A Framework for an Incentive-Based Approach to Improving Network Congestion

Background:

With the growth of the Internet in recent years, sustaining the expanding network traffic has become an increasingly large concern. Further, the pace of growth does not seem to be declining – Cisco projects that IP traffic will increase by a compound annual growth rate (CAGR) of 29% over the next 4 years. If we are to maintain quality of service for Internet users, we will need significant improvements to our networking infrastructure.

One area in which our current systems can be improved is with application-specific traffic optimization for Internet Service Providers (ISPs). Some applications today have grown so large that they consume a significant amount of total bandwidth. Netflix alone, for example, consumes a stunning 32.7% of the Internet’s peak downstream traffic in North America as of the end of 2011.

Currently, no system is in place for application developers to optimize their network performance to work with individual ISPs. Users pay ISPs in exchange for Internet access, and these same users also pay applications directly for their service. As a result, there is little direct interaction between ISPs and application developers. In this project, we will work to set up a market-style system in which application developers would be compensated for optimizing their traffic for specific ISPs with preferential treatment of their Internet traffic.

Project Description:

In this project, I will work towards providing a framework that would incentivize bandwidth-heavy applications (such as Netflix) to optimize their
traffic for specific ISPs. This would reduce overall congestion in the Internet and aid ISPs by making their bandwidth use more efficient.

This project will not only require knowledge of computer science and networks, but also of economics and game theory. In essence, application developers and ISPs are playing a game where ISPs try to optimize their network traffic for all their clients using the minimum bandwidth and maximum reliability and speed, while application developers attempt to also optimize their traffic to ensure their applications work smoothly and quickly. If proper incentives are provided, then ISPs and developers can work in unison to create systems that work better for both.

The possible incentives to the application developers could be in many forms. These could include additional bandwidth (or no application-specific throttling), more efficient routing, or some other form of preferential treatment of their traffic. Further, the incentives must be compelling enough to persuade developers to devote significant time and resources towards optimizing their network traffic.

In this project, I will be working with Professor Yang and a contact of Professor Yang’s who is a researcher at Telefónica, one of the largest telecommunication providers in Europe and Latin America. We will attempt to design such a system as described above that provides improvements to both application developers and ISPs such as Telefónica.

Applications:

The applications for such a system and the resulting analysis are extensive. As noted earlier, network traffic has grown at incredible levels over the past couple decades, and shows little sign of slowing down. In addition, large chunks of this traffic are generated by single applications, such as Netflix or Google. Much of this traffic is processed inefficiently by ISPs, as it does not always have access to all the routing information and tables that the ISP has.

If a system can be developed that incentivizes application developers to work with ISPs to optimize their network traffic, this traffic could be processed more efficiently and reduce overall Internet congestion. Ideally, this optimization would trickle down to users who would see potentially large improvements in latency, bandwidth, and reliability. Clearly, the applications of this research could potentially be quite significant and widespread.
Deliverables:

My deliverables will consist of the following:

1. All code / implementation of the system described, if any.

2. A written report detailing plans for such a framework and/or an analysis of various possibilities for such frameworks and their potential for implementation, and a summary of all my research and work.

Bibliography:

Cisco Systems
http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.htm l

NBC News
http://www.nbcnews.com/technology/technolog/netflix-uses-32-7-percent-internet-bandwidth-119517

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