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# Dynamic Content Steering Services: How to Make Everyone Happy in a Multi-CDN World

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## ABSTRACT

The video service providers commonly employ multiple vendors, each operating independent Content Delivery Networks (CDNs), to deliver video content to end-users [1]. To address this growing trend, known as the multi-CDN strategy, the technical communities responsible for developing prominent streaming standards, including HTTP Live Streaming (HLS) and Dynamic Adaptive Streaming over HTTP (DASH), have devised a system where every end-user regularly contacts with a central manager, known as the *content steering server* [3]. On each interaction, end-users receive instructions on which CDN to retrieve the content from. From the end-user feedback and the collected global metrics, the *steering server* implements a load balancing strategy, which finds a trade-off between long-term business logic and short-term Quality of Experience (QoE) maximization.

In current implementations of the steering service, the *steering server* primarily prioritizes user QoE without accommodating the evolving requirements of CDNs [2, 5]. Yet, CDNs are inherently subject to variable requirements over time. We give two examples: (i) The energy efficiency performance of a CDN hinges on the number of end-user sessions it serves and the number of available edge servers. Indeed, despite efforts from the hardware and middleware communities, the energy consumed by a running edge server is not proportional to the number of concurrent sessions. Each server has an optimal load, for which the power efficiency (expressed in egress throughput (in Gbps) per Watt) is maximal. For a given number of edge servers contributing to the delivery, the CDN is then interested in dealing with the optimal number of concurrent sessions, *i.e.*, the number of sessions that maximizes its global power efficiency. (ii) The total capacity of a CDN at any given time depends on external factors, especially in the case of *private CDN* where an operator invests in a delivery infrastructure primarily for its own video services. A private CDN should first serve the pay-TV operator video streams, and then, if room, it can allocate resources for the external steering service. In short, the number of end-users that a CDN can serve is what is left after the prioritized channel deliveries are fulfilled. Since the traffic of pay-TV services fluctuates, the capacity a private CDN can offer to the steering service also changes over time.

To date, the CDNs contributing to a global steering service lacks a mechanism to update their changing requirements over time. This includes expressing their desire to handle more or less traffic. This absence of communication leaves a void in balancing algorithms, making it challenging to meet all CDN needs.

We discuss various options to implement a consistent delivery service, comprising multiple CDNs and one steering server. We first present the internal metrics, such as power efficiency [4]

and profitability, that a CDN should strategically expose to manage its current and future traffic loads inline with its best interests. We emphasize the pros and cons of exposing these metrics to third-party entities. We then introduce our work, multi-CDN communication over content steering server that allows a CDN to manage its traffic load via communication with other CDNs over the content steering server without exposing internal metrics. The communication between CDNs involves offers, acceptances, rejections, or negotiations for user offloading/onloading, ensuring a coordinated approach. Our work adapts to real-time multi-CDN requirements, aligning with content steering standards. Future plans include learning-based approaches for the predicted future traffic loads, alongside protocol modifications to leverage content steering awareness, providing insights into multi-CDN communication intricacies and robust performance optimization.

## CCS CONCEPTS

• Information systems → Multimedia streaming.

## KEYWORDS

Content Steering, ABR, Content Delivery Network, Multi-CDN

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