today's environment for research, education, and service within the higher education community. Although much of the motivation for advanced networking and related computing infrastructure in 1996 and since has revolved around assumptions about collaboration and access to sharable and frequently expensive or unique resources, it is fair to say that expectations and motivations have increased dramatically. These increased expectations are present in the form of federal agency directions, identified grand challenge problems, and the growing use of teams of scholars, frequently interdisciplinary teams, to tackle research, education, and service issues.

Accordingly, it is imperative that the members of a national community such as Internet2 are united around a set of commitments to each other—a set of commitments that make it possible to pursue the collaborative work that will keep these members competitive and productive in today's regional, national, and international research and education environments. Furthermore, it is imperative that the organizations created to serve the members in achieving their mutual goals orient their support and activities to helping the membership meet the commitments. In this latter point, we include the Internet2 organization as well as its possible successors and partners.

The CETF believes that an individual campus member's agreement to strive for compliance in each of three areas of commitment should represent a condition of membership. It is through the intention to comply, that each member campus creates a basis of expectation within the community for mutually beneficial progress and support. These three areas of commitment are:

1. **Innovation:** a promise to enable and enhance support for research and educational goals derived via new methods, tools, collaborations, and forms of access
2. **Shared Infrastructure:** a promise not only to provide advanced networking, computing, and related technological services, but also to promote and deliver those services in appropriately available, secure, supported, and flexible ways
3. **Community:** a promise to sustain the community good through investment, contribution of time and effort, and accommodation of broad disciplinary interests

Finally, to assist campuses in making a self-determination as to their level of success in meeting these commitments, the CETF proposes establishment of a system for development of best practices and self-assessment to be vetted within the organization, published, and promulgated for use.

# Report of the Internet2 Campus Expectations Task Force (CETF)

## Context and Environment

This document is the initial and essential outcome of the work of the Campus Expectations Task Force (CETF), a group representing many roles and perspectives within the Internet2 community. A listing of the members of the CETF and a copy of its original charge appear as appendices to this report.

One might expect this document to respond quite strictly to the charge presented to the CETF, most specifically to consider what it means today to be a member of Internet2. However, the CETF has come to believe that what is here recommended applies equally well to other organizations formed by the membership, especially by the nation's research universities, to advance infrastructure supporting research and educational interests. Such organizations would include National LambdaRail (NLR), regional networking organizations, Globus, and others. The CETF offers this report with the expectation that its recommendations may be equally important to Internet2, other organizations with which Internet2 collaborates, and future organizations or partnerships.

One might also expect that the work of the CETF and this resulting report would have as its intended audience those many individuals who have, for the last nine years, been so dedicated to creating, operating, using, and advancing our evolving next generation networks. Certainly, this would include the Chief Information Officers (CIOs) from the nation's research universities, those institutions making up the essential membership of Internet2. However, this was a task force charged with considering what it means today for a **campus** (institutions of higher education, the founding members, as well as other organizations that serve research interests, such as government laboratories) to be a member of the Internet2 community. Accordingly, the audience for this document (whether directly or indirectly) must not be narrowly constrained only to these CIOs and other technology workers who already believe and who are already committed to the sometimes implicit purposes for which Internet2 was established. The audience must be extended to Chancellors, Presidents, Provosts, and the Vice Provosts or Vice Presidents for Research who surely care about the advancement of research and education and international, national, institutional, and disciplinary competitiveness. This report, either by itself or as presented in other forms and settings, seeks to engage these leaders in embracing the commitments proposed herein—commitments designed to further enable their shared visions for research and education.

Motivation for attention to this report by these senior campus representatives and others can be found in many places. Leaders within scholarly communities, Federal funding agencies and policy making groups are promoting a future that requires attention to international, inter-institutional and intra-institutional collaborations. Private sector interactions are being promoted, and both interdisciplinary and multidisciplinary research and education strategies are being advocated. To be competitive at every level (personal, disciplinary, institutional), attention to the infrastructure (advanced networking and computational resources) required to engage in such

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multidimensional work is imperative. A few examples of the demand for attention to these issues follow. Each example carries implicit demands for enabling infrastructure and its development.

The National Academies in 2005 completed an examination of the role of interdisciplinary research, describing both its benefits and challenges.

“Interdisciplinary thinking is rapidly becoming an integral feature of research as a result of four powerful ‘drivers’: the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems, and the power of new technologies.”<sup>1</sup>

“Collaborative interdisciplinary research partnerships among universities, industry, and government have increased and diversified rapidly. Although such partnerships still face significant barriers, well-documented studies provide strong evidence of both their research benefits and their effectiveness in bringing together diverse cultures.”<sup>2</sup>

At the National Science Foundation, an Office of Cyberinfrastructure within the Office of the Director has been created to further stimulate the creation of infrastructure needed to support research and education communities across all disciplines.

Envisioned is “...a cyberinfrastructure layer of enabling hardware, algorithms, software, communications, institutions, and personnel. This layer should provide an effective and efficient platform for the empowerment of specific communities of researchers to innovate and eventually revolutionize what they do, how they do it, and who participates.”<sup>3</sup>

Dr. Elias Zerhouni, Director of the National Institutes of Health, has provided leadership within that agency for new and very significant initiatives designed to revolutionize and transform biomedical research. A program called the NIH Roadmap calls for collaborative change all across the agency and throughout its many institutes. Selected institutes and centers within NIH (e.g. the National Institute of Biomedical Imaging and Bioengineering or the National Center for Research Resources) and the National Library of Medicine provide elements of leadership, but perhaps a best indication of the kind of change Dr. Zerhouni advocates can be seen in that part of the NIH Roadmap called “Research Teams of the Future.”

“The NIH Roadmap also aims to reconfigure the scientific workforce by encouraging novel forms of collaboration. The scale and complexity of today’s biomedical research problems demand that scientist move beyond the confines of

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<sup>1</sup> *Facilitating Interdisciplinary Research*, Committee on Facilitating Interdisciplinary Research and Committee on Science, Engineering, and Public Policy, The National Academies, The National Academies Press, 2005, p. 188, <http://books.nap.edu/catalog/11153.html>.

<sup>2</sup> *Ibid.*, p. 191.

<sup>3</sup> *Revolutionizing Science and Engineering through Cyberinfrastructure: Report of the NSF Blue Ribbon Advisory Panel on Cyberinfrastructure*, National Science Foundation, January 2003, p. 5, <http://www.nsf.gov/od/oci/reports/atkins.pdf>.

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their individual disciplines and explore new organizational models for team science. Advances in molecular imaging, for example, require collaborations among diverse groups—radiologists, cell biologists, physicists, and computer programmers, among others. Although researchers within the life and physical sciences have traditionally had limited interaction, it is only by forging these critical connections that the current gaps in terminology, methods, and approach that so seriously impede progress can be eliminated.”<sup>4</sup>

Within the arts, humanities, and social science disciplines, attention is also being given to these issues. In late 2005, a study by the American Council of Learned Societies on cyberinfrastructure requirements for these disciplines was completed.

“The cultural record is currently fragmented over more or less arbitrary institutional boundaries... The resources required for work in the humanities and the social sciences are comprehensive, diverse, and complex... At present, we have the opportunity to reintegrate the cultural record, connecting its disparate parts and making the resulting whole available to one and all, over the network. This goal constitutes a true grand challenge problem, one that would require intensive collaboration among scholars across all the disciplines of the humanities and the social sciences—cooperating with librarians, curators, and archivists—and it would require the involvement of many others, including experts in the sciences, business, and entertainment, as well as active participation from the general public.”<sup>5</sup>

The CETF concludes that it is critically important for the membership of Internet2 to position itself strongly behind these concepts and to enable them. The work of Internet2 and its members is not fundamentally about networking—the work is about enabling our research and education missions through access to advanced networking and computational resources.

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<sup>4</sup> “US Biomedical Research—Basic, Translational, and Clinical Sciences”, *Journal of the American Medical Association*, Elias A. Zerhouni, MD, Volume 294, Number 11, September 21, 2005, available via <http://www.nih.gov/about/director/index.htm>.

<sup>5</sup> *The Draft Report of the American Council of Learned Societies’ Commission on Cyberinfrastructure for the Humanities and Social Sciences*, November 2005, <http://www.acls.org/cyberinfrastructure/acls-ci-public.pdf>.

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## Historical Perspective

Information technology organizations at most of the nation's research universities have for more than nine years been engaged with each other in developing, supporting, and making available to their campuses a next generation Internet capability. These activities have been significantly aided by the involvement and support of the Federal government, State and regional networks, corporate organizations, and international partners. With roots in the Federal Next Generation Internet initiative and perhaps most popularly known as Internet2, these activities now also include the work of others, notably National LambdaRail (NLR).

The advanced networks that have resulted from these efforts have capacity, capability, and functionality far exceeding that of commercial Internet services. At the "edge" of each campus, a participating institution will typically have at least two network connections—one for "routine" commercial Internet access and a separate, controlled-access connection to one or more advanced networks (e.g. Internet2's Abilene infrastructure or a regional network).

In the history of the development of "the Internet", the 1990s were particularly eventful years. During this time, higher education executives and Federal science agencies called for new institutional collaborations. Federal support for the networks that interconnected our universities shifted to new initiatives, while the existing networks were transformed into the commercial Internet which is broadly available today. Technology professionals at the nation's research institutions began to express concern that their education and research interests might be overshadowed by other uses of the network. At the same time, these campuses began to realize how dated and inadequate their on-campus network infrastructure was, especially given emerging needs and uses.

A series of meetings of campus IT leaders, librarians, and prominent faculty researchers, beginning with a series of conferences in Monterey<sup>6</sup>, California, led to the shared conclusion that an independent Internet designed exclusively to support the nation's research universities was needed. Some described this as "taking back the Internet" for higher education. In order to make this possible, at least two things were deemed necessary: a national high performance backbone network, and the upgrading of each campus's network infrastructure to have the necessary flexibility and capacity to interface to such a backbone and to support advanced research and educational needs. Some Federal support for creation of a backbone was developing, along with provisions for limited campus access to such a backbone. However, no comprehensive strategy existed to attack the pair of problems.

Accordingly, in 1996, 34 research universities, represented by their CIOs, met in Chicago to discuss formation of a new organization to provide leadership for these efforts. Internet2 was born, and nearly all of the nation's research universities quickly joined the organization and committed to its plans. At that time, the only specified criterion for membership was that a campus must commit to spend a minimum of \$500,000 per year to upgrade their on-campus network infrastructure. Indeed, many of these campuses were already committed to multi-year,

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<sup>6</sup> As one example, see *Higher Education and the NII: From Vision to Reality*, Monterey Conference Proceedings, September 1995, Louise Arnheim, ed. (Educom, 1996).

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multi-million dollar investments for complete overhauls of their networks, including fiber distributions, integrated voice-video-data strategies, new inter-building pathways, in-building distribution facilities, and advanced switching and routing technologies.

Since 1996, much positive development of the advanced infrastructure has occurred, and numerous collaborative projects have been undertaken. However, the question of what qualifies a campus for membership in Internet2 or what motivates a campus to participate in Internet2 has not been reexamined. This is precisely what the CETF was asked to consider. The time is right for this reexamination, given the rise of national aspirations for advancements in science, medicine, and the arts, as outlined earlier. It is also timely given the development of new optical technologies, higher-education-owned fiber, and the related potential for developing and delivering new services to the global research and education community.

The CETF has spent a considerable number of hours revisiting the effort in which the member campuses have been engaged and has consulted broadly with the membership and its constituent groups. Based on that work, this report offers recommendations for a set of commitments that member campuses would reasonably be expected to make in order to further their own and the community's research and education interests as members of Internet2.

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## A Model for Expectations and Commitments

The charge to the CETF directed us to “articulate a current set of expectations for what it means to be an Internet2 member campus, in light of the Internet2 community’s goal to promote and enable advanced applications.” The CETF came to believe, however, that it may be more appropriate to think in terms of the community’s goal being one of supporting research and education through the advancement of networking and cyberinfrastructure. In turn, an important measure of the community’s success would be its efforts in promoting and enabling advanced applications that operate in such an environment. Accordingly, the CETF carefully considered the notions of community, membership, organization, organizational goals, organizational purposes, expectations (both member and organizational), and commitments. A framework for the CETF recommendations is subsequently based on the ideas listed here:

- A community (in this case, the higher education community, perhaps especially the research universities) forms around a set of common interests (in this case, a desire to advance mutual research and education goals enabled through access to a shared infrastructure).
- To work most effectively toward achievement of the goals, the community forms an organization (in this case, Internet2) to provide the community and its members with assistance in working toward the goals; assistance may include acquisition and operation of infrastructure, support for community projects, and the convening or hosting of member meetings and other events.
- Expectations which members may have for the organization itself, rather than for each other, are based on how the community wants the organization to serve its interests.
- As it forms, the community will articulate its common interests, create a set of shared objectives for the organization that supports it, and describe the expectations that the community has for any one of its members. These latter expectations form a basis for qualification of prospective members.
- Members of the community make commitments to each other to work toward achievement of the goals, and individual members of the community, accordingly, have expectations for each other relative to these commitments.

For the CETF, it is this last pair of bullets, of course, on which attention was focused.

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## Recommendations

The CETF recommends that to be accepted as an Internet2 member, a campus must make three commitments:

- I. To **innovation** in the methods, tools, and collaborative approaches required for the advancement of research and education,
- II. To the **shared infrastructure** required to enable this innovation, and
- III. To the **community contributions** required to sustain the future and availability of this infrastructure.

In an ideal world, a university president asked on the spur of the moment to explain why his or her institution is a member of Internet2 would say, “If we are to advance our competitive position as a research university, we must find new and innovative ways to advance the opportunities, productivity, and output associated with our research and educational activities. To do this, we must exploit the technologies and methodologies that are represented by the national and international cyberinfrastructure and the collaborative environment that it supports. Moreover, we must be committed to further evolution of this very cyberinfrastructure. Internet2 is one of the organizations through which we are meeting these challenges.”

Note again, that these three commitments are to be viewed as accepted obligations to each other member of the community. In turn, these three areas of commitment provide a basis for the expectations that one campus may reasonably have of another. Moreover, with each member campus committed to these three goals, the purpose of the Internet2 organization becomes one of assisting the membership in any and all ways required to meet these shared commitments, elaboration on each of which follows.

### I. Commitment to Innovation

*“Internet2 is a consortium being led by 207 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow’s Internet. Internet2 is recreating the partnership among academia, industry and government that fostered today’s Internet in its infancy. The primary goals of Internet2 are to:*

- *Create a leading edge network capability for the national research community*
- *Enable revolutionary Internet applications*
- *Ensure the rapid transfer of new network services and applications to the broader Internet community.”*<sup>7</sup>

These goals express the essence of innovation in the broadest sense, which the NSF defines as “the transformation of knowledge into the products, processes, systems, and services that

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<sup>7</sup> At <http://www.internet2.edu/about/> on 3/15/06

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fuel economic development, create wealth, and generate improvements in the national standard of living.”<sup>8</sup>

The commitment to innovation that each institution affirms on becoming a member of Internet2 embraces these goals in the context of its campus environment and its interactions with the broader research enterprise.

The commitment to innovation constitutes, first, a promise to *stimulate* the transformation of the knowledge created by the research and education enterprise into useful outcomes. Successful transformation often entails revolutionizing what individuals, communities, and institutions do, how they do it, who participates in the development, and who has access to the results.

The commitment also entails the promise to *catalyze and extend* the uses of new methods, tools, and collaborative approaches for sustaining the advancement of research, education, and service. This promise operates across the full range of disciplinary and interdisciplinary interests of the research enterprise. At one end of the spectrum this promise enlists those with specific interests in the underlying infrastructure itself: the transport protocols, the algorithms, the devices, and the software that make the infrastructure work. At another point in the spectrum, it includes the arts, humanities, and other disciplines for which advanced networking technologies expand horizons. For everyone engaged in the research enterprise, it provides “remote presence” mechanisms that can broaden participation, overcoming barriers of geography, organization, and discipline.

Making the commitment to innovation acknowledges that, institutionally and as a consortium, we are embarked on a journey of discovery, in which none of us yet knows all the questions, let alone the answers. The commitment to innovation includes a promise to *engage* all the interested parties on campus and in the consortium in setting and adjusting the course for this journey, as we learn together.

The execution of this commitment to innovation in all its dimensions naturally will vary across campuses and over time at any particular campus. There is no particular litmus test that can be applied to measure the strength of it. Indeed, an inherent characteristic of innovation itself is ebb and flow, experimentation and consolidation, paradigm making and breaking. At any point in time, an Internet2 member ought to be able to summarize the networking traffic, member participation, and other activities that represent its complete Internet2 portfolio. One should be able to examine the extent to which these things reflect the transformation of knowledge, extension of new methods, and engagement of the campus community with the broader community. While it is doubtful that each and every email or Web page can be held up as a significant innovation, we think it highly likely that institutions will discover and be able to document the significant role Internet2-based networking activities play in their research and education advances, on-going commitments, and goals.

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<sup>8</sup> “Partnerships for Innovation (PFI) FY 2006 Program Solicitation, NSF 06-550 at <http://www.nsf.gov/pubs/2006/nsf06550/nsf06550.htm> on 3/15/06

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## II. Commitment to Shared Infrastructure

A commitment to a shared infrastructure can mean a lot of different things depending on different viewpoints. From a technical viewpoint this involves a myriad of details associated with traditional “layer 1”, “layer 2”, and “layer 3” connections. From a network services viewpoint this starts with general issues such as performance, authentication, and security, and then extends into more specific issues related to middleware, federated authentication, and numerous other capabilities. From an organizational viewpoint each of the previous two sets of issues must be considered at and across different scales, from local to regional to national. Because the focus here is on institutional commitment, the most appropriate way to approach commitment is in terms of how technical and service issues are played out across the organizational layers. Because our primary interest is with Internet2 as a national organization, we’ll work top down through the layers.

National Layer. This is the obvious long haul networking connectivity made possible by Internet2’s national physical network footprint. Major forms of institutional commitment are obvious -- by paying its membership dues and signing on with a “connector” an institution helps support the national network infrastructure and is allowed to move its traffic across that infrastructure. Less obvious, but of ever increasing importance, are the numerous ways a member needs to commit to manage its network activities and traffic, and support its users (particularly high end users) to assure that the institution’s activity meshes well with national and regional activities and policies.

Regional Layer. In the early days of Internet2 this was envisioned as a relatively simple connection relationship between an institution and a “Gigapop” which provided the actual connectivity to the national infrastructure. In some cases it may still be this simple, but in many cases Gigapops have grown or evolved or been replaced by full blown regional networks, which for convenience we lump together under the term of a regional optical network (RON). The norm now is for an Internet2 member to be a member of or in the process of forming at least one RON, connected to Internet2 through or as a part of a RON, and being asked to make similar types of commitments to the RON as to the national network consortium. In some cases the mission of the RON may be somewhat disjoint from that of Internet2 – e.g., moving “state” business and education traffic around the state *vs.* moving national research and education traffic around the nation. However, in other cases the RON has simply filled part of the role formerly played by the national infrastructure, e.g., moving traffic between two Internet2 members which happen to be members of the same RON.

Local Layer. The local layer is no doubt the easiest to gloss over and the hardest to address effectively. Overnight it seems that the situation has changed from one in which an institution’s external links were so slow and so expensive that local issues were relatively unimportant, to just the reverse. The costs and burdens that come from supporting a high speed link to a Gigapop or RON now pale before the costs of maintaining networks of comparable speed across multiple buildings, not to mention maintaining relationships with dozens to hundreds to thousands of disparate users. It is easy for an institution to make broad commitments to support high speed networking, but it is much more difficult for an

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institution to keep up with the technology required to provide appropriate levels of service for all its buildings, work groups, and users.

Peter Freeman and Guy Almes present a very good characterization of the organizational commitments required to support an ambitious shared (cyber)infrastructure.<sup>9</sup> Their characterization avoids getting hung up in the technical details, and as a result can be effectively applied from local to regional to national layers, paraphrased here to be applied across these levels.

- At each level and between levels, there must be an *effective physical plant*, suitable to support both quantity and quality of network flow.
- At each level and between levels, there must be *effective communication, cooperation, and collaboration* between infrastructure managers and users who would stress the infrastructure by demanding high quantity and/or quality performance.
- At each level and between levels, those who manage the infrastructure must commit to maintain an *on-going program of quality assessment and quality control, tested by its application to high-stress applications*.

In order to meet its Internet2 commitment to shared infrastructure, a member must recognize and address the complex technical, service, and organizational details in each of these elements. Like any type of interface between layers, each has two sides. An individual institution (or unit within the institution) is responsible for one side, while the collective national, regional, or local organization is responsible for the other. At any point in time, an Internet2 member ought to be able to identify the interface points and evaluate in at least general terms the nature of the physical plant, collaboration, and quality control interactions across that interface. Not every Internet2 member will interface with the national infrastructure using the latest and greatest network technology, but presumably all will be connected somehow and most will be able to pinpoint areas of collaboration and application sharing. A significant measure of success here is the extent to which organizational levels are transparent. For example, if two investigators can collaborate equally well no matter whether they are on different parts of the same campus, different campuses in the region, or from different parts of the nation, the member or member institutions have clearly met their commitment to shared infrastructure.

### **III. Commitment to Community**

It is obvious, but worth stating, that the sole purpose of a network is to facilitate community activity. Communities of work practice, including research and project teams, classes, study groups, committees and departments, may form within an institution or across organizational and geographical boundaries. The work products of the teams and groups, even when they work face to face, are augmented by the network and related technology. When teams collaborate virtually, the network is a required component of the collaboration infrastructure. Whether it's a researcher utilizing a high performance computing environment 1000 miles away, a multi-institutional research team sharing data and co-authoring papers, remote virtual instrumentation labs for classes, or a field research

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<sup>9</sup> P.Freeman, G.Alnes, "Campus Cyberinfrastructure: A Critical Enabler for Science". Educause Review, January/February 2005, pp. 64-65.

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team accessing technology and information resources on their home campus, a complex structure of networks, middleware and recognized identifiers must be in place for these scholars to successfully complete their work.

In an increasingly technology-rich, interoperable academy, the IT organization can no longer assume that a scholar's use of Internet2 will be limited to a grid-to-grid or server-to-server structure. In addition to connectivity to high performance computing, scholars will want access to remote instrumentation, virtual collaboration technology, grants/policy management information, and scholarly data and publications, all offered reliably and seamlessly.

Inherent to the assumption that scholars work across organizational boundaries is that the necessary network and middleware infrastructure is available at all institutions participating in collaborative research and work. Hence, universities must make a commitment to maintaining their network and related infrastructure to a level that allows successful collaboration. The usefulness of the Internet2 community to an individual scholar or institution relies on the quality of shared services provided by the members, allowing their faculty, staff and students, to conduct their scholarship and complete the business of the institution.

There are three key aspects to the commitment, provisioning enabling network and related infrastructure, timeliness, and participation in the community.

As sophisticated use of technology becomes more commonplace across the institutions, members will increasingly need access to stable and high bandwidth, middleware, the ability to support virtual organizations, and security protocols. A single research project may require not only grid access, but collaboration space, scholarly information resources, and administrative access. The support commitment here must range across vertical layers, more in the manner the term is traditionally used in networking, from the nuts and bolts of network infrastructure to more abstract layers involving things like virtual organizations and on-line communities. The notion of reciprocity that cuts across all layers is what might be called the Golden Rule of Networking "Do unto others and the network as a whole as you would have them and it do unto you" -- this can easily be applied at levels ranging from network traffic management to middleware to virtual organizations.

Many of the participating institutions have computing and data resources specifically targeted to research needs, including clusters across a range of sizes, desktop computing pools (e.g., Condor), storage systems, data warehouses and so on. It is anticipated that interest in providing access to these resources, via Grid computing technologies, will grow in the coming years, leading to aggregations at the campus, local, state, regional and national levels. The capacity to scale is critically important to effective participation in Internet2.

Technology continues to change and evolve, and any given area of innovation will find a few institutions "out in front" with developing and piloting new technology. As technologies mature, their usefulness is related the tipping point of adoption by institutions,

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allowing collaborators to invoke the technology end-to-end in their work. The more commonplace and accepted the technology, the more useful it is to collaborators. Examples of this in the past include the network itself, and protocols like HTML and SMTP. As this document is being developed, security protocols and infrastructure like Shibboleth and Liberty are beginning to tip into widespread use, and future technology development will undoubtedly follow the same pattern. The commitment for universities and organizations is, then, to adopt technology as it matures from development into useful functionality. By committing to a timely adoption of new technology and new standards, Internet2 institutions allow successful collaboration to happen seamlessly.

As sophisticated use of the network becomes commonplace, generic commitments of this type are willingness to encourage institutional staff to participate in technical groups and annual meetings, and institutional willingness to try to build and utilize infrastructure and services within the Internet2 context if/when it makes sense. What is more difficult to express is the very institution specific, yet very important role of engaging its students, faculty, and staff on networking issues as an institution committed to Internet2 and its goals, rather than merely as an institution connected to Internet2. From this subtle distinction flow very different interpretations and perceptions, e.g., membership dues as investments vs. externally imposed costs, network policies as the parameters of good citizenship vs. externally imposed rules, etc. Clearly it is helpful here if the campus contact with Internet2 consists of more than just the CIO and network staff – support and commitment at this level is essential, but it only scratches the surface of the full cyberinfrastructure and global community vision.

In summary, a member's commitment to community will be both an outgrowth of and major driver for commitments to innovation and shared infrastructure. At any point, a member should be able to identify steps it has already taken, particularly in upgrading infrastructure, in order to enhance its community efforts. Similarly it should be able to identify work planned or in progress to further enhance the infrastructure to promote innovation for particular communities. Further, taking the time to actually do this assessment can be very productive. Rather than justifying network upgrades on a simple IT basis—existing facilities were getting old, and newer, better facilities were available—it would be very helpful to the institution to understand the ways in which evolution of infrastructure are linked to fostering innovation and expanding and evolving a broader sense of community.

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## Evaluating Commitments

Interpretations vary on how the set of expectations-as-commitments should be applied to Internet2 members/membership. At one end of the spectrum is the view that expectations should be merely advisory guidelines. This is based on the rationale that Internet2 as an organization should be as inclusive as possible, helping institutions to identify paths to high quality network capabilities but leaving as much flexibility as possible for institutional variation. At the other end of the spectrum is the view that expectations should lead to external assessment of an institution's suitability for membership. The rationale here is that service and support levels are often determined by lowest common denominator – to ensure a relatively high quality of service and support an organization has to set and maintain the lowest common denominator at an appropriately high level. The CETF has sympathy with the rationale at both ends of the spectrum, but recommends an approach more in tune with the former than the latter.

- (1) Membership fees and requirements for some type of connection are important and should be continued. But beyond this the appropriate approach is to provide guidelines rather than strict requirements. Membership should be largely self-selecting.
- (2) To assure that services and support are not limited to lowest common denominator, Internet2 should not be discouraged from developing services of interest to members that require levels of commitment, including possible financial commitment, above those of basic membership, even though this means that some services might not be accessible to all members.
- (3) Internet2, through the mechanism described above (or something comparable), should actively develop, evolve, and publicize guidelines and examples showing how the commitments can be met and/or leveraged to enhance an institution's overall support for and utilization of technology.
- (4) Members should be strongly encouraged to utilize guidelines from #3 to do their own self-study, but Internet2 should resist the temptation to move beyond this into more formal review or evaluation. In keeping with the principle in #1, Internet2's efforts should be focused on helping each member understand and assess its own commitments, not on making an official Internet2 judgment about whether the appropriate commitments have been made.

This approach is meant to suggest a framework analogous to high level guidelines and self study that form the core of the typical academic program review, but stopping short of any external judgment. The process of periodic self study should be familiar, and thus there is some hope that members will actually do periodic self-studies. But to repeat: the CETF recommends against pushing further into more official external review and evaluation. The CETF notes that an institution may decide to do a more formal review which may include review of Internet2 commitments. Providing a framework for such a review, done based on the institution's needs and in the institution's context, can be a positive benefit provided by Internet2 to a member. However, the CETF feels strongly that moving beyond this into more focused evaluation activities would be counterproductive.

# Report of the Internet2 Campus Expectations Task Force

## Translating Commitments into Practice

The CETF recognizes the need to translate the high level descriptions of commitment into concrete terms, which raises three important questions: how do we do this, how often is this done, and who does what to make it happen? To start with the first question, note that the original Internet2 expectation regarding resource commitment was translated into practical terms through the simple statement “a member will commit at least \$500K/year to networking”. Unfortunately it is not easy to translate more diverse, high level commitments related to innovation, shared infrastructure, and community into comparable one-liners. As an alternative the CETF recommends that linkage between commitment and practice be established through a set of published reports on best practices, case studies, lessons learned, and other such material, in which member institutions describe what they are doing or have done to meet their commitments. Assuming this as a starting point, we clearly want these updated as frequently as possible so they evolve as time, technology, and organizations change. This whole approach hinges on finding a manageable, effective way to evolve the best practices on an on-going basis. Having Internet2 staff dictate best practice to the members is not appropriate. Internet2 clearly must play a role, but that role should be in facilitating a process through which best practices flow naturally from the members.

The CETF has identified a mechanism which it feels is appropriate to this purpose. Internet2 currently hosts two member meetings per year. Presentations are screened with some notion of topic balance, and a substantial part of the program is typically devoted to members presenting case studies, examples, and lessons learned that relate to the areas of commitment. We think it would be an easy and natural evolution to explicitly include “Meeting Member Commitments” as a regular theme included in the technical program. Currently, there is an active effort to solicit feedback from attendees on their reactions to the presentations, and presentation materials are collected from presenters for dissemination to the audience. We think this could be pushed farther to use feedback to identify best of show presentations, and follow up with authors to develop more polished versions that could be published as the best practices. This mechanism is routinely used by other conferences, and assuming that reasonable editorial and peer review standards are followed, can produce an on-going body of decent material in focused areas, as well as incentives for authors to participate. The CETF feels that this can be a primary, sustainable means through which the practical aspects of member commitments can be effectively developed and evolve over time.

To summarize, the CETF recommends that Internet2 utilize the technical portion of its member meetings to foster the on-going development of quality, peer reviewed material that addresses questions of how an institution, group, or individual did, can, might, or should address the commitments outlined earlier. We emphasize that the goal here is to produce quality material of a practical nature specifically related to member commitments. To draw an analogy with traditional print journals related to software development, the goal here is to produce contents more along the lines of the practical material found in *Software: Practice and Experience* and *IEEE Software* rather than the more basic research results found in *ACM Transactions on Programming Languages and Systems* and *IEEE Transactions on Software Engineering*. The goal is not to discourage the inclusion of technical material in member meeting programs –

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rather to make sure that a channel dedicated to material specific to Internet2 member commitments is included.

## Appendix—Campus Expectations Task Force Roster

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## Appendix—Charge to Internet2 Campus Expectations Task Force

The Internet2 Campus Expectations Task Force is convened under the auspices of the Advisory Councils of Internet2, led by the Applications Strategy Council and the Network Planning and Policy Advisory Council. Its principal purpose is to articulate a current set of expectations for what it means to be an Internet2 member campus, in light of the Internet2 community's goal to promote and enable advanced applications. When Internet2 was formed, the expectation for University members was investment in local infrastructure at the level of at least .5 million annually. The work undertaken by the Internet2 community in the subsequent 8 years – in infrastructure development, advanced network services, core middleware, end-to-end performance, security, common collaboration tools, and more – has produced a much richer set of capabilities for support of research, teaching and learning.

At the same time, it is apparent that many faculty and researchers still experience significant barriers in creating and using advanced applications. The barriers include incomplete extension of high-speed switched networks to the desktop/office/lab; lack of ubiquitous help identifying and solving performance problems; lack of well-integrated and easy-to-use tools for human collaboration; lack of secure, authenticated access to data and resources; and incomplete implementation of multicast and IPv6 on campus networks. Most of these issues have little to do with network capacity or throughput.

The Task Force should consider focusing on what the campus infrastructure needs to be 2-5 years out in order to support the advanced applications on the horizon. The group will identify a set of best practices in a variety of areas that taken together can serve as a profile of the ideal Internet2 member campus. The areas considered should include campus network configurations, campus directory implementations, privilege management, data storage, image transfer/management, computation, security, campus bandwidth management, collaboration environments, and others. The Task Force should also consider the responsibilities that come with supporting sponsored participants and SEGPs. These best practices will be promulgated among Internet2 members and can be used by each campus to measure its progress in lowering the barriers to creation and use of advanced applications. A series of case studies that illustrate the best practices of campuses in resolving these issues will also be created. Ideally, these case studies will show how increased capabilities have paid off in attracting research dollars, top faculty, and other competitive indicators. The Task Force should work to produce guidelines rather than prescriptive responsibilities, recognizing that not all campuses have the same resources or the same needs. The Task Force should collaborate wherever possible with other similar groups, e.g., the Internet2/EDUCAUSE Security Task Force.

The Task Force will be responsible for:

- Developing a concise, well-defined list of advanced technology areas and applications that campuses should manage and support including, where possible, a forecast of where each area is heading and what to track over time
- Compiling information on where best practices have been developed for campus implementations in these areas
- Consulting broadly with different constituencies to draw on a range of knowledge and expertise
- Sponsoring the creation of a series of case studies that illustrate how a variety of campuses have addressed these areas
- Recommending information and educational programs to support the promulgation of Task Force outcomes

The Task Force members will be jointly appointed by the chairs of the ASC and NPPAC from recommendations. The members should broadly represent and/or seek input from a broad range of constituency groups, including but not limited to CIOs, application developers, GigaPoP operators, network engineers, support staff, faculty, researchers and other users. The Task Force will be supported by Internet2 staff. The Task Force will be identified and convened during the Spring of 2005. It will gather input and be prepared to report preliminary recommendations by the Fall 2005 Member Meeting and complete its work by the Spring 2006 Member Meeting.