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ANALYSIS ON SOLUTION TO IMPROVE THE EFFICIENCY OF CONTENT DELIVERY NETWORK

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Abstract

Due to the explosive growth of Internet traffic and the rapid development of network technology, content delivery has becomeanimportant service in the current Internet. However, the existing content delivery solutions, such as peer-to-peer (P2P) and content delivery network (CDN), have many insufficient aspects. Meanwhile, the analysis on solution to improve the efficiency of content delivery networkhas been considered as a promising technique in network field. From the perspective of solution, content delivery systems can make full use of the network characteristics and the effective information provided by the network operators, so as to improve the efficiency of the content distribution and optimize the overall performance of the network. In this paper we present analysis on solution to improve the efficiency of content delivery network. Firstly, we provide some of the works which have been done on solutions from two perspectives: evolutionary and revolutionary. And then, the advantages and disadvantages of these solutions are compared and analysed from two aspects of technology and business. Finally, we outline some challenges and research directions in the future.

Index Terms:*Collaboration, Content Delivery, Network Architecture, Network Optimization*

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1. INTRODUCTION

With the continuous development of many emerging technologies, such as mobile Internet, cloud computing, big data, Internet of Things and so on, the demand for Internet traffic is increasing rapidly. According to the Cisco Visual Networking Index (VNI) report 2016[2], global IP traffic has increased more than fivefold in the past 5 years, and will increase nearly threefold over the next 5 years. Meanwhile, consumer Internet video traffic will be 82 percent of all consumer Internet traffic in 2020, up from 70 percent in 2015. In addition, content delivery network traffic will deliver nearly two-thirds of all Internet video traffic by 2020.

The existing network faces great challenges due to the rapid growth of Internet traffic, especially video traffic. On the one hand, the network becomes extremely congested, and the response for user request becomes quite slow. In order to improve the network conditions, Internet service providers (ISPs) have to constantly expand the network bandwidth. However, with the reduction of voice and short messaging service (SMS) business as well as the drop of traffic price, ISP network bandwidth expansion does not bring considerable benefits for themselves. On the other hand, the content providers are also faced with enormous pressure. For example, every 400ms delay in search responses will result in a 0.59% drop in users' search requests for Google[7], and every 100ms increase in latency will cut profits by 1% for Amazon.

In order to further improve the efficiency of content delivery, some solutions has been proposed. Through the perception of network topology and link load information, it can optimize the transmission path of content distribution and the selection of content servers. Thus it can reduce the time delay for request and response, and improve user quality of experience (QoE).

In addition to the traditional content delivery solutions, recently, the clean-slate approaches such as software-defined networking (SDN), information-centric net-working (ICN) have emerged, which inherently have advantages in content delivery.

2. EVOLUTIONARY SOLUTIONS

2.1. The Solution for P2P and ISP:

The first solution for P2P and ISP is Oracle Network Architecture[9], which can enable ISP to help P2P to optimize the selection of service nodes, so as to improve the performance of P2P. Accordingly, in the Oracle scheme, the P2P user supplies a list of potential P2P neighbours to the oracle system operated by ISP, then the Oracle system ranks them according to certain metrics. Thus, the P2P node can

choose a more reasonable adjacent nodes based on the rank list. Hence, P2P traffic can get more reasonable guidance by the Oracle system. At the same time, the operators can use this mechanism to better manage the huge P2P traffic, such as maintaining the P2P traffic localization, optimizing the P2P traffic flow path, thereby improving the network performance.

Another P2P and ISP solution named P4P [8]. In the traditional P2P network, the selection of content nodes and transmission of content are random, which leads to inefficient network resource usage and low application performance. Accordingly, the P4P provides the iTrackers, which consist of multiple interfaces for networks to communicate with P2P applications. Moreover, the iTrackers operated by network providers can provide a lot of information regarding the network status. And the P2P clients can query the iTracker to obtain a number of desired information regarding the network providers, such as policy, distance and network capability. According to the information, P2P clients choose the better neighbour nodes and transmission links. Therefore, the P4P can effectively utilize the network bandwidth resources, reduce the backbone network transmission pressure and operating costs and improve the performance of P2P applications.

2.2. The Solution for CDN and ISP:

Nowadays, a large amount of Internet traffic is carried by CDN, and CDN has become the one of the most important content delivery technologies. However, the CDN still exists a lot of issues, which impact the efficiency of content delivery. One of the issues for CDN is the lack of the awareness for the network conditions. Namely, the CDN has to dynamically map end-users to appropriate servers without being fully aware of the network conditions within an ISP or the end-user location. As a result, the CDN and ISP are in such a situation. On the one hand, ISP has the network topology and link load status information, but the content distribution capability is insufficient, and the network is very congested. On the other hand, CDN is difficult to achieve the optimal content routing and distribution.

The solution for CDN and ISP can achieve triple-win results. For CDN, it can obtain the network information that can help the CDN improve performance, such as network topology, link load and user location. So it is not required to carry out large-scale network measurement and topology detection. For ISP, it can reduce the traffic pressure and gain better traffic management and network utilization, thereby reducing the cost of investment and operation. For users, they can get a better network experience.

To cope with the challenges driven by CDN, a solution named Provider-aided Distance Information Systems (PaDIS) [6] is proposed. The method is that PaDIS lets an ISP influence server selection of CDN by extending its DNS infrastructure. In more detail, PaDIS can discover different content servers' location, and monitor information regarding network state including topology information and connectivity information,according to this PaDIS maintain an up-to-date annotated map of the ISP network. Accordingly, PaDIS can rank lists of available servers based on the server different location and up-to-date network state. According to the server lists, PaDIS can suggest CDN to select best servers, thus the CDN can assign the best servers to users for end-user performance.

3. REVOLUTIONARY SOLUTIONS

In revolutionary solutions there are two important technologies namely SDN and ICN which includes in clean slate approach.These new approaches can make the network more flexible and controllable as well as make the content distribution more efficient. Hence, the clean-slate approaches can provide more possibilities and opportunities for efficient content delivery. In this section, we first introduce the clean slate network technologies, which include SDN and ICN. And then, we present the revolutionary solutions based on SDN and/or ICN.

3.1 Software-Defined Networking:

Software-defined networking (SDN) technology is an approach to computer networking that allows network administrators to programmatically initialize, control, change, and manage network behavior dynamically via open interfaces and provide abstraction of lower-level functionality. SDN is meant to address the fact that the static architecture of traditional networks doesn't support the dynamic, scalable computing and storage needs of more modern computing environments such as data centers. This is done by decoupling or disassociating the system that makes decisions about where traffic is sent (the SDN controller, or control plane) from the underlying systems that forward traffic to the selected destination (the data plane).

Software defined networking is an emerging network architecture that decouples the control plane from the data plane and provides programmability for network application development. These two features can bring great improvements and benefits to the current network.The network administrators can programmatically configure and manage the network in a centralized way, without requiring independently accessing and configuring each of the networks hardwaredevices.The SDN architecture is shown in fig 3.1.

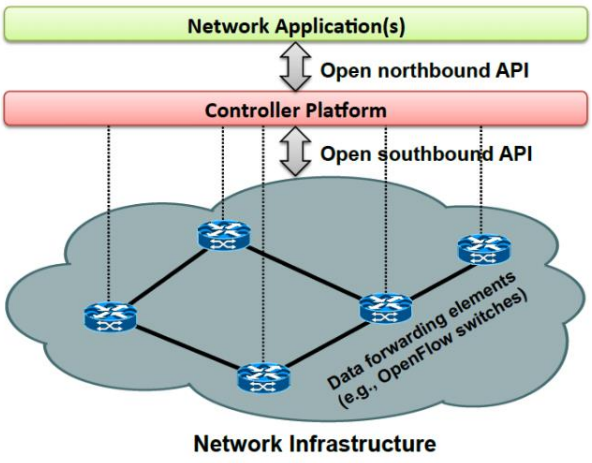

Fig 3.1. SDN Architecture

In this model, SDN architecture[5] consists of three layers, namely infrastructure layer, control layer, and application layer. The infrastructure layer consists of data forwarding devices including routers and switches, which are

responsible for collecting network status and processing data packets based on rules provided by a controller. The control layer mainly contains SDN controllers, bridging the application layer and the infrastructure layer. And network intelligence is (logically) centralized in software-based SDN controllers, which maintain a global view of the network. And the application layer contains SDN applications designed to fulfil user requirements.

3.2Information-Centric Networking:

Compare to SDN, Information-Centric Networking (ICN) is a more revolutionary network architecture which aims at achieving the content-centric communication instead of host centric end-to-end communication. Moreover some ICN oriented research projects have been gained a lot of great achievements, such as Named Data Networking (NDN) [10]. In this subsection, we briefly present NDN architecture shown in fig 3.2.

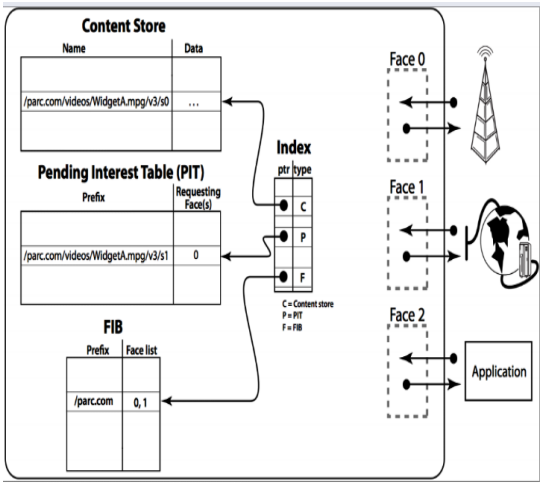

Fig.3.2. The NDN Architecture

In NDN architecture, Content consumers perform communication through exchanging two types of data packets: Interest Packets and Data Packets. And both types of packets carry a name that uniquely identifies a piece of data. In NDN architecture, the important role is of NDN router, which maintains three data structures: a Pending Interest Table (PIT), a Forwarding Information Base (FIB), and a Content Store (CS). The FIB is responsible for forwarding Interest packets toward potential sources of matching Data. The CS is responsible for caching Data packets. And the PIT is responsible for keeping track of Interests forward upstream toward content sources, so that Data can be sent downstream to its requesters.

4. ADVANTAGES AND DISADVANTAGES

Advantages:

- Evolutionary solution can be easily integrated with the current network and the complexity is relatively low.
- In revolutionary solution caching mechanism is one of the main feature of ICN which can greatly increase the efficiency of content delivery.
- Similarly as for SDN decoupling the control plane from data plane can more easily control and optimize content delivery.
- Evolutionary solutions have lowermodification cost.

Disadvantages:

- Evolutionary P2P-based solutions mainly aim at popular content delivery, but it is inefficient for unpopular content delivery.
- Revolutionary solutions have higher modification cost.

5. CHALLENGES AND FUTURE RESEARCH DIRECTIONS

Although the research of solution for efficient content delivery has made great progress, it is still a new research area with a lot of challenging issues that need to be addressed. In this section, we present some important yet challenging problems, at the same time, we also outline possible future research directions.

A] Network Monitoring:

- Although a lot of works have been done on network monitoring, there are still a lot of challenging issues to be solved.
- Recently, the big data has become an important technology and combining with the big data method has been considered as an important research point of view for the network monitoring [4].

B] Network Reliability and Security:

- Although revolutionary solutions can easily solve a lot of problems but they have many problems on network reliability.
- Therefore, improving the network reliability is an important research direction, which should be paid more attention in the future.
- Network security is a huge challenge for the revolutionary solution.Some research work regarding SDN security have been done. Besides, ICN also has lot of security Challenges which include privacy, access control [3] and attacks. Although many work have been done to try to solve this problems, network security is still an important research direction in the future.

6. CONCLUSION

This paper presents ananalysis on solution to improve the efficiency of content delivery network. We first introduce the evolutionary solutions, which include P2P-ISP, CDN-ISP, Then, the new important network techniques, including SDN and ICN, are presented. And we also discuss the revolutionary solutions which have adopted these new network technologies. Besides, we compare the evolutionary solutions and revolutionary solutions from the perspective of technology and business. And we analyse the advantages and disadvantages among the solutions. Finally, we present the challenges and future research directions. In summary, this research on efficient content delivery is of great value, and there are a lot of issues and challenges that need to be addressed. It is necessary to take much more efforts to develop more efficient, flexible and practical methods, so as to greatly improve the content delivery in the future.

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