INTERNET2

FOURTH GENERATION INTERNET

Latika Chaudhary[#1], Sangita Panmand[#2], Prachi More[#3],Prof. M.A.Devmane[#4]

Department of Computers, Padmabhushan Vasantdada Patil Pratishthan's College of Engineering, Mumbai

latikac92@gmail.com(8879473603), sangitapanmand@gmail.com(9870788680), prachi.more91@gmail.com(8898564789)

***Abstract*— After the World Wide Web and other great inventions of the academic world, comes Internet 2. The new Inter-University project is rapidly evolving into a powerful consortium. 181 universities, 60 American companies and a few dozen international institutions are collaborating to create the communications technologies of the future .Think of Internet2 as a higher-tech version of the regular Internet. Like "Internet1," Internet2 connects computers all across the country. But it uses newer, more experimental technology. That can make it less stable than Internet1 but it's also about 100 times as fast under typical conditions. A key objective of the Internet2 applications effort is to inform faculty and researchers about the opportunities presented by advanced network environments. By accelerating the technology transfer necessary to move the appropriate technologies into the commercial sector, Internet2 provides both a next generation network and the applications that run on high performance networks.Internet2 community is developing breakthrough technologies that support the most exacting applications of today and spark the most essential innovations of tomorrow. Internet2's core is to offer unparalleled possibilities for exploration and innovation.**

***Keywords*— Internet , High Bandwidth, Advance Application.**

I. INTRODUCTION

Internet2 is a collaborative effort by over 180 United States universities to develop advanced Internet technology and applications vital to the research and educational missions of higher education.[1]Internet2's primary purpose is development of advanced network applications ,as well as collaborative work and distance learning.[2] Internet2 is guiding a transformative overhaul for research and education networks by helping to create dynamic and collaborative-based models at the national and global levels. Bigger pipes, new technologies, and new ideas are opening the doors to a new era of connectivity that may reshape the Web. Internet2 is a member-led advanced technology community founded by the nation's leading higher education institutions in 1996. The non-profit consortium consists of more than 450 U.S. universities, corporations, laboratories, government agencies, and national, regional and state research and education networks as well as several other global organizations. Through the help of federal funding, Internet2 currently is deploying a 100G optical backbone for connecting regional networks all over the United States at higher speeds. Internet2 serves the high-end, sophisticated needs of the world's research and education community, connecting some of the greatest institutions anyone has ever seen [3]. Internet2 is faced with unique challenges to meet and exceed the global expectations of its constituents.The Internet2 community has been deploying high performance Internet networks for nearly ten years. Today the networks operated by the Internet2 community including campus, regional, and nationwide networks connect over 5 million individuals at more than 240 research and education institutions. These same networks interconnect with research networks in dozens of other countries and to broader education networks in 35 states [2]. The fourth generation of the Internet2 Network is already being deployed, and will provide an unprecedented 8.8 Terabits of capacity, reaching into underserved areas of the nation. The infrastructure uses standards-based technologies and protocols, will support the same wide range of IP and optical services available today from leading-edge IPv4, IPv6 and multicasting to static and dynamic point-to-point circuits and is already stimulating a new generation of innovative capabilities. In addition to enabling the research and education community to conduct their work in ways not possible on the commercial Internet, a notable feature of this large-scale network infrastructure is that it provides an ideal test bed for new Internet technologies, services, and applications [8].

II.TECHNOLOGIES

1.ADVANCE LAYER-1 SERVICE

It is the most specialized and cost-effective way to build a custom, high-capacity network on the most advanced research collaboration platform in the world.

a.*Internet2 Wave Services*

The Internet2 network provides over 8.8 terabits per second of dedicated capacity on a 16,000+mile national footprint. The Internet2 network includes the capability to provision 10 to 100 gigabit per second Ethernet or 10G and 40G SONET waves between 52 locations throughout the continental United States. Each wave can extend between two points on the network or be configured with multiple point-to-point links forming a full mesh for fail-safe capabilities that support the most demanding production or research network deployments.

b.Internet2 Dark Channels

It provides dedicated optical channels for reliable, bandwidth-intensive, high performance networking with Preferred Ciena optics at 40G, 4x10G, 100G,10x10G, and future bandwidth options. Customer-provided optics or Internet2 procured

optics according to desired specifications.Customer control and flexibility for provisioning and utilization of capacity.

c.Internet2 Virtual Dark Fiber

It provides cost effective and scalable solutions for bandwidth intensive long-distance networking. The wavelength network can have its own dedicated equipment shelves and optics. Thus get the operational flexibility and security of managing your wavelength network without the underlying pain points of owning and operating a national physical fiber network.

d.Internet2 Dark Fiber Service

It provides custom, cost-effective solutions for any dark fiber requirements acquiring, holding, and distributing dark fiber network assets. Internet2's Dark Fiber Service provides optimal solutions for projects requiring a large number of circuits, and specific user partnerships/collaborations [4].

Fig.1Advance Layer1 Service

2..ADVANCE LAYER-2 SERVICE

Internet2's Advanced Layer 2 Service provides member organizations the ability to meet diverse requests from their most demanding users. It provides a scalable and flexible national network where members can build Layer 2 circuits between endpoints on the Internet2 Network and beyond to meet every user need. Efficient and effective network management, allowing CIOs and IT staff to support the varied needs of all their network users. Dedicated bandwidth free of policy or capacity restrictions to support scientists and researchers' big data networking needs. The option to enable software-defined networking (SDN) through technologies such as Open Flow for network innovators. Maximum value of Internet2 network bandwidth, and better management of network traffic for network operators[5].

Fig.2 Advanced Layer2 Service

3.ADVANCE LAYER-3 SERVICE

It delivers a specialized Research and Education(R&E) network service. The Internet2 Research and Education Internet Protocol (R&E IP) service is optimized for the most demanding, high performance peak-plus-potential network traffic. The goal of this service is for users to never experience the dropping packets, jitter or other underperformance characteristics of commodity networks. Additionally, the R&E IP service provides, Hybrid Port that provides broad range of Services and capabilities on Internet2's R&E IP backbone IPv4 and IPv6 connectivity to all Internet2.Advanced Layer 3 network users and peer networks. Wide range of options to provide scalable bandwidth to meet campus and research needs such as 2x5G, 10G, 2x10G, 3x10G, 100G.Layer 2 service capabilities, provision VLANs over Layer 3 service to connect with other Internet2 Advanced Layer 2 service users and peers[6].

Fig.3.Advance Layer3 Service

4.MIDDLEWARE

Middleware is a layer of software between the network and the applications. This software provides services such as identification, authentication, authorization, directories, and security. In today's Internet, applications usually have to provide these services themselves, which leads to competing and incompatible standards. By promoting standardization and interoperability, middleware makes advanced network

applications much easier to use. The Internet2 Middleware Initiative is working toward the deployment of core middleware services at Internet2 universities. Authentication, authorization, and accounting capabilities allow advanced applications to operate seamlessly among many organizations [1].

III.APPLICATIONS

Internet2 applications are those that make a difference in how we engage in teaching, learning, research, and clinical activities in higher education. Advanced applications do not operate across commercial Internet connections. These applications require enhanced functionality, such as high-bandwidth, low latency (delay), low jitter, and security characteristics not available on commercial Internet connections. The higher education community drives Internet2 requirements. Therefore, application development encourages and supports all disciplines. Access to Internet2 applications should be ubiquitous, with connectivity available from the classroom to the laboratory, the library or the dormitory. It is clear that there are four critical attributes present in the most compelling applications. The first is advanced collaboration environments; that is, true interaction of users without the barriers of distance. The second is common access to remote resources, from telescopes to microscopes. The third is use of the network to build network wide computation and data services, such as those under development in the Grid forum .The fourth attribute is displaying information through virtual reality environments, moving from static graphics and images to moving, three-dimensional animations. The area that provides the widest benefit and largest aggregate use of the Internet2 network capacity is digital video. Video-based applications cover everything from Internet-based videoconferencing, to on-demand content, to remote control of microscopes and other instrumentation. Videoconferencing technologies used by Internet2 member institutions range from H.323, an international standard using connections typically at speeds of 384 to 768 kilobits per second, to advanced full broadcast quality video at speeds up to 15 megabitsper second[1]. Following are some of the applications areas of Internet2:

1.Remote Surgery

Through advances in advanced networking applications such as haptics , surgical simulation training and collaborative video conferencing technologies, Internet2 is enabling pioneering scientists in medical and technical fields to make minimally-invasive, Internet-based surgery techniques a future reality. Professor W. LeRoy Heinrichs of Stanford University demonstrates the use of haptically-enabled laparoscopic tools to demonstrate simulated surgical procedures across Internet2 advanced networks.

Fig.4 Remote Surgery

2.Office of the Future

The Office of the Future project is striving to to bring together geographically distant persons in a realistic, tele-collaborative environment. Using real-time computer vision techniques, dynamic 3D images of your colleague in their office surroundings are captured and transmitted to your Office of the Future where virtual reality technology is used to create a life-size, visual portal into the distant space. By transmitting these 3D streams over the advanced networks of Internet2, participants in remote locations are able to interact with each other and manipulate shared virtual objects in real-time.

3.Problem Solving Environment

The Scientific Computing and Imaging Institute (SCI Institute) at the University of Utah integrates visualization, simulation, and geometric modelling into computational problem-solving environments in fields including cardiology, neurosurgery, radiology, nuclear fusion, and the atmospheric diffusion of pollutants. Internet2 advanced networks provide a direct data channel to SCI collaborators throughout the country, providing the networking needed to pursue collaborative Grid-based research.

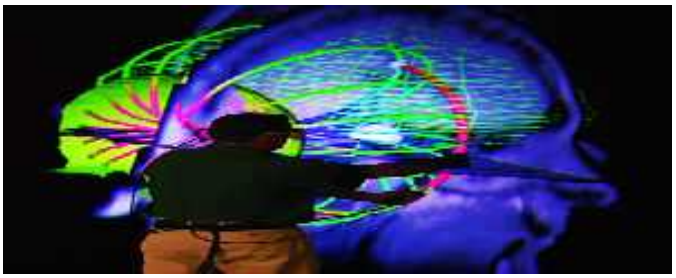

Fig.5 Problem Solving Environment

4.Remote Microscopy and Distance Learning

For the past four years, a Scanning Electron Microscope (SEM) at the University of Michigan has played a key role in a “microcourse” taught at Lehigh University. Each year, The Lehigh Microscopy School attracts 100-150 engineers and scientists who receive instruction in a wide variety of microscope techniques. The attendees range from novice users to expert professionals who need to stay current on the latest developments in the field of scanning and analytical electron microscopy. These 4-5 day lecture/lab courses are taught by noted experts and course attendees receive instruction on SEMs and other state-of-the-art instruments. Extending its

usability via remote-control to an Internet wide audience resulted from the work of Dr. John Mansfield and collaborators. Mansfield, Manager of the North Campus EMAL at UM, explained, "Advanced networks provide the bandwidth and performance required to control the SEM in real-time from anywhere in the world. Remote access extends the use of this extremely costly resource for instructional and collaborative research purposes".

Fig.5 Distance Learning

5.Tele-vator Excavation Backhoe

Tele-vator is a computerized excavation backhoe that can be remotely operated over Internet2 High Performance networks. Because of its size and potential criticality of operations (e.g., in rescue hazardous situations) Tele-vator requires a high level of sophisticated two-way feedback, including adequate depth of vision provided via high-definition stereovision. Guaranteed Quality-of-Service (QoS) such as network bandwidth, latency (delay) control, and jitter (variability in delay) control are essential to insure the quality of the 3D image, audio, and equipment control channels required by Tele-vator´s remote operators[7].

Fig.6 Tele-vator's Excavation Backhoe

IV.INTERNET2 V/S INTERNET

Some ITS experts have suggested that for many institutions there is no difference between the Internet and Internet2, except that the I2 pipeline is kept relatively free of traffic so that the full benefit of Broadband can be utilized in select events managed by the I2 Consortium. While Internet1 is open to pretty much anyone with a computer, access to Internet2 is limited to a select few, and its backbone is made up entirely of large-capacity fiber optic cables. Rather than Internet1, which is cobbled together out of old telephone lines, Internet2 was built for speed the roads are all wide and smooth, like your own private autobahn. Internet2 moves data at 10 gigabits per second and more, compared with the 4 or so megabits you'll get using a cable modem. As a result, Internet2 moves data 100 to 1,000 times faster than the old-fashioned Internet[9].

VI.CONCLUSION

Internet2 networks today routinely enable applications that require 10 to 100Mbps of bandwidth or even higher. Scientists from astronomers to cancer researchers routinely exchange extremely large datasets in real-time, students participate in remote classes using DVD-quality video-conferencing, and doctors share critical life-saving medical data instantly. Critical to supporting the continued development of networking technologies, Internet2's infrastructure also supports network researchers investigate new Internet technologies, architectures, and protocols. Today, the Internet2 community uses off the-shelf leading edge technology in its networks and operates on the very same fiber footprint that the commercial Internet uses.The slowest network connection between any two desktops within the Internet2 community is typically the 100 megabits per second (Mbps) link between the computer and the local area network and many of these links are moving to a gigabit, or 1000 Mbps. Regional and nationwide networks are increasingly using 10 gigabit per second (10,000 Mbps) technology, with 40 and 100 gigabit per second technologies expected to be available within the next few years.

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