RFI: 100 Gbps Backbone Network

Introduction and General Requirements

Internet2 is interested in the feasibility of deploying and operating a 100 Gigabit backbone network to serve the needs of the Research and Education community. Internet2 is chiefly interested in technologies that provide native 50-100GHz ITU Wavelength capabilities presented on pre-standard or standard IEEE 100G interfaces. Client-side interfaces must support individual flow speeds greater than 10Gbps.

This RFI is intended to identify potential partners who will be capable of deploying 100Gbps optical transport and Ethernet switch/router capabilities at the leading edge of product availability. Internet2 seeks not only to analyze the current state of product roadmaps, but to also identify partners who can accelerate deployment of end to end optical and switch/router 100G Ethernet solutions during the 2010 calendar year.

Accordingly, Internet2 is seeking input from potential partners --- vendors and other interested parties who have, or have plans for, components that could be used in this project. The project might break into three or more areas:

1. A base infrastructure, which might be:
    - A managed wave service
    - A dark fiber proposal, potentially including a national pair of fiber and Internet2-owned/managed optical equipment
    - A "dim fiber" proposal, with a national pair of fiber lit by carrier-managed optical equipment on behalf of Internet2 with an option to buy the IRU and equipment at the end of the term
2. Optical equipment to light a nation-wide dark fiber deployment on fibers owned by Internet2
3. Routing ("layer 3") and/or packet switching ("layer 2") equipment needed to build a routed and/or switched backbone network based on the optical transport infrastructure.

Respondents may present information on any combination of these areas. For instance, a company may have information about fiber and optical equipment but not routing equipment. Or they may participate in only one of these areas. Respondents are encouraged to provide information even in those areas where they only have a partial solution.

Further, respondents should be aware that Internet2 would welcome suggestions about alternative approaches that do not necessarily fall within the general guidelines suggested above. Also respondents should feel free to suggest more than

one approach if they believe that they have alternatives that will allow Internet2 to meet its overall goal of 100 Gigabit transport.

Geographic Area

Internet2 is interested in providing a 100 Gigabit network with support for 10 Gigabit and 40 Gigabit waves between some subset of the following sites:

- Boston
- New York City
- Washington, DC
- Atlanta
- Nashville
- Houston
- Albuquerque
- Los Angeles
- Sunnyvale
- Seattle
- Boise
- Salt Lake City
- Denver
- Kansas City
- Chicago
- Cleveland
- El Paso

For example, please consider a sample network including Sunnyvale, Denver, Chicago, and New York, with route diversity between Chicago and New York. Proposals might include amplifier spacing /quantity proposals, node configurations, fiber regeneration points, ILA site and regen site costs, etc.

Internet2 Node Requirements

Internet2 nodes would be interconnected with a mixture of 100G, 40G and 10G circuits. Downstream networks will connect at 10G, 40G or 100G interface speeds. Internet2 will need enough space and power for Internet2-owned equipment at sites, as well as sufficient available space and power for expansion.

Responses

This RFI is not intended to be highly prescriptive. Internet2 welcomes innovative ideas and solutions including new technologies and products about which Internet2 may be unaware.

Responses should be kept brief, concise, and should not to exceed 10 pages - excluding supporting material (diagrams, sample contracts, marketing material, detailed descriptions of equipment or fiber). Responses must be submitted by e-mail and are restricted to e-mail text with Word, Excel, Power Point, and PDF attachments.

Responses must be sent to network-rfi@internet2.edu and must include "RESPONSE: RFI for 100 Gbps Backbone Network" in the subject line of the e-mail message.

Responses must be received by 5:00 p.m. ET, June 30, 2009.

Questions about this RFI may also be sent to network-rfi@internet2.edu.

Internet2 reserves the right to reject any and all responses, to negotiate all terms of any agreement resulting from this Request for Information, to request additional information from respondents, and to consider information from potential respondents that may be received outside of this RFI process.

Any information furnished to, or obtained by, any party or its representatives, in connection with this RFI, shall be treated as confidential information except (a) to the extent such information is or becomes otherwise public or generally available to the public other than as a result of a disclosure by a party not authorized to disclose such information, or (b) as required by law or required or requested by any governmental or quasi-governmental body with authority over either party hereto to impose such requirement or to make such request. For avoidance of doubt, this RFI shall not be considered confidential information.

The following sections describe in more detail information Internet2 would find useful in the project areas mentioned above.

Managed Wave Service

Internet2 is interested in responses that include a vendor managed 100 Gbps wavelength delivery service. The service offering should also support 10 Gbps and 40 Gbps wavelength delivery. Internet2 would not own or operate any equipment at the optical layer. The vendor would be responsible for all operations and maintenance of the optical equipment.

As part of the description of the managed wave service, Internet2 encourages you to provide information about any of the following:

- Budgetary pricing, including the non-recurring costs, a one year annual cost and a total cost over 5 years. Volume discounts for additional waves, or predictable decreases in cost through a 5 year term, should be described.
- Optical equipment vendor
- Client interface specifications, including plans for compliance with as-yet-incomplete IEEE 40G and 100G standards
- Addresses of points of presence in the cities where proposed service is to be provided
- The incremental cost of adding additional wave capacity on proposed segments
- Service-level guarantees
- Expected circuit reliability
- Availability of operational statistics (error rates, wave availability, etc.)
- Cost and availability of cross-connects, collocation space, and power for any Internet2-supplied routing or switching equipment
- Any other information deemed appropriate

Dark Fiber

Internet2 is interested in responses that include a 20 year dark fiber IRU on a national footprint (please refer to the list of cities given above), as well as facilities along that footprint to house Internet2-operated optical equipment.

As part of the response, Internet2 encourages you to provide information about any of the following:

- Addresses of the respondent's point(s) of presence in each city for which dark fiber is proposed. This should include optical amplification sites between the major cities.
- Cost and availability of cross-connects, collocation space, building entry fees, and power for any Internet2-supplied optical, routing, or switching equipment that would be needed at each point of presence or optical amplification site.
- Standard IRU and OAM contractual information
- For each fiber segment please provide:
    - Cost per mile per strand
    - Fiber type (e.g., SMF-28)
    - Typical distance between line amplifier sites
    - Number of strands available
    - Expected loss
    - Expected dispersion (chromatic and polarization mode)
    - Incremental cost of additional strands

    - On-going operations and maintenance costs of the fiber
    - Roll-pair and collocation swing-space options for mid-IRU upgrades.
- Any other relevant information

Dim Fiber

Internet2 is interested in responses that include a dedicated 100 Gbps optical delivery service that is carrier-operated on behalf of Internet2. The optical transport layer should also support 10 Gbps and 40 Gbps wavelength delivery on the same platform. Internet2 desires direct provisioning and monitoring access to the optical layer, with the carrier's responsibility to operate and maintain the optical equipment. Internet2 is further interested in proposals that include a provision to obtain an IRU on the underlying fiber plant at any point in the contract.

For responses that will manage and operate an optical transport platform on a dedicated Internet2 fiber system, please describe proposed solution. As part of the response, Internet2 encourages you to provide information about any of the following:

- Budgetary pricing, provided as a one-time cost and annual operating cost, including cost models for incremental growth of 10, 40, and 100 Gpbs waves and scale of economies that might be expected during the term.
- A proposal of how during a potential 20 year agreement the operation of the "dim" fiber proposal could convert to an Internet2 owned system with IRU and equipment and a service contract for operating and maintaining the equipment.
- The proposed optical transport equipment
- Whether the line-side wavelengths are native 100 Gbps or multiplexed across multiple smaller wavelengths and the technology employed
- The number of 100 Gbps wavelengths supported
- Client interface specifications
- Information about compliance with as-yet-incomplete IEEE 40G and 100G standards
- Operational access to the optical transport equipment offered (alarms, provisioning, TL1 query, etc.)
- How capacity enhancements would be provisioned, and budgetary pricing of the one time costs and incremental per-wave costs
- Any on-going maintenance costs
- Cost and availability of cross-connects, collocation space, building entry fees, and power for any Internet2-supplied optical, routing, or switching equipment that would be needed at each point of presence or optical amplification site.
- The service level guarantees

- Any other information you think would be helpful

Optical Transport Equipment to Enable 100G Optical Transport

Internet2 is interested in obtaining information regarding 100 Gbps capable optical equipment that can provide services on a national footprint. The optical transport equipment should also support 10 Gbps and 40 Gbps wavelength delivery on the same platform.

Please describe the equipment proposed. Internet2 encourages you to provide information about any of the following:

- Requirements of the fiber plant
- Whether the line-side wavelengths are native 100 Gbps or multiplexed across multiple smaller wavelengths
- How many 100 Gbps wavelengths supported
- Client interface specifications
- Information about compliance with as-yet-incomplete IEEE 40G and 100G standards
- Maintenance options
- Budgetary pricing, both for the equipment and ongoing maintenance agreements
- Physical characteristics of the equipment, including size, weight, and power requirements
- Any other relevant information

Routing and Switching Equipment

Internet2 seeks to provide higher layer transport to its members at both layer 2 and layer 3. This RFI is not prescriptive of a solution, but there are some baseline services requiring support across a portion of the network:

- Support for individual flows that may be greater than 10G
- Carrier-class reliability
- Standards-based implementation that interoperates with other vendors' equipment

Please describe the equipment proposed. Internet2 encourages you to provide information about any of the following:

- Forwarding plane capabilities per slot and per chassis
- Client interface specifications (not limited to 100G)
    - In particular, information about compliance with as-yet-incomplete IEEE 40G and 100G standards
- Protocol support and key feature sets
- Physical characteristics of the equipment, including size, weight, and power requirements
- Maintenance options
- Budgetary pricing, both for equipment and maintenance
- Any other relevant information