Computing Resources Placement in a Multi-CDN Context

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***Abstract*— As sensitive contents like video become more popular; coping with these contents constraints requires a more sophisticated computing of adequate resources placement. In this document, we motivate this problem and we propose, for solving it, a multi-steps framework that allows, based on static and dynamic inputs, moving from a single CDN to a multi CDN placement of required resources. Strengths of proposed framework lie in the granularity of resources fetching and in the dynamicity of resources computing over time.**

***Keywords*— Multi-CDN, Resources Placement, Video Content**

I. INTRODUCTION

As video traffic exceeds half of global internet traffic, more questions concerning the specificity of this content are raised by content providers (CPs) and ISPs. In fact, video content presents many particularities. First, it generates a lot of load on CPs and ISPs networks. Second, its constraints in terms of capacity (storage and processing), hardware and network (connectivity, bandwidth) make its distribution quite complex. Third, users are highly sensitive to video quality.

Content Delivery Networks (CDNs) were introduced as a content distribution solution which enabled, through hosting CPs' videos, dealing with many of the raised issues. Presenting an overlay network of distributed caches, a CDN reduces CPs' load, cuts their costs and decreases latency through delivering content from the internet edge.

CDNs present many differences in terms of supported contents (streaming content Vs Web pages), surrogates placement (Tier 1 ISP Vs Tier 2 & Tier 3 ISPs) and dimensioning scale. While CDNs like Akamai [1] are very large and highly distributed, others are more limited in terms of capacity and geographic coverage.

Difference between CDNs raises the question of viability of CDN Interconnection (CDNI). Besides, experience has shown that no CDN can be considered as the best. Even though some CDNs may benefit from a huge and diversified capacities portfolio and from a large coverage, their performance is influenced by the dynamicity of users' demand as well as by the state of ISPs networks. Thus, in the context of video like contents, resources placement should not be restricted to a single CP or CDN domain. Instead, it should be dynamically computed and highly widened in order to ensure a permanent availability and a good quality of the concerned service.

Works concerning CDNI have been already launched in IETF [2] [3]. Here, we consider a concrete interconnection use case (Fig. 1) and we build on it in order to propose a framework for dynamically computing resources placement in a multi-CDN context.

II. OUR SHOWCASE

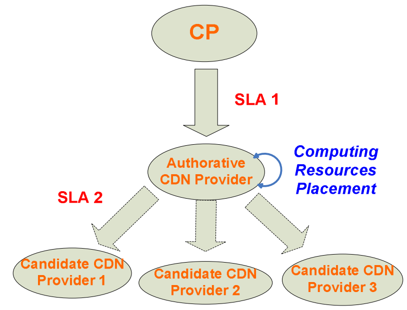

Fig 1: Use case Overview

A Service Level Agreement (SLA1) is established between a CP and an authorative CDN Provider. Based on it, a process aiming to compute resources placement is run either by the provider himself or by a third party. This process aims to map contents based on their requirements and constraints to adequate resources that can be based at the authorative CDN level but also in other CDNs (candidate CDNs). In the latter case, new SLAs (SLA2) are established between authorative CDN and selected candidate(s).

III. OUR APPROACH

Computing resources placement in the previous use case requires following the next three steps (Fig. 3):

A. Information Gathering

Actors concerned by resources allocation are CDN providers and ISPs (Tier1/ Tier2/ Tier3 / eyeballs [4]) (Fig. 2). Information gathered from these actors includes:

1) CDN Profile: Capabilities in terms of CPU, storage and hardware of different CDN servers/ servers' physical and overlay topologies.

2) ISP profile: ISP type/ neighbors/ agreements (peering/transit)/ internal capacity.

3) SLA1: CDN availability ratio and target QoS level as requested by the CP.

4) Service Requirements: Target footprint description (e.g: Europe), Content related Metadata (content type/ description/ volume etc), demand related statistics (demand volume, requests provenance etc), Target CDN Hit Rate.

5) Monitoring data: CDN servers' workload, CDN global Miss Rate, ISP links state, ISP available bandwidth.

6) Economic Inputs: Authorative CDN business/ revenue model, extra resources allocation cost, candidate CDNs delegation costs.

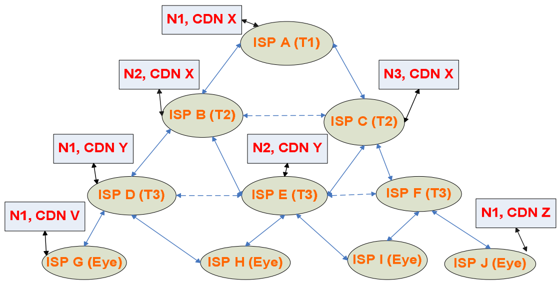

Fig 2: CDN servers Distribution over the internet

B. *Information Merging*

Information gathered in A is merged in order to give the following outputs:

1) CDN Footprint: Concatenation of CDN servers' individual footprints. "Footprint" is defined as a number of Eyeballs that can be reached by a server/ Autonomous System through following a strict downlink path toward the network edge.

2) Path(s) from CDN servers to each component of their footprint.

3) Established paths Ranks in terms of path expected QoS. QoS is computed based on path length, path capacity and path eventual congestion. It is then compared to the required QoS as defined by SLA1.

4) "CDN Resources List": list of available CDN servers with each server capabilities, footprint and QoS (best path(s) QoS) associated to it.

5) "CDN Content List": list of CP contents that authorative CDN is expected to allocate resources for with each content requirements and constraints associated to it.

C. *Computing Local and Distant Resources*

Performed operations are the followings:

1) Matching "Content List" components to "Resources List" components in order to track the adequacy between contents' constraints and servers' capabilities.

2) Detecting initial problems at the authorative CDN level (lack of enough capacity/ hardware incompatibility problem/ low QoS guaranties / footprint reach ability problems).

3) Detecting subsequent problems based on "Monitoring data" (high server workload/ ISP bottleneck/ bandwidth insufficiency at an intermediate ISP level).

4) Identifying missing resources profile based on the encountered problem(s) description.

5) Contributing missing resources placement based on the availability of these resources in candidate CDNs (candidate CDNs Resources List) and on economic inputs.

6) Establishing flexible SLAs with selected CDN candidates.

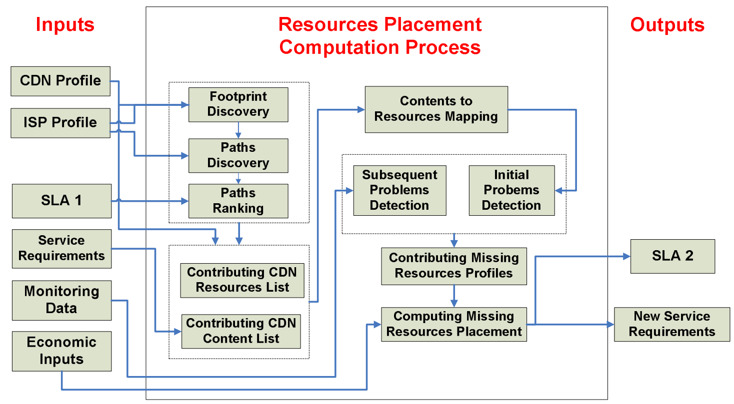

Fig 3: Resources Placement Computation Process

IV. EVALUATION

Our approach owns many advantages over existing ones. Main strengths lie in the following points:

1) Diversity of gathered information in terms of information types and sources (many actors are involved).

2) Enhancement of Initial resources placement at the authorative CDN level through moving from a random content distribution to a more granular and service aware content to resources mapping.

3) Dynamicity and flexibility of inter CDNs interaction: Candidate CDNs selection is very dynamic and can be done based on initial conditions but also next to the evolution of ISPs and CDNs resources state. Flexibility is ensured through the ability to re-compute resources placement as service and actors' conditions evolve.

V. CONCLUSION & FUTURE WORK

As video content gain more popularity, network and storage resources should be carefully selected in order to deal with this content's constraints. In our research, we consider a specific use case where a SLA is established between a CP and an authorative CDN provider. We depart from it in order to propose a framework for computing required resources first at the authorative CDN level and then at other CDNs level. This computation has the advantages of being granular when mapping contents to available resources and dynamic in terms of reacting to resources state evolution over time. In the future, we will try to quantitatively assess our approach and to consider new use cases for our work.

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