SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

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

Action number: CA15127
STSM title: Joint Preparation of Chapter 1.5 and Chapter 2.9 of RECODIS Book
STSM start and end date: 25/11/2018 to 7/12/2018
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PURPOSE OF THE STSM

On a previous STSM where Amaro de Sousa visited KTH between 21 of March of 2018 and 28 of March of 2018, a joint work has started (involving Amaro de Sousa, Marija Furdek, Carlos Natalino and Lena Wosinska) on optimization methods and algorithms for improving the robustness of Content Delivery Networks (CDNs) to malicious link cut attacks. This joint work is addressing one of the essential problems in CDN planning which is the replica placement problem (RPP). The focus is a combination of two key aspects: the minimization of the distance between the users and replicas (it reduces communication latency and network resource usage) and the robustness of the network to malicious link cut attacks. To achieve a comprehensive evaluation of the trade-offs between distance minimization and robustness to link cut attacks, the problem is being tackled in two steps: (i) the k-best replica placement problem aimed at minimizing the average user-replica distance and (ii) the critical link set detection which allows us to identify the p most critical links whose cutting causes maximum service disruption. A framework was developed to compute Pareto-optimal solutions that can be applied to real-world network topologies.

Clearly, the joint work under development includes the adoption of appropriate measures for the evaluation of the network vulnerability to link cut attacks (which is the primary objective of Chapter 1.5) and also the adoption of appropriate optimization methods to improve network robustness to link cut attacks (which is the primary objective of Chapter 2.9). Moreover, the KTH team has also other recent published research results which also fit in the aims of these two chapters. So, the main purpose of this STSM was to jointly work on the content of these two RECODIS book chapter: Chapter 1.5 “Structural measures to evaluate network vulnerability to attacks” whose main editor is Carlos Natalino from KTH and Chapter 2.9 “Structural methods to improve network robustness to attacks” whose main editor is Amaro de Sousa.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

- The content of the recent KTH works published in [1,2,3] and the recent joint work between KTH and IT teams published in [4] were analysed and the appropriate contributions for each of the two chapters were identified.
- The identified contributions to Chapter 2.9, edited by Amaro de Sousa, were partially written during the STSM and are being now finalised.
- New computational results were generated with the purpose of being included in Chapter 2.9 (the aim is to have more illustrative examples and to avoid copyright issues with the published articles).

- As follow-up joint work, new research results were generated that extend the previous work published in [4] for the case of hierarchical CDNs.

[1] C. Natalino, A. Yayimli, L. Wosinska and M. Furdek, “Content accessibility in optical cloud networks under targeted link cuts”, in Int. Conference on Optical Network Design and Modeling (ONDM), Budapest, Hungary, May 2017

[2] C. Natalino, A. Yayimli, L. Wosinska and M. Furdek, “Link addition framework for optical CDNs robust to targeted link cut attacks”, Int. Workshop on Resilient Networks Design and Modeling (RNDM), Alghero, Italy, Sept 2017

[3] C. Natalino, A. Yayimli, L. Wosinska and M. Furdek, “Infrastructure upgrade framework for Content Delivery Networks robust to targeted attacks”, Optical Switching and Networking, vol. 31, 202–210, 2019

[4] C. Natalino, A. de Sousa, L. Wosinska and M. Furdek, “On the trade-offs between user-to-replica distance and CDN robustness to link cut attacks”, Int. Workshop on Resilient Networks Design and Modeling (RNDM), Longyearbyen, Sweden, Aug 2018

DESCRIPTION OF THE MAIN RESULTS OBTAINED

One of the main obtained results is the identification of the most appropriate contributions to each of the two chapters:

- The work in [1] is to be included in Chapter 1.5 as a contribution for the CDN vulnerability evaluation to link cut attacks.
- The works in [2,3] are to be split over the two chapters. The vulnerability evaluation part will be included in Chapter 1.5. The methods to improve the CDN robustness to link cut attacks based on new network links [2] and new CDN replica locations [3] will be included in Chapter 2.9.
- The work in [4] is to be included in Chapter 2.9 as a structural method to improve CDN robustness to link cut attacks.

Concerning the edition of the chapters, most of the time was dedicated to write the contributions for Chapter 2.9 and to produce new computational results to be included in these contributions. The aim is to have results that can be used as illustrative cases and, at the same time, to avoid using the results of the original works due to copyright issues.

Concerning the follow-up of the joint work, the previous work in [4] was extended to consider hierarchical CDNs. The methodology was adapted to this case and the previous developed framework adapted accordingly. Meanwhile, new computational results were generated and will be submitted to the special issue of Networks journal dedicated to RNDM 2018.

FUTURE COLLABORATIONS

It is planned to keep the collaboration between the two teams. Future collaboration includes the generalization of the work conducted so far to consider the dynamical move of replicas between DCs so as to react to ongoing link cut attacks.