Internet2 Network Services
Community, Service and Business Overview

Executive Summary:

For universities and colleges to succeed in the broader transformation of higher education, successful collaboration and cooperation of campus, state, regional, national and global organizations are required to deploy and support new and better networks and network-based services to our collective membership. The Internet2 Network Services business unit is positioned to ensure the success of our members by moving into a new era of national and global networking.

The US Department of Commerce Broadband Technology Opportunities Program (BTOP) funding has allowed Internet2 to refresh its entire network to the most advanced standards, offering over 20 times more capacity than the previous national research and education (R&E) networks combined. The Internet2 Network has been designed from the ground up to support an uplift of basic services from 10G to 100G+ standards and the ability to implement Software Defined Networking (SDN) capabilities that provide new dimensions of opportunity for members. This is especially significant in the recognized absence of a national data networking strategy and the understandable hesitation of commercial enterprises to meet specialized networking needs at times when sufficient or timely return on investment is not clearly demonstrated. Enabling experimental capabilities while simultaneously providing trusted research and education production solutions is a hallmark of our community and a core reason for our existence.

While the BTOP funding provided our community with an infrastructure capable of advancing new dimensions of solutions and discovery, we must also ensure the network is financially sustainable. The network funding is stable and growing, but still remains short of the goal for accumulated savings for future network replacement. Internet2 has a business development goal to acquire additional “national partners” from outside the traditional academic community to share the cost of the network with the community and to build revenue for network replacement. These target partners likely include government agencies and research arms of major American industries. The current agreement with the Department of Energy’s (DOE) ESNet is an example of this effort.

The new Internet2 Network transitions the Internet2 community from a leased network to a network of over 15,000 miles of 30-year IRU fiber. This repositioning fixes many of the operating costs regardless of utilized capacity and positions for growth in usage at substantially smaller incremental cost. That change creates a new opportunity to develop a network fee model that evolves to separate the ongoing base costs of network operations from the incremental costs to access services on the network.
We have the opportunity to address many of our community’s goals with this new network, including:

- ensuring the US R&E community has the most advanced services;
- aiding the US R&E community to move aggressively “to get out in front” of innovative technologies;
- providing the most advanced network architecture supported with fair commensurate fees based on a transparent and well-managed cost structure; and;
- enabling advanced services for community adoption.

Internet2 community leaders, including campus CIOs and regional leaders, believe now is the time to implement changes to the current network fee model, which is over 15 years old. The current model was developed to support a previous infrastructure and fails to take full advantage of new services and features of the new, advanced network.

Through the Network Architecture, Operations and Policy Program Advisory Group’s (NAOPpag) Fee Subcommittee, Internet2 staff and community leaders are meeting with leaders of campus and regional organizations together to assess options to evolve the Internet2 network fee model for the academic community. The goal is to make the new network more accessible and encourage adoption of its most advanced services by both regional and campus organizations.

In parallel, Internet2 leadership is also developing opportunities with aligned but new potential national partners to build additional revenue that will further reduce the shared costs of the new network borne by the academic community.

The Internet2 community has benefitted greatly by the one-time investment the federal government has made in the expansion of broadband capacity in the United States through the BTOP program. The Internet2 Network and many of its member regional networks have been able to deploy networks in which we own the underlying fiber infrastructure. As has been proven over the past ten years by our community, when we own the fiber asset with fixed costs covered, we are then able to offer expanded services at lower marginal costs.

We are presented now with the best opportunity in over 15 years to reinvent the future of Research & Education networking and computing for our community. We are at a time when we need advanced networks to help solve the great challenges of “big science”, deliver transformational education models, and provide better-yielding solutions that bring greater efficiencies to the business of education.
This is one of those seminal moments in our community when we need to decide, collectively and decisively, to let go of models of the past and take on the investments and risks that are required to move our community forward, together.

**Working Towards a new Business Model:**

Any evolution of the Internet2 Network business model must first embrace community goals for the new network, must move the community towards adoption of the most advanced network capabilities, and must help to evolve healthy state, regional and national collaborations. It is important to note that this effort is not intended to garner additional revenue for Internet2 from the academic community; we endeavor to find ways to take advantage of the economics of an owned-fiber network.

**Community Objectives**

The Internet2 Community is looking to Internet2 Network Services to:

- create new services and capabilities to support the massive growth of data intensive science within existing budgets;
- provide new services that once again differentiate network capabilities for research, education and service from ever improving commodity services;
- position U.S. research institutions to have robust, predictable and scalable capabilities internationally as their programs globalize;
- establish new network technology leadership to spark long term innovations and opportunities for science and innovation; and
- position a unique new service-oriented network infrastructure to support a portfolio of dynamic, integrated and tailored commercial and community solutions Internet2 members can use to transform the way education is delivered and how scientific research and university business is done.

Internet2's objectives in support of these community demands must use the nearly completed BTOP infrastructure to reposition service offerings and meet these demands as aggressively as possible. We must do this within the academic community’s current financial envelope and in a way that increases opportunities without disrupting existing partnerships.

In several community forums, Internet2 has heard from both CIOs and regional network leaders that the new services must be offered “at fees no higher than is rationally necessary.” We have also heard that “the business model shouldn’t be driving the network architecture.” In conversations with the NAOPpag Fee Subcommittee, led by Dave Gift, we have come to an understanding that these
drivers indicate that we must find a new balance between Internet2 fees, services and regional models to assure services are robust, advanced, cost effective and well-integrated across Internet2, global and regional/state networks.

To this end, Internet2 Network Services staff has been meeting jointly with regional network leadership and CIOs. The goal of these meetings is to share these potential business models and determine the effects any changes might have on the Internet2 member universities, the regional networks and the constituents we collectively serve. There are myriad business models among the regional networks and it seems likely that a change to the Internet2 fee model will adversely affect some of these entities. Therefore, we are talking with community leaders about a multi-year transition plan that will allow all members to adjust to any fee changes that are chosen to be implemented on their own timeframe, while at the same time laying out a path that will move our community forward in fully utilizing the great capabilities of our new infrastructure.

The Fee Subcommittee has begun an investigation of several potential fee models and how the community could transition to them in coming years. The committee has set goals to look at the models through lenses that show their overall benefits to the community, how they may affect dozens of different regional network business models, and how new fee models promote desired behaviors, architecture, and advanced service adoption.

**Service Offering Objectives**

To support the community objectives, Internet2 must begin to reposition its overall network service portfolio from a monolithic service offering based on the 15-year old Advanced IP (Layer 3) centric offering to a full portfolio that includes wave services (10G, 40G and 100G), Advanced Layer 2 services, and potentially differentiated Advanced IP and commodity IP peering services. These services must be increasingly offered so they are extended seamlessly both within U.S. regional and state networks and globally. The fees need to be set in a way that maintains the revenue needed to fund the programs and meets the community objectives of being reasonable fees that do not encourage sub-optimal architecture decisions.

For each of the Advanced Layer 1, Layer 2 and Layer 3 offerings, service value must include the ability to offer scalable, open, advanced and programmable capabilities.

**Layer 1 – Circuits, waves, dark channels and virtual dark fiber**

Advanced Layer 1 Services are dedicated high capacity 10, 40 and 100 gigabit or dedicated optical spectrum paths between distinct endpoints on the national optical network infrastructure. Layer 1 services are typically of interest to dedicated long-term science projects, overlay networks and national partners with specific performance or security requirements. Both ESnet and NOAA have made use of the
Internet2 Layer 1 resources to build their own networks using the Internet2 infrastructure.

Layer 2 – Ethernet Virtual Local Area Network (VLAN) Services

Internet2 has introduced new Advanced Layer 2 Services to allow virtual communities to stand-up virtual networks at national and global scale as easily as a campus administrator currently establishes a VLAN on the campus network. The new Layer 2 Service offering will be based on the Open Science, Scholarship and Services (OESS) software suite. The underlying platform will also have the ability to instantiate OpenFlow-based software defined networking capabilities. If researchers need resources at other institutions, they are able to create virtual organizations and move their data to the computing resources. It is easily accomplished by building VLANs from their institution to the institution with the computing resources.

Layer 3 – Advanced IP and Commercial Peering

Internet2 continues to support the R&E IP routes as well as commercial peering. These services create universal reachability for Internet2’s members using advanced capabilities and will remain the most ubiquitous service within the community. The Advanced Layer 3 Services must continue to be supported as a reliable, production quality services that remains more advanced and better positioned than any other Layer 3 service available. The Advanced Layer 3 infrastructure is carrier-class built and supports leading-edge IPv4, IPv6, multicast and other advanced networking protocols. The Transit Rail-Commercial Peering Service (TR-CPS) offers more than 66,000 routes through peering partnerships with commercial networks. Internet2 connectors use Advanced Layer 3 Services to connect member institutions to the Internet2 Network.

For each of the primary services, the fees assessed allow Internet2 to offer more advanced services than anything available from generic providers, while also keeping the fees competitive with what commercial providers charge to the mass market. For Layer 3, this means a continued focus on capacity to support massive data sets, IPv6, and large packet support. For Layer 2, it means software-defined networking support, and simple and rapid inter-domain provisioning from the campus through regionals to global partners. For Layer 1, it means access to 100G and higher wavelengths, access to raw spectrum blocks, and operational virtualization. For all of the services, operational transparency, service/support excellence and the ability to easily integrate Internet2 services with other regional and global partners is essential.
Business Objectives for the Academic Community

Internet2’s business objectives are to substantially update and expand the capacity and capability of the Internet2 services offered to and used by the US academic community by enabling the current funding envelope provided by the combination of Internet2 Network Participation, SEGP and connector fees.

Today, most of Internet2’s direct network fees within the academic community are collected through a small number of Layer 3 connector fees. These fees come from about 20 sources, although those fees represent well more than 100 individual ports and services. In the next iteration of the fee model, community members have advocated for less aggregation of fees into the Layer 3 connection fees and better match of fees with individual service offerings. This means finding ways to continue to support the best Advanced Layer 3 services, making it more accessible and introducing unbundled Layer 2 and Layer 1 capabilities.

We anticipate within the next five years, dozens of new individual use cases, working with a regional or national project, will want to subscribe to a mix of Layer 1, 2 and 3 services across the global network. As these use cases develop, the users of the services will want to see a fee model that will allow them to see how their payment of fees directly relates to the services that they are using. Therefore, the goal for new fees needs to be to both allow access to new services at the lowest possible fee, and also provide services in a way that is transparent to users and that assures stability in supporting the national resource as a whole.

Business Objectives for New National Partners

Internet2 sees an opportunity to increase the value of the network capabilities to the academic community and to bring additional funding to the shared costs of operating the network by providing unused capacity on the network to aligned research and government organizations. Replicating the successful ESnet and NOAA partnerships would allow other government agencies to find benefit and efficiencies through closer collaboration with the R&E community.

Internet2’s business plan includes developing new long-term partners that might take portions of the network’s capabilities to support their own research or service programs. Internet2’s objective is to bring several small and one or two large partners on to the Layer 1 and Layer 2 networks each budget cycle to continue to grow support for continuous renewal and replacement of the network. A current target is to find $2-3 million per year in new net revenue from these partner sources to support ongoing network renewal and depreciation projects. Internet2 is investing in staffing to support this outreach and coordination effort to identify and contract with potential new national community partners.
The Internet2 NET+ service portfolio has the potential to require additional ports on the Layer 2 and Layer 3 network that will generate supporting revenue. Internet2 is working closely with the NET+ team to build a self-supporting and sustainable port fee structure to support NET+ service providers and to identify and track other partnership opportunities for NET+ collaboration.

Summary

Internet2 has begun working with several members of the research and education technology community to explore how we can alter the current business model to take better advantage of the greater capabilities our new network can deliver. We have gathered community objectives that inform us that we need a multi-layered network that will provide new services, support massive growth of data intensive science and support the introduction of transformative services such as those offered through the Internet2 NET+ program.

Our service offering objectives should take advantage of the capability this new network has to deliver services through the Advanced Layer 1, 2 and 3 Services. It is time to enable a new services model.

We are anticipating our academic community developing several use cases for this new network over the next five years. It is important that we develop both the technical capability and the financial models that will provide services in a way that is transparent to users, allows the lowest possible fee for use of discreet services while assuring stability in supporting the national resource as a whole.

This new network also has the capacity to allow us to partner with other like-minded organizations that might utilize portions of the network’s capabilities to support their own research or service programs. Plans to partner with organizations such as federal agencies, non-governmental organizations and others will allow the investment they make in the network to help augment the support of our financial commitments.

As a community we need to create a virtual enterprise for higher education for the 21st century; it will likely need as much investment in this century as higher education has invested in brick and mortar buildings in the past century. Our new network has put the Internet2 community in a unique position to be the platform upon which this virtual enterprise is built. Whatever shape the virtual enterprise takes, it will depend on networks to reach the billions of people that are going to make up the community of learners and leaders in the future. Universities need to be investing in a platform that will allow the institutions to survive in this new century and the changes that are facing us. Now is the time for us to put old technical and financial models aside, and use this great opportunity to work together purposefully to develop the networking future that best serves the needs of research and education.
Addendum 1: Current & Future Revenue Sources

Internet2’s current Network Revenue comes from four primary categories. They include:

Participation – Fee paid by University members to utilize the network (regardless of how they are connected to the network).

Connection – Fee paid by the organization that manages the physical Layer 3 connection to the national Internet2 Layer 3 network. In most cases, this is the regional or state network that is servicing the Internet2 member universities in a particular geographical area.

SEGP – Sponsored Educational Group Participant fees are paid by state entities (often the state network, but sometimes a university or state agency such as the state department of education). This fee allows any organization that is part of the group (e.g., all K-12 schools and community colleges in a state) to access Internet2 Layer 3 Services through the state or regional connector.

National Partners – Fees paid by major partners to Internet2 for Layer 1 wave services and NOC support services. Examples include ESnet, NOAA and a small number of other government contracts. Most of these contracts are structured as wholesale long-term capacity agreements.

![Current Fee Distribution](chart.png)
Future Revenue

Within the traditional Internet2 academic community, Internet2’s current revenue goal is to maintain existing revenue levels to support network operations. While there may be some organic growth due to uptake of new services, planning efforts for fees to the community primarily focus on rebalancing the fee structure to allow new network services to be adopted by interested members of the community.

Internet2 is planning for substantial growth in the “national partners” area, investing both in revenue-development staff and expecting growth in national partner projects to offset the increased operating expenses of the new network. Internet2 is targeting $2 million in new revenue per year for the next six years to help fund operations, replacement and sustainability of the new network.

Note 1: Expected expenses are held flat assuming efficiencies will offset expected annual increases.

Note 2: Revenues and expenses reflect “net” changes. Actual revenue and expenses are likely to be large.

Note 3: "Misc. Revenue" includes pass-through power, colocation and maintenance services, SIP, MANlan and other services and deferred revenue fees.
Addendum II – Current and Future Expense Profile

Internet2's accounting systems allow Internet2 to track expenses within the network cost centers in substantial detail. There are over 60 individual line items in the accounting system for each major program that range from salaries to postage to colocation to maintenance expenses. Typically major program areas are assigned individual cost centers in which each of these categories of expenses are tracked.

Such an accounting approach does not afford the ability to easily assign costs associated with individual network products to a cost center. While some operating programs (i.e., MAN LAN) stand on their own bottom, other services are more difficult to track in the accounting system because they draw resources across several distinct pools of expenses. For example, in order to offer a Layer 3 Network Port, Internet2 combines fractional resources from its Layer 1 network (waves), Layer 2 network (distribution), Network Operations Center (support), network and administrative staff. In just the Layer 1 system alone, there are over 3,000 elements, some of which support Layer 3 Services and many of which do not. Each carries maintenance and depreciation cost that could affect the cost basis of the Layer 3 network.

As a starting point for the new network, Internet2 worked diligently to assure that the Layer 1 optical network plus any additional new network expansion (including Layer 2/3 equipment) that was being built with BTOP funds could be operated within the existing $10 million/year that was being spent on the Level3 DWS leased network. Although this approach did not cover the depreciation load of the new assets, it did assure operational sustainability of the network itself within the existing funding window and allowed planning to recover the depreciation through growth of national partner programs.

As completion of the network approaches, Internet2 remains largely on track with the 2010 budget planning for the network itself, expecting now to come in slightly below anticipated BTOP operating expenses. However, there have been increases in NOC expenses, support for U.S. UCAN operations and organizational overhead assignments that negatively change the level of contribution to the depreciation from the original projections.

The following graphs show the expected cost projections for 2012 through 2020, with 2012 and 2013 based on actual budgets, and 2014-2020 representing a carry-forward of the 2013 budget with conservative adjustments for known expense changes.

There are potentially opportunities for expense control in the “network maintenance” category through restructuring of maintenance contracts and approaches in the coming years. Corresponding revenue increases would likely offset potential growth in colocation and power.