Internet II
Introduction

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Current networking weaknesses

1 - existing commodity Internet is unreliable, overloaded and costly
2 - control-of-network support needed for advanced applications
3 - widely distributed high quality network needed to support distance learning

Internet II - focused on weakness number 2

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Technical objectives

Maintain a common bearer service to support existing and new applications

Move from best effort packet delivery to differentiated communications service

Provide the capability to dynamically tailor network service characteristics to meet specific applications requirement

Network Services

"on demand" configuration of services

guaranteed bounded delay

low data loss

high capacity

support for QoS protocols such as RSVP

access to underlying network technology

GigaPOPs

- point of interconnection and service delivery between
  - one or more institutions or consortia
  - ISPs
  - Internet II interconnection
  - telecommunications providers
- high speed connection to institution
- dynamically configured QoS
- statistics collection point
- 1st phase - 20 to 30 GigaPOPs

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GigaPOP interconnections

- at least 622 Mb links between GigaPOPs
- QoS-knowledgeable paths required between GigaPOPs
- vBNS could be initial interconnection network
  - assumes changed vBNS AUP
  - assumes addition of QoS protocols to vBNS
- parallel test network implemented over PVCs

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GigaPOP operations

redundant NOCs
collaborative management

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Ad Hoc technical group

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Background Paper

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MISSION

"A broadband infrastructure for all communication applications"

OBJECTIVES

Maintain a common bearer service to support new and existing applications

Move from best effort packet delivery to a differentiated communications service

Provide the capability of selecting service characteristics to suit the application

Achieve an advanced communications infrastructure for the Research and Education community

Provide a platform for "precompetitive developmental activity"

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Prose, contd.

THE NEED FOR THE NETWORK

The Higher Education community has articulated a set of advanced applications that will greatly enrich teaching, learning, collaboration and research activities. A major impediment to the realization of these applications is lack of advanced communications services in the current commodity Internet. The broad use of distance learning will require selectable quality of service and efficient "one-to-many" data transport in support of multimedia and shared information processing. Our leading edge research community needs high capacity and selectable quality of service to make effective use of national laboratories, computational facilities and large data repositories.

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Prose, contd.

Medical researchers need support for remote consultation and diagnoses over highly reliable and predictable communications services. Applications have been proposed that could provide the needed wide area communications services but there is not yet a testbed in which to prove their effectiveness.

NETWORK SERVICES

Internet-II is designed to provide a variety of services "on demand" in support of advanced applications. These dynamically selectable services will include guaranteed bounded delay, low data loss, and high capacity. For example, in order to support delivery of advanced multimedia teaching materials from a digital library

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Prose, contd.

repository to a dispersed audience of learners, it will be necessary for the service delivery infrastructure to support "multicast" data delivery with guaranteed upper bounds within the transport components on delay and data loss.

New protocols to enable this functionality have already been defined and will be deployed early in the Internet-II project. These protocols include the IETF defined quality of service protocols such as RSVP and RTP along with IPv6, the IETF-developed replacement for the version of IP that is in current use on the Internet. In addition, Internet-II will provide access to the underlying network infrastructure for those environments that can support that access and for those applications that can make use of specific capabilities offered by the infrastructure.

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Prose, contd.

IMPLEMENTATION

At the heart of the Internet-II design is a new technology for providing advanced communications services. The technology, referred to as a GigaPOP, is a complex of technologies developed over the first decade of the Internet integrated with new technologies developed by vendors and the Internet Engineering community. The Internet-II project will demonstrate the effectiveness of this new set of technologies and services so that they can become the basis for the next generation of commercial Internet service offerings.

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Prose, contd.

The GigaPOP is the point of interconnection and service delivery between one or more institutional members of the Internet-II development project and one or more service providers. Typical institutional connections will be made via ATM or SONET services at very high speeds. The fundamental advance represented by the GigaPOP architecture is the support of dynamically acquired "quality of service" in support of a broad range of new applications while maintaining a common interoperable "bearer service.” Service characteristics will include end-user definable capacity as well as latency. An essential part of the Internet-II project will be to determine the incremental costs associated with support of differentiated classes of service and to develop the mechanisms to collect data about the use of these resources by individual users.

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Prose, contd.

The architecture of the GigaPOP also will support service delivery to regional or state-based not-for-profit consortia such as the Virginia Educational Network, the Washington State K-20 network, or the combined University of California and California State University system. It is envisioned that 20-30 GigaPOPs nationwide will be adequate. These will be designed and managed collectively on behalf of the Internet-II project community.

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Prose, contd.

Equipment comprising the GigaPOP will include:

* One or more very high capacity advanced function packet data switch/routers capable of supporting at least OC12 (622 megabit/second) link speeds and switched data streams as well as packet data routing;
* Switch/routers supporting Internet Protocols (both version 4 and the new version 6), advanced routing protocols such as MOSPF, and "quality of service" protocols such as RSVP;
* SONET or ATM multiplexers to enable allocation of link capacity to different services such as highly reliable IP packet delivery, experimental testbeds for emerging protocols, or special requirements determined by new initiatives among the Internet-II member institutions;

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Prose, contd.

* Traffic measurement and related data gathering to enable project staff to define flow characteristics as part of the operational and performance monitoring of the GigaPOPs.

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Prose, contd.

One or more wide area communications service providers will connect to the GigaPOPs in order to provide communications paths between the nationwide set of GigaPOPs and between GigaPOPs and the established commodity Internet. Thus participating institutions would be able to acquire a wide variety of commercial as well as pre-competitive communications services over a single high capacity communications link to the nearest GigaPOP facility. In particular, to support high performance distance learning and remote collaboration initiatives, the GigaPOP architecture will facilitate local interconnectivity between the higher education community and those commercial providers offering the emerging high-bandwidth home access technologies.

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Prose, contd.

The most advanced applications will require a set of communications paths among the GigaPOPs that are engineered especially for the Internet-II project. It is essential that these interconnect pathways fully support the protocols and functions noted above. Recently, NSF has proposed an expanded role for its vBNS infrastructure that potentially could attach as many as 100 sites nationally to the current OC-3 backbone and could provide a deployment platform for emerging applications in support of research and collaboration. It is envisioned that the vBNS, with its proposed new capabilities, will be the initial interconnect network among the GigaPOPs. If the vBNS should prove insufficient for the full range of Internet-II requirements, commercial alternatives will be evaluated.

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Prose, contd.

Although direct SONET pathways might be most effective in providing the inter-GigaPOP pathways, it seems most likely that ATM-over-SONET will be the most commonly available commercial service. Because Internet-II uses virtual connections within and between the GigaPops, a test network can be implemented along side of the production network without having to duplicate facilities. This test network will be used to experiment with new capabilities of the network itself where the production network can be used to provide reliable service for proven applications as well as a platform for testing new applications.

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Prose, contd.

OPERATIONS

Clearly the design of the GigaPOPs must meet the requirements of very high reliability and availability. Each GigaPOP site will be physically secure and environmentally conditioned, including backup power and resistance to damage from acts of nature. Physically diverse fiber optic and wireless communications paths will maximize service robustness against the unlikely event of physical damage external to the site. In addition, the Internet-II infrastructure is designed to be secure from the threats of those who would seek to disrupt its operations.

Not all GigaPOP sites will be staffed 24 hours per day. Instead, redundant Network Operations Centers will monitor the operation of all equipment remotely via both in-band and out-of-band circuits and will dispatch problem resolution staff as needed to effect restoration of normal services.

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CONCLUSION

The Internet-II architecture has been chosen to demonstrate the effectiveness of new technologies in providing the next generation communications infrastructure. The success of Internet-II will allow our higher education and research institutions to remain world leaders in the development of advanced applications of information technology.

Submitted by the ad hoc Internet-II technical committee: Scott Bradner, Scott W Brim, Steve Corbato, Russ Hobby, and David Wasley.

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