Project Summary

In recent years both ISPs and end systems have deployed various forms of network "intermediaries" with accelerating frequency. Examples of intermediaries include proxies, NATs, web caches, firewalls, load balancers, and protocol converters. The result of these deployments is a more complicated *Discrete Internet*: an Internet composed of discrete subnetworks, attached at a relatively small number of choke points, lacking universal addressability, and including stateful in-network intermediaries as vital service components.

We propose a novel technical mechanism—a new definition of the "session layer"—as a way to manage the new complexity, retrieve some of the lost benefits of the original homogeneous model, and open a variety of new possibilities. The session layer protocol allows endpoints to become aware of and manage intermediate services. The philosophy is to recognize the growing number of in-network services and make such services visible, first-class entities in the future Discrete Internet.

Using our session protocol, each endpoint of an application (client and server) can specify which intermediate services it desires, permits, or prohibits to exist along the path between it and the other application endpoint. No unapproved service is made part of the session. The result of the setup negotiation is an indication of which services are available, and in which order, along the path. A session is named by an ID, not by a combination of addresses and ports; therefore, a session can survive a change to the underlying transport parameters, including change of endpoint's IP address. This capability facilitates mobility models that employ frequent address changes.

The session layer runs over a sequence of transport connections. For example, if X and Y are endpoints, and Z is an intermediate service, then two transport connections, X-Z and Z-Y, would be used. The intermediary Z is not transparent but rather is explicitly addressed, allowing it to be placed anywhere in the Internet. The session layer verifies end-to-end delivery, offering a variety of semantics. An interesting side effect is that relieving transport protocols of the burden of end-to-end delivery verification can lead to new research that explores the re-definition of the transport layer as well.

Intellectual merit. The extra layer of indirection provided by the session layer promises many benefits. Among them are a cleaner programming model for both applications and intermediate services; simplified physical network design; improved performance of the individual session; reduced congestion and greater bandwidth utilization for the Internet as a whole; better fault tolerance and manageability; and the enabling of important new services. The proposed work includes experiments to evaluate potential advantages and disadvantages, and to quantify design trades.

Broader impacts. The proposed session layer allows network intermediaries to be placed anywhere rather than only at network choke points. This capability allows anyone—not just network owners/operators—to provide in-network services. Therefore, the proposed work, if widely deployed, could help to enable a new industry of intermediate in-network services that are easy to deploy and locate. This is the primary possible broader impact of this work. To encourage wide experimentation with and dissemination of the session layer protocol, we have created a page on the popular `sourceforge` web site, where we maintain the current implementation. This page will be kept up to date as the work progresses.