CS490 Senior Project
Description: Optimizing Content Multihoming for QoE and Cost
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Background

Content Delivery Networks (CDNs) are used by content providers, such as Netflix, Hulu, and the New York Times, to distribute content to users. Traditionally, content providers have chosen the most reliable CDNs at the expense of cost, because these providers place a premium on user quality of experience (QoE).

Now, major content providers are using a process known as content multihoming to distribute their content across multiple CDNs. This allows the content providers to have fine-grain control over the proportion of their traffic going over any particular CDN. However, as of yet, no content providers have a way of optimizing the distribution of traffic across CDNs. The ability to optimize this distribution for cost as well as quality of experience would be of tremendous value to these content providers, saving them hundreds of thousands, perhaps millions, of dollars in content delivery costs.

Overview of Research

Recently, a framework and a set of efficient (polynomial time) algorithms have been developed for content multihoming, which is the use of multiple Content Delivery Networks (CDNs) to distribute content (videos, audio, pictures, etc.) from content providers (i.e. Netflix, Hulu, New York Times) to users.

In particular, the framework and algorithms optimize for both user Quality of Experience (QoE) and cost. QoE is defined as a set of conditions that the algorithm must provide, namely, content must be served to a user in a particular location, at an acceptable user quality (for example, no freezes during the playback), when the user requests that content. Cost is the sum, across all CDNs, of the amount of money a content provider will pay to each individual CDN it contracts with to distribute its content.

The algorithms consist of a server-side algorithm and a client-side algorithm. Substantial work has been done on the client-side algorithm, which is being
implemented in ActionScript 3.0. The server-side algorithm is being implemented in C++.

In addition to the algorithmic work, there is substantial market analysis that accompanies the implementation of this service. If most content providers begin using the algorithms to distribute their traffic to multiple CDNs, how will the CDN market change? How will individual CDN firms respond to a decrease or increase in their traffic as a result of distribution optimization? Both short-run and long-run analyses are relevant to understand the impacts of the research. The market analysis is of academic interest to the study of computer science because these shifting market forces have significant implications for the future of network infrastructure around the world. Additionally, an understanding of the economic interests at stake may quite possibly contribute to the development of algorithms that provide further optimizations in the future.

**Personal Contribution**

I will be providing two main contributions to the emerging content multihoming research.

- My first contribution will be to assist in the implementation of the server-side and client-side algorithms, with a focus on the client-side algorithm.
- My second contribution will be to lay the foundation for a market analysis by providing a rough, high-level analysis of the current market and how it stands to change as a result of content multihoming.

Specifically, the client-side code is implemented in ActionScript 3.0. I will do research into whether or not there can exist a viable HTML5 implementation—it would be advantageous to implement the client code in HTML5, because many mobile devices do not support Flash and ActionScript 3.0. This will include research into RTCWeb, a proposed IETF and W3C activity that would facilitate the implementation of Professor Yang’s algorithm in HTML5. I will learn ActionScript 3.0, and I will then familiarize myself with the existing client-side code base. I will aid in implementation and any other tasks required for work on the client-side code.

For the market analysis, I will do research into the state of the CDN industry right now. I will read about major CDN firms and attempt to understand the structure of individual firms in hopes that it will give me insight into the industry as a whole. Some of the major CDN firms include Akamai, Level3, Limelight, Amazon CloudFront, and ChinaCache. I will use these firms as a springboard for my research.

**Deliverables**

My final project will consist of two main deliverables:
1. The first deliverable will be any and all of the code I contribute to the client-side implementation of content multihoming.

2. The second deliverable will be a typed analysis of the current state of the CDN market as well as how I anticipate the market to change as a result of the implementation and deployment of content multihoming.

**Bibliography**

*Programming ActionScript 3.0*
livedocs.adobe.com/flash/9.0/main/flash_as3_programming.pdf

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http://rtc-web.alvestrand.com/

**Amazon CloudFront**
http://aws.amazon.com/cloudfront/

**Akamai CDN**

**Level3 CDN**

**LimeLight CDN**
http://www.limelight.com/software-video-delivery/

**ChinaCache CDN**