Phoebus

Overview

Conceived and developed by University of Delaware researchers, Phoebus establishes a new network framework and protocol that brings the high performance of advanced backbone networks all the way to the end-user's desktop.

Designed to improve end-to-end throughput for long-distance data transfers, Phoebus embeds greater "intelligence" in the network, enabling it to choose the best transport technology for any application based on its needs and the available network resources at application run-time. Phoebus works by transparently splitting the full network path into distinct segments at specific adaptation points called "Phoebus gateways" and then finding the best path for the data on a segment-by-segment basis, which could include a combination of IP and dedicated optical circuits. With little to no modification needed by the end-user, applications that utilize Phoebus have experienced significantly improved throughput.

Why Phoebus?

The Internet Protocol (IP) suite has been tremendously successful in providing a basis for universal connectivity. Science and industry are increasingly global endeavors as ubiquitous, reliable, high-performance Internet connectivity enables incredible innovation. As the Internet continues to evolve, it has become evident that the current infrastructure may not be sufficient to provide for the breadth and exponential growth of new services. To solve this problem, Phoebus provides an additional layer of network infrastructure, and associated protocols that can provide important functionality to naturally augment the current Internet model and allow it to grow to meet these future demands.

Solving the End-to-End Performance Challenge of TCP

Today, a typical end-to-end path through the Internet traverses a variety of technologies which each have unique characteristics. Combinations of wireless, high-speed Ethernet, optical, and satellite links can be used as data flows from source to destination. These networks often have dramatically different characteristics and the interaction between them can lead to suboptimal performance. The current Internet model abstracts away the differences between the underlying media and is thus unable to address the potential performance degradation that can be associated with high-bandwidth flows over long distances using heterogeneous networks.

By augmenting the current Internet model with an additional service layer, Phoebus addresses many of the fundamental issues in long-distance data movement associated with TCP. The system includes a protocol and software infrastructure that allows an end-to-end connection to become "articulated" and thus able to rapidly adapt to the environment and conditions of each network segment. By utilizing standard TCP connections at the edge of the network, and a transparent "shim" on the end-user's system, Phoebus can accomplish these things with little to no modification by the end user. This technology allows the core Internet infrastructure to evolve while transparently preserving compatibility at the edges.

Phoebus is developed by Dr. Martin Swany, Assistant Professor, Department of Computer and Information Sciences, University of Delaware, and an Internet2 Faculty Fellow since 2005. Phoebus is supported by:

For More Information:

damsl.cis.udel.edu/projects/phoebus/

www.internet2.edu/performance/phoebus/

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"To date our testing has shown dramatic performance increases, even while using well-tuned applications that were already achieving good performance over the routed IP network. A high-energy physics researcher at Syracuse University has been able to increase his performance by over 10 times, reducing the time needed to transfer a dataset that is central to his research from 40 days to less than 4!"

Bill Owens
Director of Advanced Technology and Networking
NYSERNet

Expanding the Use of Revolutionary Dynamic Circuit Networks

A key element of Phoebus's functionality is the ability to bridge the gap between traditional shared packet and on-demand circuit networks. Advanced dynamic circuit networks (DCN), like those being deployed by Internet2, ESnet, and GÉANT, allow users to set up network paths on-demand for high-performance data transfers. These networks offer applications unprecedented control over network resources and enable demanding applications to maximize their utilization of the network. However, in many cases, it is not feasible to bring circuit capabilities to every resource that can benefit from them, e.g., directly to each user's desktop. In these cases, Phoebus can transparently send high-demand flows onto the dynamic circuit network without user effort. Thus, legacy applications and systems can immediately take advantage of the performance capabilities of DCNs with no modification and without being aware of the underlying mechanisms.

How Phoebus Works

Phoebus works by changing the current Internet model, which binds all end-to-end communication to Transport layer protocols such as TCP and UDP. Using an end-to-end layer called the Session layer, Phoebus can segment a connection into a series of Transport layer connections. The edge connections can still use TCP and in many cases, existing software works with no modification. These edge connections are serviced by Phoebus Gateways. The flow of traffic over the backbone network is handled by a series of these gateways. The gateways can choose the best transport protocol and protocol settings for sending the data across the network, and can allocate additional network capacity on behalf of the user.

Phoebus Testing and Deployment

To refine and test Phoebus in a live network setting with real applications and users, the project leveraged a 10 Gigabit wave on Internet2's IP Network. Phoebus Gateways were deployed at various Points-of-Presence (POP) locations including Los Angeles, Sunnyvale, Seattle, Washington D.C., Atlanta, New York City, and Chicago. Using this configuration, the development team demonstrated very significant improvement in throughput when testing the effectiveness of the Phoebus infrastructure using several data transfer and network testing applications including GridFTP and Iperf.

Internet2 continues to deploy Phoebus technology as a part of its networking infrastructure in its IP router nodes and plans to continue deployment at its optical sites to facilitate greater adoption of new DCN among its members. Other national and regional research networks worldwide like NYSERNet, ESnet, GÉANT2, RNP (Rede Nacional de Ensino e Pesquisa) in Brazil, and GLORIAD (in partnership with KiSTi in Korea) are also working to further explore and implement the technology.