Cost Effective Approaches for Content Placement in Cloud CDN Using Dynamic Content Delivery Model

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ABSTRACT

Cloud providers give storage access and efficient content placement and delivery services to content providers by optimizing cloud-based content delivery. The cost-efficient model should not only consider the content delivery cost but also the storage cost associated with the cloud network. In this article, a novel cloud-based content delivery model is proposed that uses shared storage models for cost optimization in content delivery. Shared storages are placed in different areas of the content delivery network and an efficient replica placement strategy is employed using optimization techniques. Different content delivery schemes are used in proposed model for different situations and overall content delivery cost is optimized. Experimental results show better performance and lesser cost in terms of storage, traffic and latency and also satisfy Quality-of-Service (QoS) and Quality-of-Experience (QoE) in content delivery using PSO when compared to ACO and GA.

KEYWORDS

Ant Colony Optimization Algorithm, Cloud Computing, Content Delivery, Genetic Algorithm, Particle Swarm Optimization Algorithm, Shared Storage

1. INTRODUCTION

Content providers aim to seamlessly deliver their contents to their intended customers or end users and for this purpose, the Content Delivery Networks (CDN) have been (Wang et al., 2015). The traditional CDNs that are existing now can be too expensive for small to medium-sized content providers (Salahuddin et al., 2017). Also, creating a CDN for self and maintaining the storage and content delivery process by a content provider is an even more challenging and costly task that not many content providers can handle or afford. The maintenance of the servers and the storages within the CDN are cost expensive and suitable resources is required (Stocker et al., 2017). To make things easier for the content providers, cloud- based content placement storage and cloud-based content delivery mechanisms provide an alternate and much cheaper solution (Zhang et al., 2015). Cloud-based content delivery provides faster, cheaper and on-demand content delivery to the end users using the cloud computing concept (Ouf et al., 2015). For handling large amounts data such as a large number of web contents, cloud resources can be used that can handle big data easily (Bagui et al., 2015).

Cloud based Content Delivery Network (CCDN) has been a major research focus on recent times (Gkatzikis et al., 2017) and the focus is more on optimization of content placement with lesser resource usage and optimization of content delivery for less delivery cost (Xu et al., 2017). The metric that defines the resource usage in CCDN is the amount of storage consumed within the cloud. In
case of content delivery cost, the metrics that define the latency cost and traffic cost are considered that are incurred in the cloud for delivering the contents to end users (Chu et al., 2016; Carlsson et al., 2014). By moving the content delivery process to the cloud environment (Mansouri et al., 2016), the content provider need not worry about optimization and maintenance of content placement and delivery. But the content provider still has to pay the cloud provider for the service that has been opted for. An efficient cloud provider with well optimized CDN models will incur a lesser content delivery cost and resource usage and can achieve high performance content delivery. As a result, the cloud can provide cheaper CDN services to the content provider (Mansouri et al., 2017), since the cost incurred by the cloud provider itself has been reduced. So, CDN optimization is an essential task and is beneficial to both cloud providers and content providers (Liu et al., 2017).

The challenge is to optimize the CDN with an efficient content placement or replication strategies (Gupta et al., 2017) that can place contents in desired locations of the CDN network to achieve optimal content delivery cost and also make sure that the number of replicas used and the overall storage occupied in the CDN are less (Koch et al., 2016). Many Cloud-based CDN schemes and models have been used till now that focus on improving only one of the problems or parameters at a time (Yao et al., 2014). But the storage optimization is something that has not been dealt with in most cases and by considering the amount of data that are being manipulated at both user end and the cloud end, there is an urgent and efficient need for a solution. The expected solution is to provide a cost efficient and a high-quality content delivery scheme that can do on-demand and seamless content delivery to the end users by dynamically updating itself for replica placement and removal based on the requirement. Also, the content delivery cost should be kept optimal even though the number of replicas has been reduced by this dynamically updating scheme. This research aims to answer the following research questions and also propose an efficient solution that can achieve Quality-of-Service (QoS) (Haghighi et al., 2017) and Quality-of-Experience (QoE) (Garmehi et al., 2014) in content delivery.

1. **RQ1**: Is it possible to optimize the content delivery cost by reducing the number of replicas?
2. **RQ2**: Are dynamic content replication and removal possible without affecting the content delivery of the network?
3. **RQ3**: How content delivery and content replication affect the QoS and QoE in Cloud-based Content Delivery (CCDN)?

In order to answer these RQs, the various research gaps should be identified and handled effectively to obtain the necessary information that are required to provide a conclusion to each of these questions. One of the major gaps to be filled is the information related to the random user requests that keeps changing over time. Unless this randomness is overcome, the efficient content placement cannot be obtained. By using efficient optimization techniques, the change in user requests can be identified and a dynamic content placement can be made based on the changes in user requests. Similarly, further research gaps such as impact of customer experience and satisfaction on the CDN cost, maximum and minimum storage requirements, and the current state of the CDN network should also be considered. By taking the research gaps into consideration, the obtained information can be used to model an efficient CDN network that can dynamically place contents based on the user request.

In this article, content delivery optimization has been considered with respect to the overall resource usage within the CDN which in this case is the overall storage consumed. Initially the proposed CDN has been designed using both architectural model and mathematical model. The architectural model implements different schemes of push-pull strategies for content delivery and the mathematical model provides the latency, traffic and storage cost models of the CDN. The architectural model is further enhanced by modifying its basic network topology to add one or many shared storages that connect many proxy servers in a particular area of the network. The content placement or replication strategy is enhanced by using optimization techniques that considers the
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