Project Summary

SOCRATES: Series of Circuits Rapidly AllocaTed for Efficient Sharing

This project takes a new look at the decades long debate over the inherent value of connection-oriented (CO) vs connection-less (CL) network architectures. It considers a design where the inherent benefits of both can be leveraged, not just in the same network, but across a single application flow. We propose a Partial-Path Circuit (PPC) service that uses CL networking as the service baseline but employs CO to augment portions of the data path precisely where and when it is needed. The proposed architecture is dubbed SOCRATES, a Series of Circuits Rapidly AllocaTed for Efficient Sharing.

The objectives for SOCRATES are in contrast to much of the recent work in dedicated, high performance networking for the science community. These projects focus on a narrow set of high-bandwidth and/or real-time applications delivered at what remains a premium price. Instead, we address the more moderate bandwidth and delay requirements of the millions of Internet users and look for feasible, scalable and marketable enhancements that could drive improved performance for end-users as well as efficiency improvements for network providers. This work combines large-scale measurement, analytical modeling and real-time control to deliver improved resource efficiency and better performance for applications that require moderate amounts of bandwidth.

The project begins with a significant measurement component that leverages existing connectivity tools, bottleneck detection tools and utilization monitoring services. These tools will be enhanced to better identify the path components that do not meet the needs of the application. Extensive mathematical analysis and modeling work will be done to both validate the measurement results and optimize the network allocation using utility functions and Markov decision-theoretic methods. This measurement and analysis will result in a set of path components that must be "enhanced" to meet the user needs. Finally, the networking system software component of the project will study methods to allocate resources through the creation of partial connections that peel off bandwidth on a bottleneck through reservations or alternative circuit allocations. The SOCRATES project aims to automate this process to an extreme degree. It uses measurement-based mathematical algorithms that run seamlessly (unbeknownst to the end-user) to determine where the bottleneck links lie and to request bandwidth reservations on these links, as and when needed by end host application software.

Intellectual Merit

The intellectual merit of the work is in the significant and novel application of both measurement tools to dynamically assess the state of the network and partial-path connections to overcome network bottlenecks. The investigators believe that this approach will result in a practical, scalable solution to the problems faced by network users that need some amount of deterministic capacity without the expense of separate end-to-end circuits. The strong analytical component of the proposed work plan will result in well-founded solutions. The strong implementation and standards-based component will result in solutions that will be deployed in current and future networks.

Broader Impacts

The broader impact of the proposed work is in the significant enhancements to the infrastructure for end-users and network providers. The proposed networking solutions are intended to make moderate-speed, low-delay network services available to more users at a fraction of the cost required today. We plan to leverage the geographic and intellectual diversity of our team, covering a breadth of topics from modeling to mathematics to operational networking, to develop inter-disciplinary courses, expose our students to national laboratory research (through the participation of SLAC), and bring greater opportunities to our minority and women students.