SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA15127 RECODIS: Resilient communication services protecting end-user applications from disaster-based failures
STSM title: Experimentation of a Resilient Network Control Solution Leveraging on SDN and MPTCP
STSM start and end date: 08/04/2018 to 21/04/2018
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PURPOSE OF THE STSM/

The number of devices with an internet connection has increased very rapidly with the widespread use of smart and mobile devices. They have multiple interfaces to get connected to the internet. However, the infrastructure and commonly used communication protocols like TCP/IP support only one interface. This means that each device can only use one interface with one path to reach the target at a given time. The challenge of having one or more network paths is not used in standard TCP/IP communications and any congestion, problem, failure or disaster on this path leaves the communication vulnerable. MPTCP is one of the most significant approaches for these problems allowing using multiple subflows for the communication.

In order to sustain the connectivity in case of a technology related disaster, providing multipath connection infrastructure can be an alternative. The purpose of the STSM was utilizing MPTCP, which allows devices to establish more than one TCP connection, for minimizing the connectivity problems in case of a failure and developing an approach to increase the performance of MPTCP for providing a resilient network. It is known that the performance of MPTCP can be increased if the paths for the subflows are carefully chosen by considering the disjointness and end-to-end delay of the paths. In this STSM, we planned to investigate MPTCP performance and to develop a system for determining the paths of MPTCP subflows.

The host of the STSM was Assoc. Prof. Dr. Stefano Secci from Computer Science Department in Sorbonne University. The research related to MPTCP, SDN, LISP and resilient networks, conducted by Dr. Secci, are correlated to the purpose of this STSM.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

During the STSM, at first we investigated the performance and characteristics of MPTCP. Specifically, we were focused on the MPTCP schedulers proposed for different type of applications. While examining the works published in several journals and conferences, we also investigate the design characteristics of

various MPTCP schedulers issued in [1].

The selection of the MPTCP scheduler and the paths determined for routing the MPTCP subflows are crucial for designing a resilient network solution. The selection of the paths for routes can be done by using a technology like SDN. During the STSM, we also worked on LISP, another technology that allows to select the routes for Internet flows. SDN and LISP technologies can be used together. Lip6 research lab has a subscription to the Lisp-Lab which is a real LISP-based network installed for experimental purposes. It's planned that the system that was developed in this STSM to be tested over Lisp-Lab in order to obtain results by using a real test-bed. For this purpose, during STSM, literature related to LISP, the studies done by Dr. Secci and research group [2, 3] as well as literature about resilient networks [4, 5, 6, 7] were examined.

During these works, I also listened to different talks related to LISP and MPTCP which were given by the researchers working at LIP6. I also attended the security and performance workshop organized by Dr. Secci in Lip6. In the workshop, the participants presented their works related to performance and security aspects of ONOS and ODL.

We also had regular meeting with Dr. Secci and sometimes with the researchers from his team to discuss about ideas, research steps and possible future works related to this STSM proposal.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The investigations conducted during STSM show that the selection of scheduler selection effects MPTCP performance and in order to provide a resilient infrastructure, we should consider the delay differences between the paths of MPTCP subflows.

We investigate the design characteristics of various MPTCP schedulers issued and tested them on a simulation environment. The network topology to use for this tests is given at the below.

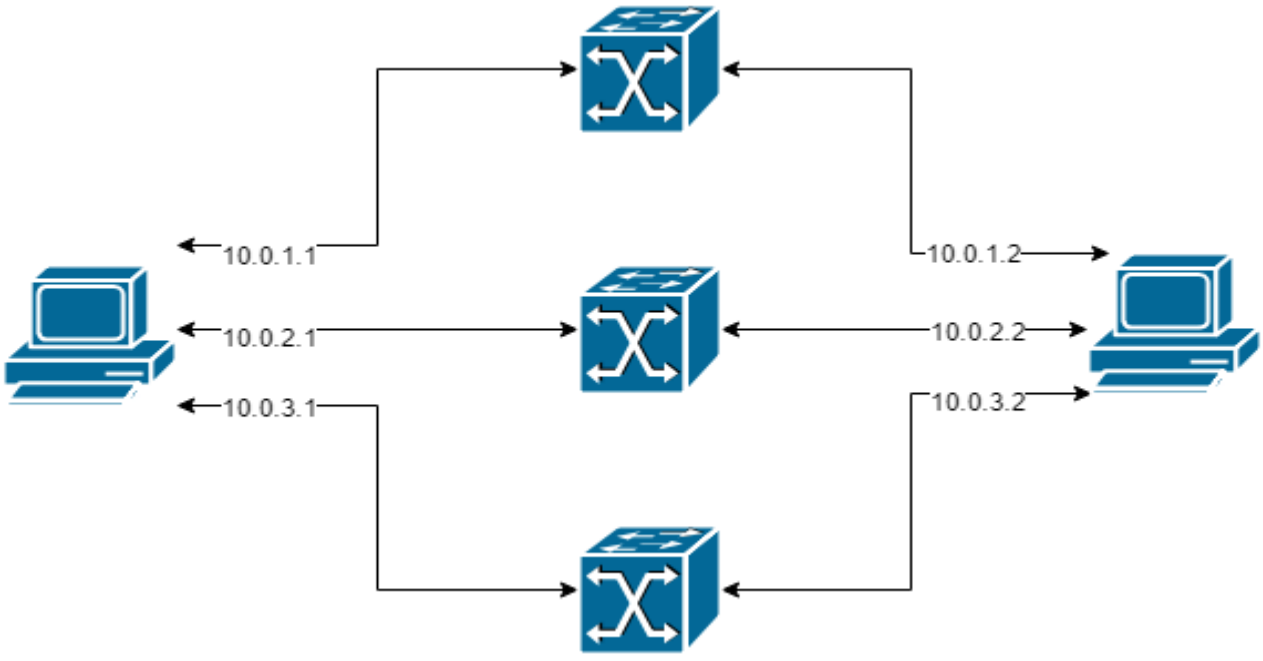

Fig.1 Network Topology for MPTCP Schedulers Tests

We design a novel MPTCP scheduler, which while considering the delay differences of the paths of MPTCP subflows selects backup paths. The parameters are the length of the packets, current CWND size, lost packets and RTT. The scheduler was designed as the paths whose delay differences are below a certain threshold are selected as main paths for MPTCP subflows while the paths having different delay characteristics are utilized as backup routes. Backup paths will be used as redundant paths for sending unacknowledged packets.

We used two different delay sets for our tests. The first test set which is called as optimistic has 200 ms delay for all paths. On the other hand, the second one which is called as pessimistic have different delays of 50, 200 and 350 ms.

In the optimistic test environment, we observed an average of 410 ms idle time for per path with %1 difference. In the pessimistic test environment, we observed same average idle times but there was %85 difference between the lowest and highest idle times. This indicates that our scheduler algorithm uses the high RTT paths only for backup transfers and it shows that those paths are used less frequently.

Similar tests were done in MPTCP's default schedulers. It has been observed that with "Round Robin" scheduler, the higher RTT subflow kept the others waiting. It has been observed that the performance of the "default" scheduler decrease with high latency differences on the paths. This indicates that in some cases the usage of multi paths is not a good choice. We didn't observe this problem on our scheduler because of the threshold usage. The amount of packets sent by "Redundant" Schedular is 38% higher. The reason for this difference is that our algorithm uses the highest RTT paths for backups and use it to sends the unacknowledged packets.

References:

[1] A. Frömmgen, A. Rizk, T. Erbshäußer, M. Weller, B. Koldehofe, A. Buchmann, R. Steinmetz “A Programming Model for Application-defined Multipath TCP Scheduling”, Middleware ’17, December 11–15, 2017, Las Vegas, NV, USA.

[2]C. Phung, M. Coudron, S. Secci, "Internet Acceleration with LISP Traffic Engineering and Multipath TCP", Proc of 21st Conference on Innovation in Clouds, Internet and Networks (ICIN 2018), Feb. 20-22, 2018, Paris, France.

[3] B. Felix, I. Steuck, A. Santos, S. Secci, M. Nogueira, “ Redundant Packet Scheduling by Uncorrelated Paths in Heterogeneous Wireless Networks”, Proc. of 23rd IEEE Symposium on Computers and Communication (ISCC 2018), June 25-28, 2018, Natal, Brazil.

[4] D. Andersen, H. Balakrishnan, F. Kaashoek, and R. Morris, “Resilient overlay networks”, SIGCOMM Comput. Commun. Rev. 32, 1 (January 2002).

[5] R. M. Ramos, M. Martinello and C. Esteve Rothenberg, "SlickFlow: Resilient source routing in Data Center Networks unlocked by OpenFlow," 38th Annual IEEE Conference on Local Computer Networks, Sydney, NSW, 2013, pp. 606-613.

[6] J. T. Araújo, R. Landa, R. G. Clegg and G. Pavlou, "Software-defined network support for transport resilience," 2014 IEEE Network Operations and Management Symposium (NOMS), Krakow, 2014, pp. 1-8.

[7] N. L. M. v. Adrichem, B. J. v. Asten and F. A. Kuipers, "Fast Recovery in Software-Defined Networks," 2014 Third European Workshop on Software Defined Networks, Budapest, 2014, pp. 61-66.

FUTURE COLLABORATIONS (if applicable)

We are planning to connect to the Lisp-Lab network by connecting a server in Ege University. The approaches developed in this STSM will be implemented over Lisp-Lab and it's planned that the results will be submitted to an international conference. We are planning to enhance this work and submit the enhanced work to a SCI journal.

The outcomes of this STSM will be included in a chapter of COST RECODIS book.

We are also planning to submit a joint project under France and Turkey Cooperation Program.