

# **2009 Internet2 Network Architectural Directions**

**Version 1.8**

## **Document Purpose**

To prepare for the next generation of the Internet2 Network, Internet2 staff in collaboration with the Indiana University GRNOC have prepared a set of architectural statements that seek to clarify the overall Internet2 Architectural direction. The contents of this document are meant to be broad in scope and are not indicative of a committed set of directions. Instead, they are intended to spur rapid community discussion on the Internet2 architectural vision. Many of the core principles below are taken directly from recommendations collected during a set of outreach calls in June of 2009.

## **Anticipated Outcome**

Internet2 seeks focused community discussion around each of the items below and recommendations for additional content.

## **Internet2 Architectural Statements**

### **“Multiples of 10GigE will be the primary transport to Regional and State Networks over the next 3-5 years”**

The economics of 40G and 100G technologies are not likely to force a disruptive change at the Regional and State levels in the next 3, and possibly, 5 years. Equipment vendors are positioning 40G and 100G technologies on their core routing platforms that are generally seen as cost-prohibitive at the Regional and State levels. Though there will be some level of need to support >10G flows on the Internet2 backbone via 40G and 100G interface speeds, Internet2 envisions the primary interface to the downstream Connectors will likely involve multiple 10GigE interfaces in support of many large flows that are less than 10Gbps in size.

### **“Internet2 Network access will be uncoupled from physical interface speeds and available for apportionment across the network”**

Internet2 Connectors will have the capability to provision their contracted bandwidth across one or multiple interfaces at varying speeds under their contracted bandwidth cap. This opens up the possibility of obtaining redundant network connections or specialized pass-through connections for individual Participants to obtain subsets of Internet2 services for special projects. The goal of this uncoupling is to allow more flexible physical interconnects and service deployment options to meet the needs of individual Connectors and Participants such as resilience and service profile,

while still being mindful of the overall bandwidth and financial realities.

**“100GigE at the optical layer is an important technology to adopt today”**

Internet2 seeks to invest in optical platforms that provide long-term growth toward 40G and 100G technologies. This will make Internet2 competitive in the high-speed transport space and lay the groundwork for flexibility in future growth opportunities of the combined IP and Layer2 infrastructure. The optical infrastructure needs to support full-rate 100Gbps service in a spectrally-efficient fashion. In addition, the optical system must have the capacity to support OTN capacities at OTU3 and OTU4 speeds.

**“Collapsing Layer2 and Layer3 services onto a single delivery platform is an important step toward the hybridization of the network”**

The Internet2 Network should migrate from its existing separate IP and circuit-based networks to a combined platform that can support both services over a single set of links to the Regional networks. This will enable reduced infrastructure costs and enhanced capabilities to obscure the national transport technology from the end-user. A researcher could, for example, introduce a high-bandwidth flow into the shared IP network at the Regional level that is eventually carried to its destination over a traffic-engineered private overlay on the Internet2 network. While the specifics of the technologies and service delivery characteristics need to be matched to Member needs, possible candidate technologies include MPLS L2 VPNs, Layer2 Ethernet VLANs and Virtual Private LAN Service (VPLS).

**“The Internet2 IP and Layer2 Networks need a migration path to 40G and 100G in the next 2-3 years”**

As the economies of scale continue to drive down 10GigE equipment pricing, and as 10GigE is pushed further into the campus toward the researcher, Internet2 needs to be prepared to handle the increased traffic demands on its combined Layer2 and IP network. As 40G and 100G transport becomes economically feasible for a small number of researchers, Internet2 must be prepared to handle individual network flows greater than 10Gbps. In addition, the Internet2 Network and individual Connectors need to be able to efficiently

deliver multiple large flows near 10Gbps. Strategies for accomplishing this over multiple 10G interconnects will need to be investigated and planned. The Internet2 IP infrastructure must contain a roadmap toward 40G and 100G backbone interconnects to satisfy those needs. At the same time the Internet2 Network also needs to be well-positioned to support parallel 10G interconnects where the service requirements aren't driving the need for 40G and 100G interconnects.

**“The Internet2 Network emphasis should be on additional services and technologies that will drive transport bandwidth requirements”**

The Internet2 Network needs to be about more than large pipes. The driver for network growth needs to be based on a strong sense of the services and capability requirements of the Regional and State networks. Backbone technologies will be driven by these enhanced services.

**“Internet2 will coordinate with the Regional and State Network partners to determine the most optimal node quantity and locations”**

In a continued focus on the 3-tiered model (National, Regional, Campus), Internet2 will work with the Regional and State networks to determine the most optimal network interconnect points to form a holistic architecture that meets the needs of researchers. This may result in an increase in Layer2/Layer3 network on-ramps to provide enhanced capabilities closer to the Connector. Combined with the ability to spread bandwidth across multiple links, this should offer additional opportunities for redundancy and optimal traffic engineering. Where possible, Internet2 will seek to collocate in carrier-grade vendor neutral facilities if they match the needs of the Internet2 Regional/State network.

**“The Internet2 Network must support network virtualization at a level that supports Regional and Statewide business models as well as network research priorities”**

Internet2 will engage network researchers, the Regional, and State networks to help build overlay networks on the Internet2 backbone that will support their needs. These may be as simple as MPLS overlay networks, or as complex as a logical router run on Internet2 Core Routers. The membership requirements of the virtual overlay

networks may vary depending on their use cases. As an example, two Regionals may wish to partner to provide disaster recovery functionality to non-Internet2 members. Combined with the ability to interconnect Regional assets at differing speeds, this could offer potential cost savings to Regional networks that had previously expected to run and support their own separate network. In support of network research and next generation testbed evolution, Internet2 will provide virtualization and measurement capabilities, which will be designed and implemented in close consultation with the representative community groups including NetSE and GPO.

**“As mission-critical applications become more integral to the Regional cost-recovery model, the Internet2 Network must focus on enhanced redundancy where needed.”**

As Internet2 Connectors continue to trend toward providing a suite of production networking services (commodity Internet, video conferencing, health-care transport, etc.), the Internet2 Network must continue to evolve toward effective national transport of those services. Regional networks must have topological and operational options available to support these services across the national footprint. The Internet2 Network will encourage diverse interconnects into the infrastructure at network layers that support the particular redundancy need.

**“The Internet2 Network will continue to be instrumented and operated in a transparent fashion that supports the end-to-end model”**

The operation of the Internet2 network must continue to be transparent and open to Regional operators and network researchers. This includes public operational statistics, programmatic access to measurement data via perfSONAR, and continued support of the Internet2 Network Observatory.