Internet-based Content Delivery:
Traffic Management with CDN and P2P Overlays

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I. ABSTRACT AND INTRODUCTION

CONTENT delivery (CDN) and peer-to-peer (P2P) networks are carrying most of today's Internet traffic with different effect on delay and throughput as main quality-of-service characteristics. We compare current techniques for content distribution over the Internet via server-based and peer-to-peer overlays regarding their effect on the traffic flows and profiles. P2P overlays are fully scalable and adaptive to flash crowds focusing on temporary popular content even without own network layer infrastructure [7][8] whereas CDNs are currently more efficient in shortening transport paths to the users [1][3][4]. Nonetheless, different administrative domains of content and network providers impede optimized IP transport on a global scale [9].

Many current activities in research, industry and standardization are addressing localized delivery of large content volumes from the network edge and between peers. Short end-to-end paths and delays are beneficial for the user experience as well as for network providers to reduce the load in the backbone and on expensive interconnection links, and last not least, also to reduce energy consumption. Our main focus is on cross layer traffic management on IP and overlay level.

Keywords—**Internet traffic, content delivery, overlays, P2P, CDN, caches, traffic engineering, path optimization.**

II. CONTENT DISTRIBUTION OVERLAYS ON BROADBAND ACCESS NETWORKS

Figure 1 illustrates the relationship between broadband access networks as well as CDN and P2P overlay structures on top of them. Both overlay types are compared with regard to [3][4]

- their flexibility and scalability for supporting established and new services (HTTP file transfer and downloads, streaming, IP-TV, gaming, VoIP),

- their performance in terms of main QoS criteria (throughput, delay) as well as resource utilization and costs,

- their cross-layer (in-)efficiency due to the (mis-)match of application and network transport infrastructure, regarding traffic management and efficient delivery paths.

In addition, hybrid CDN-P2P solutions are promising for cost efficient throughput optimization. Different perspectives are relevant from the view of the content and network providers as well as the users. Improved service quality and economic aspects are crucial for all parties to enable new trends towards IP-TV integration and increasing VoD traffic. Future Internet activities explore new concepts for naming and locating distributed content independent of IP addresses to avoid inefficiencies in host-to-host communication [2], which face the challenge to set up new and more efficient search methods.

III. NETWORK MANAGEMENT PERFORMED BY OPERATORS

Network providers have management and planning processes running on their broadband access platforms including short and long term monitoring and adaptation procedures to changing traffic conditions and demands [3][5]. This includes a continuous process of link upgrades to adapt to fast traffic growth. Redundant resources for failure resilience mechanisms have to be provided in the core and aggregation network, where single link failures can affect a large user population.
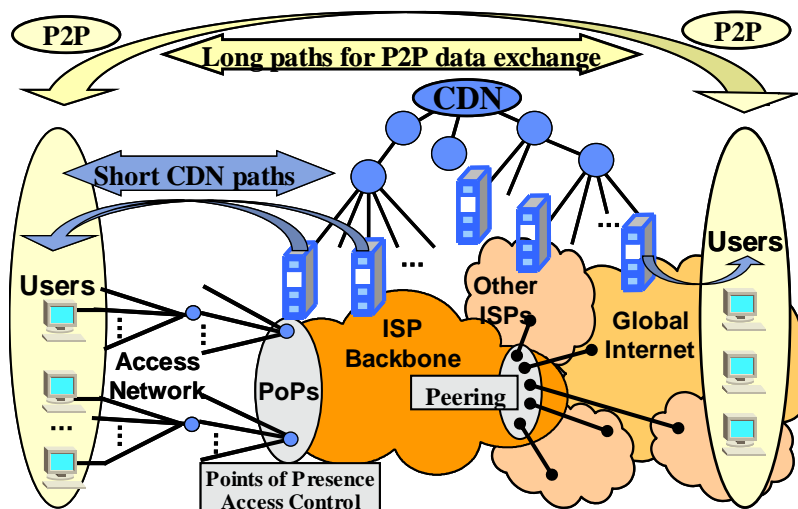

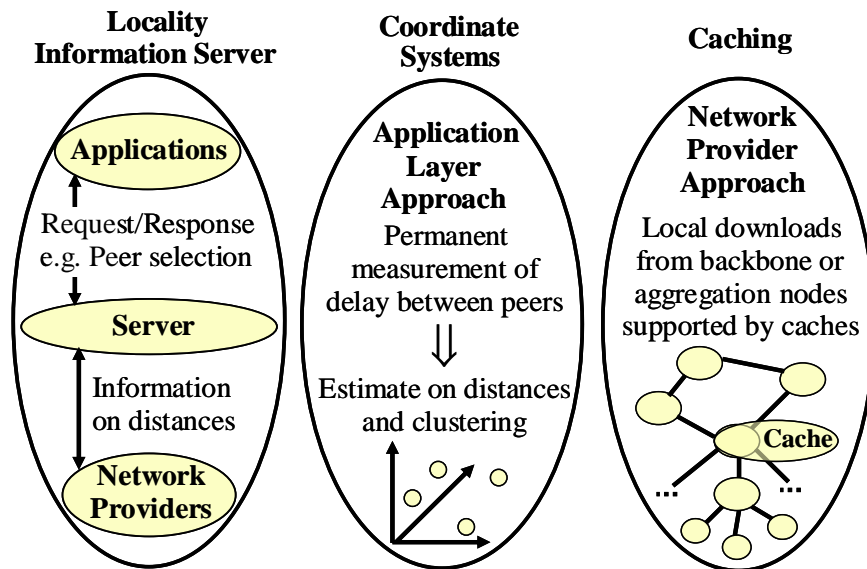Figure 1: CDN and P2P overlays on top of broadband access networks

Figure 2: Approaches for traffic path optimization in content delivery

Overprovisioning can be reduced by traffic engineering tools which balance the load for optimized network wide throughput. Therefore the flexibility in redirecting traffic flows is crucial in order to react to shifts in demands and to failure cases. Traffic engineering within an administrative domain also depends on peering with external content providers who offer content from many popular sources. In addition, network providers can introduce caches and CDN servers within their own network platform [1][4]. The relevance of Zipf laws in user access behaviour, i.e. a high preference in access to small fraction of the most popular items [6] makes small caches efficient.

On the other hand, a lack of cooperation between content and network providers beyond their administrative boundaries detracts from the efficiency of global content distribution. This implicates demands for standardization which are partly addressed in current IETF activity in a working group on CDN interconnection [9].

IV. APPROACHES FOR SHORT TRAFFIC PATHS AND ENHANCED PERFORMANCE IN CONTENT DISTRIBUTION

There are further standardization and research approaches to shorten transport paths by preferring local instead of globally distributed sources. Suggestions for locality awareness can be classified according to figure 2 as

➢ cooperative cross-layers solutions aided by information servers [8],

➢ coordinate systems on the overlay as application layer solutions and

➢ network layer approaches through traffic engineering and caching.

The cooperative approach is currently driven by the Application Layer Traffic Optimization (ALTO) working group within the IETF together with work in research and in the industry [7][8]. Therefore locality information is collected e.g. from

the BGP routing protocol, from Prefix WhoIs <www.pwhois.org> servers and/or from cooperative network providers. The gathered information has to be made available to applications in a standardized way.

Large overlays, e.g. BitTorrent, can perform delay measurement and collect routing information to estimate distances between sources and destinations and to map them in coordinate systems, such that application layer source selection and routing can establish its own traffic management independent of the network provider. The cross-layer aspects of such approaches are addressed including possible inefficiency arising due to limited mutual awareness and non-cooperative administration on the application overlay versus network infrastructure layers.

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