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Pitfalls on Using NDN Over UDP for Large-Scale Scientific Data

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ABSTRACT

The future network architectures like Named Data Networking (NDN) are currently evolving to change the way how data can be transferred from one point to another. However, NDN still needs to overcome the existing problems related to the optimization, lack of different applications and tools, and overall immaturity of the protocol. At the same time, NDN expected to work on top of the existing IP network in its initial stage. Therefore, it requires to support various types of existing transportation methods including TCP and UDP. In this paper, we have shown and compared the performance of the two different transport protocol with use of NDN based climate application on top of them. Furthermore, we described the current state of those two transport protocols in NDN.

Key Words : NDN, ICN, Climate Application, UDP, TCP

Ⅰ. Introduction

Transport protocols like UDP and TCP are essential in existing IP based network. Both of this protocols can be utilized based on application requirements i.e. for not a loss sensitive and bulk data delivery, UDP is used while TCP is used for loss sensitive applications. Therefore, the majority loss sensitive application is working on TCP. NDN[1], that needs the overlay to communicate in currently existing IP networks, also provide support for these transport protocols. Depending on the type of NDN application the specific transport protocol can be chosen. At the same time, the existing NDN based congestion control algorithm[3] can be a possible way to improve the reliability of UDP without changing the actual protocol.

The Name Data Networking is a data-centric future network architecture where each packet based on hierarchically executable names. It allows the data consumer to disregard data producer actual location and communicate only with a network. Communication in NDN based mostly on two types of packets Data and Interest packet, where Interest packet is a form of the request message that contains the name of the requested data and a Data packet is an actual content that host sends back. NDN use hop-by-hop way of forwarding where each node on the path knows path only to next hop. The architecture also includes inbuilt security that is based on hierarchically signed keys and trust system, and in-network caching that will reduce network utilization, delivery time and fast retransmission of the data.

On our NDN based testbed for data-intensive science, we have deployed our climate application. Our intercontinental testbed utilizes overlay to connect two sides of our network. In our previous experiments, we have utilized the TCP as a transport protocol for the overlay part of our network. In this paper, we will investigate the performance of UDP overlay together with the NDN congestion control protocol.[4]

Ⅱ. NDN testbed over TCP and UDP

We have developed and deployed the NDN based climate data delivery application on top of our testbed. Application consist of three main blocks: climate data name translator, data server and

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client-side UI. Name translator converts the existing climate data names and metadata into the hierarchical NDN namespaces and stores them in the database. Data server respond to the request for climate data names list with metadata or actual data when client-side UI helps to search, discover and request those climate data. Currently, NDN translator supports only the Coupled Model Intercomparison Project Phase 5 (CMIP5)[6][8], latest extension of experimental framework for studying the output of atmosphere-ocean models, which climate modeling dataset names structure is highly compatible with the NDN naming scheme.

Figure 1 represents our testbed and connections between each node. The NDN consumer side (Korean Institute of Science and Technology Information (KISTI)) connected to producer side (Colorado State University (CSU)) through IP overlay network. To established connection between two NDN nodes in the IP network, NDN can utilize transport protocols like TCP or UDP. The previously performed experiments with NDN based climate data delivery over TCP have shown that it is possible to achieve the nearly full utilization of 1Gbps link with increased packet size and pipeline. In our more recent work[2] we showed that TCP together with applied NDN/AIMD[5] congestion control can increase the overall performance of the delivery. Moreover, the dynamic control of pipeline in NDN/AIMD, provide more balanced traffic load compare to the manual control. On the other hand,

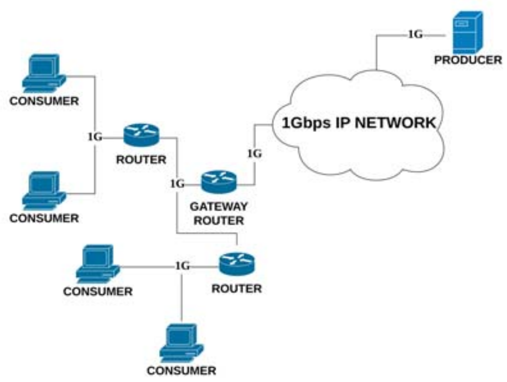

Fig. 1. NDN intercontinental testbed

the congestion control algorithms that exist in both NDN and TCP are overlapping each other which may create the extensive window control. Which makes UDP to be viewed as more matching protocol for NDN with applied congestion control. Furthermore, it can compensate for the absence of the basic reliability functions in UDP.

Initially, it was not possible to utilize UDP overlay together with bigger NDN packet sizes (over 64Kbyte) due to the absence of fragmentation function in UDP stack of NDN Forwarding Daemon (NFD)[7] platform. But from the recent updates, it became possible to perform it with packet size bigger than the previous threshold. And provide a possibility to compare two transport protocols as an NDN overlay network.

Ⅲ. Experimental Results

We have performed a delivery experiment with the use of both TCP and UDP based overlays. The experiment was done with several different packet sizes and pipeline equal 6. In Figure 2 it can be seen that overall the performance of UDP is lower compared to the TCP based delivery. The lower performance is related to the specifics of the NDN retransmission and fragmentation. Each NDN packet before being sent through overlay will be fragmented into smaller segments of UDP MTU size (64Kbyte). However, NDN platform could only retransmit NDN packet and it is known that UDP doesn’t contain any of its own reliability functions as TCP. Each lost UDP segment of certain NDN packet will cause the retransmission of whole NDN

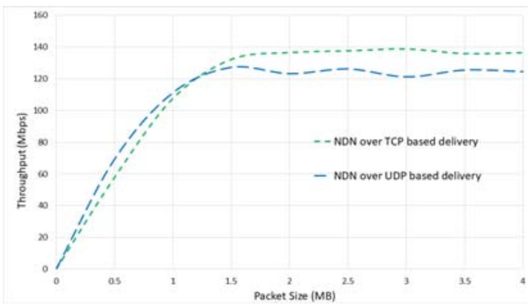

Fig. 2. Comparison of TCP and UDP overlays

packet, even though the rest of the UDP segments was delivered properly.

Figure 3 shows the comparison between NDN over UDP and conventional delivery tools like FTP and HTTP that exist in IP. The NDN over UDP is showing comparatively lower performance to both HTTP and FTP. Together with our previous experiments with TCP that highlights the beneficence of utilizing TCP overlay for large-scale scientific data transfer.

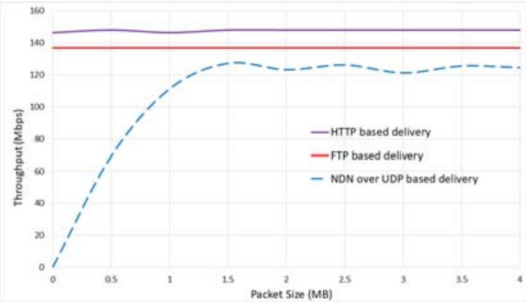

Fig. 3. Comparison of NDN over UDP and standard IP based delivery tools

Ⅳ. Conclusion

In this work, we have experimented with both NDN TCP and UDP overlays in order to compare their performance. As results have shown, even though the current implementation of NDN platform support packet over 64Kbytes, it is still lack in performance compared to the TCP based overlay. Which can be related to the immaturity of UDP fragmentation function and the point that NDN retransmission can be performed only with NDN packet and not with lost UDP segment.

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