

SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA15127

STSM title: Resilient communication services protecting end-user applications from disaster-based failures (RECODIS)

STSM start and end date: 12/03/2019 to 18/03/2019

Grantee name: Torsten Braun

PURPOSE OF THE STSM:

Mobile Edge Computing (MEC, aka Multi-Access Edge Computing) is an emerging network paradigm in future mobile networks, in particular in 5G and beyond networks for Ultra-Reliable Low Latency Communications. MEC aims at pushing services for applications towards virtualized computing and storage infrastructures at the edge of the network, e.g., close to the wireless base station, such that communication between user equipment and service entity experiences low delay. Moreover, adaptation to wireless link level characteristics can increase the reliability of the communication, e.g., by adapting media encoding and forward error correction in the communication depending on physical layer link characteristics such as signal strength, packet loss, etc. An important MEC service is caching, which allows to provide requested content with low delays to the users. Caching can be supported by proactive content placement and / or communication mechanisms with built-in caching support such as Information-Centric Networking (ICN). Thus, MEC can be considered as a promising mechanism to support ultra-reliable and low-delay communication. On the other hand, in a mobile scenario with highly mobile users (pedestrians, vehicles), content and services might have to migrate through the network as users migrate through the network as well. This might have some impact on the reliability and delay for the services offered to the end user. Moreover, the deployment and instantiation of MEC services might raise a reliability issue as well. Thus, while MEC can improve latency and reliability of services, reliability measures for MEC must be foreseen as well.

The STSM discussed and investigated the opportunities and challenges of MEC and ICN to support ultra-reliability and low-latency communications. We started to draft an overview of the state-of-the-art on reliability and low-latency in MEC- and ICN-assisted networks.

In addition, new research challenges have been identified. We aim to develop new research proposals on such topics. More detailed topics addressing low-latency and ultra-reliability in MEC and ICN-assisted networks are

- (ICN) Caching
- Proactive content placement
- Virtualization techniques for MEC
- Service placement and load balancing
- Service migration
- Mobility prediction
- Applications for URLLC communications, in particular virtual and mixed reality

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

We have started a literature study on the related work in MEC and ICN to support ultra-reliable and low-latency communications. More details see in the Description of the main results. The literature study will be the basis for a chapter of the planned RECODIS book.

A seminar talk has been organized. More information about the talk is available at

<https://www.cisuc.uc.pt/home/news/deicisucseminars28>

There were several discussions between the grantee and other professors at Universidade de Coimbra, namely Prof. Edmundo Monteiro, Prof. Marília Curado, Prof. Fernando Boavida, Prof. Helder Araujo, Prof. Paulo Simoes on the topics of the seminar talk as well as on potential topics for future research projects and collaborations.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

For the RECODIS book a chapter on “Resilience in Information-Centric Networks” has been drafted. The chapter is currently based on the following references:

1. Schiller E, Nikaein N, Kalogeiton E, Gasparyan M, Braun T: CDS-MEC: NFV/SDN-based Application Management for MEC in 5G Systems, Elsevier Computer Networks, Volume 135, 22 April 2018, pp. 96-107, <https://doi.org/10.1016/j.comnet.2018.02.0132>.
2. Eryk Schiller, Eirini Kalogeiton, Torsten Braun, Andr Gomes, Navid Nikaein: ICN/DTN for Public Safety in Mobile Networks, in: Daniel Cmara, Navid Nikaein (eds.): Wireless Public Safety Networks 3, Elsevier, 2017, pp. 231-247, <https://doi.org/10.1016/B978-1-78548-053-9.50011-13>.
3. B. Ahlgren, C. Dannewitz, C. Imbrenda, D. Kutscher and B. Ohlman, “A survey of information-centric networking,” in IEEE Communications Magazine, vol. 50, no. 7, pp. 26-36, July 2012.
4. Vasilis Sourlas, Onur Ascigil, Ioannis Psaras, and George Pavlou: Enhancing Information Resilience in Disruptive Information-Centric Networks, IEEE Transactions on Network and Service Management, Vol. 15, No. 2, June 2018.
5. E. Monticelli, B. M. Schubert, M. Arumathurai, X. Fu and K. K. Ramakrishnan: An information centric approach for communications in disaster situations, 2014 IEEE 20th International Workshop on Local and Metropolitan Area Networks (LANMAN), Reno, NV, 2014, pp. 1-6.
6. H. M. A. Islam, A. Lukyanenko, S. Tarkoma and A. Yla-Jaaski: Towards disruption tolerant ICN,” 2015 IEEE Symposium on Computers and Communication (ISCC), Larnaca, 2015, pp. 212-219.
7. I. Psaras, L. Saino, M. Arumathurai, K. K. Ramakrishnan and G. Pavlou: Name-based replication priorities in disaster cases, 2014 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), Toronto, ON, 2014, pp. 434-439.
8. G. Tyson, J. Bigham and E. Bodanese, Towards an information-centric delay-tolerant network, IEEE Conference on Computer Communications Workshops (INFOCOM WK-SHPS), Turin, 2013, pp. 387-392.
9. G. Tyson, E. Bodanese, J. Bigham and A. Mauthe, Beyond content delivery: can ICNs help emergency scenarios?, in IEEE Network, vol. 28, no. 3, pp. 44-49, May-June 2014
10. M. F. Al-Naday, M. J. Reed, D. Trossen and K. Yang, Information resilience: source recovery in an information-centric network, in IEEE Network, vol. 28, no. 3, pp. 36-42, May-June 2014.
11. V. Sourlas, L. Tassiulas, I. Psaras and G. Pavlou, Information resilience through user-assisted caching in disruptive Content-Centric Networks, 2015 IFIP Networking Conference (IFIP Networking), Toulouse, 2015, pp. 1-9.
12. Y. Yu, J. Joy, R. Fan, Y. Lu, M. Gerla and M. Y. Sanadidi, “DT-ICAN: A Disruption-Tolerant Information-centric Ad-Hoc Network,” 2014 IEEE Military Communications Conference, Baltimore, MD, 2014, pp. 1021-1026.
13. Carlos Anastasiades, Tobias Schmid, Jürg Weber, Torsten Braun: Information-centric content retrieval for delay-tolerant networks, Computer Networks, Volume 107, Part 2, 2016, pp. 194-207.
14. Joao M. Duarte, Eirini Kalogeiton, Ridha Soua, Gaetano Manzo, Maria Rita Palattella, Antonio Di Maio, Torsten Braun, Thomas Engel, Leandro A. Villas, Gianluca A. Rizzo: A Multi-Pronged Approach to Adaptive and Context Aware Content Dissemination in VANETs, Springer Mobile Networks and Applications, October 2018, Volume 23, Issue 5, pp 1247-1259

FUTURE COLLABORATIONS (if applicable)

Universidade de Coimbra and Universität Bern identified several topics to be considered for upcoming EU project proposals. Such topics are 5G and beyond networks, fog computing, Internet of Things (in particular security). We mutually plan to assign co-referees for upcoming Ph.D. thesis defenses.