Newsletter

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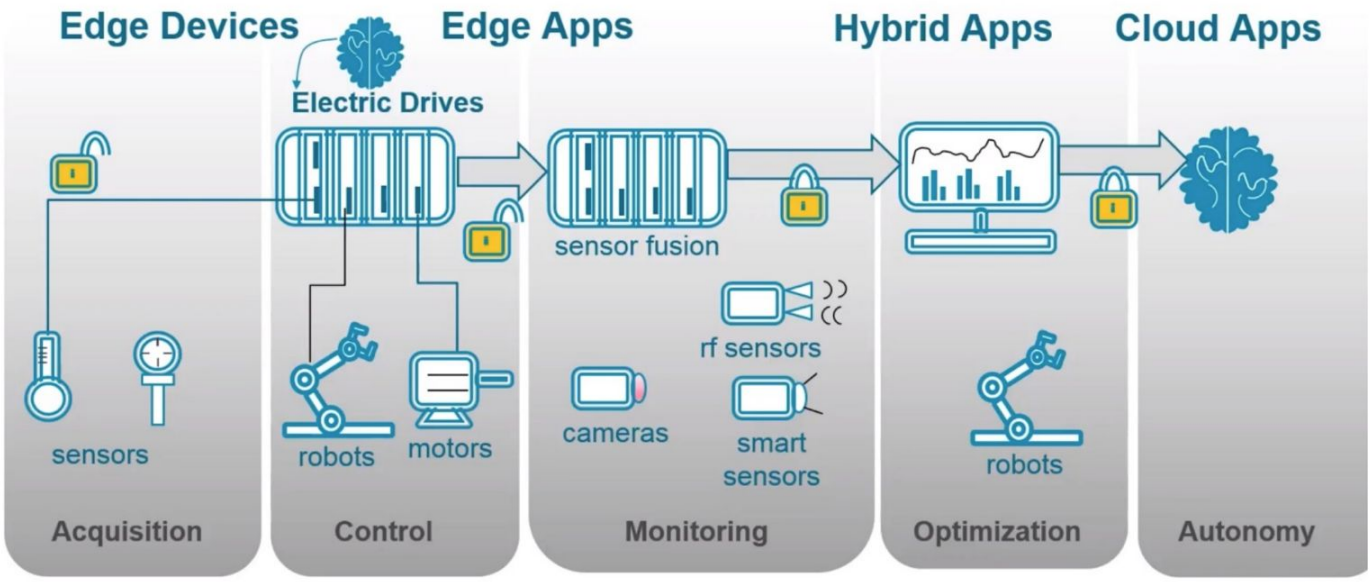


FORA—Fog Computing for Robotics & Industrial Automation

Dear readers,

Welcome to the third issue of the FORA newsletter. Within this newsletter, you will find information about the progress of the FORA International Training Network (ITN) from Winter 2019. As you are well aware, we are in the midst of the Corona pandemic which has made us to stay safe by **isolating** ourselves, to **adapt** to new modes of living and to **virtualize** our lives. In a lighter vein, these three aspects summarize the core of what the FORA project strives to achieve technically. However, despite these challenges, the FORA project is going smoothly with all the activities happening as planned.

We are very happy about the progress of our training network. Let's zoom in!

* FORA project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 764785,

Publications

Full list of published papers can be found at the link below:
Link: fora-etn.eu/publication

Secondments

Koen Pieter Tange
Sysgo, April-May 2020

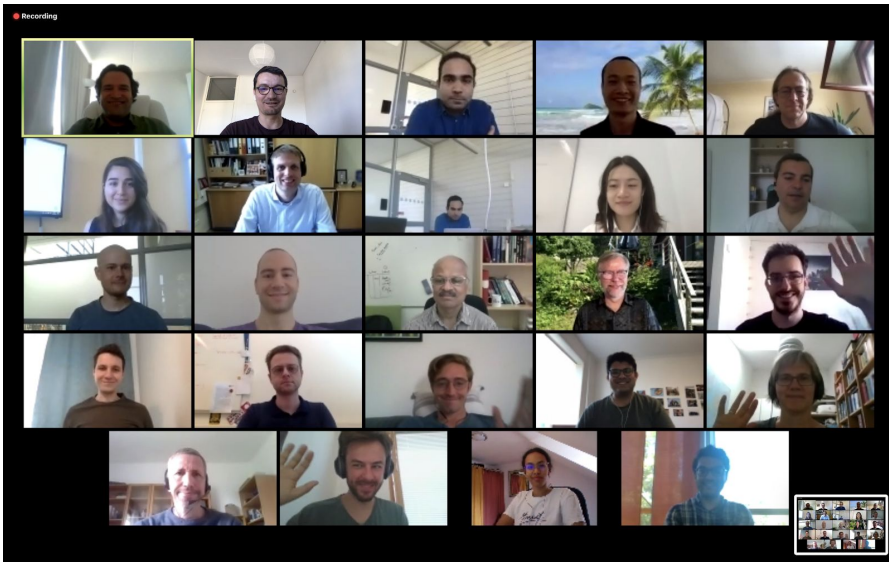
Jia Qian
TUKL, March-June 2020

Cosmin Avasalcai
MDH, March-April 2020
DTU, November 2019

FORA Summer School at Mälardalen University

This year the summer school TS3 was held on-line at Mälardalen University, Västerås. The ESRs were offered several courses that are relevant to enhance expertise in fog computing: Optimization Techniques (given by Stefan Schulte, TU Vienna), Introduction to deep learning (Sima Sinaei, MDH) and Innovation and Entrepreneurship (IdéLab team, MDH).

A virtual meeting in progress...



Paper Highlights

The FORA Use-case papers exemplify the **F**og **C**omputing **P**latform (**FCP**) with the help of industrial use-cases from our industrial partners in the project - Danfoss, ABB & TTTech.

These were presented at the Emerging Technologies for Factory Automation Conference (ETFA) held in Vienna from Sep. 8-11 2020. This is the first time that a conference has been held in a hybrid manner - with onsite presence as well as online presentations seamlessly synchronized.

Alexandre Silva Venito
Sysgo, October-March 2020

News from ESRs

Jia Qian, DTU
The paper "A Noble Double Dictionary based ECG Compression Technique for IoTH" was accepted by IEEE Internet of Things Journal in February. It designed a two-dictionary framework for ECG compression in IoT healthcare. The proposed compression scheme achieves both energy and space efficiency, low reconstruction error, and it is robust to noise during the wireless transmission and aware of the dynamic statistics change during compression.

Nitin Desai, MDH
A workshop paper titled - “Enhancing Fault Detection in Time Sensitive Networks using Machine Learning” was presented at the COMSNETS conference in Bangalore, India on 07.01.2020.

Paper - “Addressing the Node Discovery Problem in Fog Computing” was accepted at Fog-IoT workshop at CPS-IoT Week, Sydney 2020.

On April 21, Nitin had the chance to present this work to all the participants of Fog-IoT, and further discuss various aspects and challenges related to discovering and integrating compute nodes in fog computing systems. The paper is currently published open access by

Reza (ESR8) [top] explaining the Danfoss use-case and **Patrick** (ESR7) [bottom] presenting TTTech use-case at the TU Wien to an eager audience of researchers from around the globe.

Van-Lan Dao (MDH) presented his licentiate proposal at MDH on 29/9 titled "Performance enhancements and analysis of pairwise NOMA". In Sweden, the Licentiate proposal is a precursor to the Licentiate degree which is considered as a half-way point in the journey towards PhD.

Schloss Dagstuhl-Leibniz-Zentrum für Informatik.
The paper titled - "Fogification of Electric Drives - an industrial use-case" was published in the IEEE ETFA20 conference held in Vienna from Sep. 8-11 '20.

Vaclav Struhar, MDH
Vaclav has published a paper exploring the topic of real-time container-based virtualization. The paper has been published at the Fog-IoT workshop at CPS-IoT Week, Sydney 2020.

Vaclav presented his paper "DART: Dynamic Bandwidth Distribution Framework for Virtualized Software Defined Networks" at the 45th Annual Conference of the IEEE Industrial Electronics Society (IECON19) in Lisbon, on 14.10.2019. The paper focuses on a flexible network bandwidth distribution in virtualized SDN networks. The framework presented aims to maintain Quality of Service in large virtual networks utilizing the same physical infrastructure.

Mohamadreza Barzegaran, DTU
Reza's paper titled "Quality-of-control-aware scheduling of communication in TSN-based fog computing platforms using constraint programming" was accepted for publication in the 2nd Fog-IoT workshop held in Australia.
Due to COVID19 Crisis, the workshop was held online. The paper is published by Schloss Dagstuhl-Leibniz-Zentrum für Informatik.

Vaclav (ESR9), **Salman** (ESR15) & **Lan** (ESR4) after a successful presentation of the ABB use-case paper at ETFA'20.

Further News from ESRs

Cosmin Florin Avasalcai, TU Wien

The paper titled " Efficient Hosting of Robust IoT Applications on Edge Computing Platform" was accepted for publication in the ICFEC 2020 conference held in Australia. However, due to COVID19, the conference was postponed until 2021, where the paper must be presented.

Vasileios Karagiannis, TU Wien

The second secondment of Vasileios, that was planned for August-October 2020 in MDH, was unfortunately canceled due to the coronavirus outbreak. Despite not being physically located in MDH, Vasileios collaborates with the ESRs from MDH using virtual meetings. This collaboration has contributed to an accepted paper in the International Conference on Emerging Technologies and Factory Automation (ETFA 2020), titled "Enabling Fog-based Industrial Robotics Systems". In February 2020, the paper titled "Addressing the Node Discovery Problem in Fog Computing" co-authored by Vasileios and Nitin was accepted for publication in the 2nd Workshop on Fog Computing and the IoT (Fog-IoT 2020).

Patrick Denzler, TU Wien

With the end of June 2020, a complete AADL model of an OPC UA / DDS gateway was finished. The model will be available to the public via a git repository to support further research in the area. A publication about the model is in progress. Patrick shares his

Reza presented his paper titled "Fogification of electric drives: An industrial use case" at the IEEE International Conference on Emerging Technologies and Factory Automation in September 2020.
He recently applied for "Fabrikant Mads Clausens fond" to run "Fog Computing Industry 4.0 demonstration" in DTU IoT Lab and it has been accepted. With this grant, It is possible for all PhDs in DTU, Nordic Universities and of course FORA to use the lab.

Zeinab Bakhshi, MDH

The paper titled "Cost-Aware Task Scheduling in Fog-Cloud Environment" was accepted for publication in the RTEST Conference held virtually due to COVID'19 Crisis. The paper is published in IEEE.

Jan Ruh Education, TTTech

The paper titled: Towards Consolidating Industrial Use Cases on a Common Fog Computing Platform is presented at the ETFA 2020 in Vienna. The article is a collaboration between Marine Kadar, Jan Ruh, Cosmin Avasalcai and Patrick Denzler, four ESRs in FORA.

Marine Kadar, SYSGO

In cooperation with the Technical University of Kaiserslautern, Marine Kadar has been implementing an anomaly detection engine prototype for PikeOS's SYSGO hypervisor. The solution is based on the observation of hardware and software system events at

feedback on how work-life has changed during the pandemic. As everyone would agree, the social implications of work from home are quite severe with reduced interaction and access to other resources such as high bandwidth Internet, printers, books etc in a university environment. Online conferences are not as exciting in comparison to onsite conferences which allows collaborations and networking.

Cosmin Florin Avasalcai, TU Wien
During this period, Cosmin visited the Technical University of Denmark where I worked on a collaboration paper. His work aims at providing a more flexible IoT application model to enable the efficient utilization of available resources found on edge and fog devices. The result of his collaboration was submitted to ICFEC 2020 as a technical paper. His work has received good reviews and was accepted for publication in the conference proceedings.

Recent Publications :

- Shaik MS, Struhár V, Bakhshi Z, Dao VL, Desai N, Papadopoulos AV, Nolte T, Karagiannis V, Schulte S, Venito A, Fohler G. Enabling Fog-based Industrial Robotics Systems. In The 25th International Conference on Emerging Technologies and Factory Automation ETFA 2020 (link)
- Avasalcai C, Zarrin B, Pop P, Dustdar S. Efficient Hosting of Robust IoT Applications on Edge Computing Platform. In 2020 IEEE 4th International Conference on Fog and Edge Computing (ICFEC), May 2020 (link)
- Barzegaran M, Desai N, Qian J, Tange K, Zarrin B, Pop P, Kuusela J. Fogification of electric drives: An industrial use case. In The 25th International Conference on Emerging Technologies and Factory Automation ETFA 2020, Sep 2020
- Karagiannis V, Schulte S. Comparison of alternative architectures in fog computing. In2020 IEEE 4th International Conference on Fog and Edge Computing (ICFEC) 2020 (link)
- Struhár, V., Behnam, M., Ashjaei, M., & Papadopoulos, A. V. (2020). Real-Time Containers: A Survey. In 2nd Workshop on Fog Computing and the IoT (Fog-Io 2020). 2020. (link)
- Barzegaran M, Zarrin B, Pop P. Quality-of-control-aware scheduling of communication in TSN-based fog computing platforms using constraint programming. In2nd Workshop on Fog Computing and the IoT (Fog-IoT 2020) 2020. Schloss Dagstuhl-Leibniz-Zentrum für Informatik. (link)
- Kadar M, Tverdyshev S, Fohler G. Towards Host Intrusion Detection for Embedded Industrial Systems. In2020 50th Annual IEEE-IFIP International Conference on Dependable Systems and Networks-Supplemental Volume (DSN-S), January 2020 (link)
- Kyriakakis E, Lund M, Pezzarossa L, Sparsø J, Schoeberl M. A time-predictabl open-source TTEthernet end-system. Journal of Systems Architecture. February 2020 (link)
- Karagiannis V, Desai N, Schulte S, Punnekkat S. Addressing the Node Discovery Problem in Fog Computing. In2nd Workshop on Fog Computing anc the IoT (Fog-IoT 2020) 2020. Schloss Dagstuhl-Leibniz-Zentrum für Informatik (link)
- Qian J, Tiwari P, Gochhayat SP, Pandey HM. A Noble Double Dictionary based ECG Compression Technique for IoTH. In IEEE Internet of Things

runtime. She presented the paper "Towards Host Intrusion Detection For Embedded Industrial Systems", which introduces basic principles for design and integration of the security tool into a mixed-criticality environment, at the 50th conference on Dependable Systems and Networks Industry track on 30 June.

Mohammed Salman, ABB
In September 2020, Salman presented the paper "Enabling Fog-based Industrial Robotics Systems" at the IEEE International Conference on Emerging Technologies and Factory Automation (ETFA'20). The paper discusses a system involving robots and robot cells at a factory level, and then highlights the main building blocks necessary for achieving such functionality in a fog-based system. Further, we elaborate on the challenges in implementing such an architecture, with emphasis on resource virtualization, memory interference management, real-time communication and the system scalability, dependability and safety. We then discuss the challenges from a system perspective where all these aspects are interrelated.

Eleftherios Kyriakakis, DTU
By the end of June 2020, we developed a WCET-analyzable bare-metal framework that allows us to schedule, synchronize and execute real-time tasks. We integrated this framework with TTEthernet and evaluated it using an example control application. The work-in-progress results will

Journal. February 2020. (link)
- Desai N, Punnekkat S. Enhancing Fault Detection in Time Sensitive Networks using Machine Learning. In Workshop on Machine Intelligence in Networked Data and Systems (MINDS). January 2020. IEEE. (link)
- Bakhshi Z, Rodriguez-Navas G. A preliminary roadmap for dependability research in fog computing. In ACM SIGBED Review. January 2020. (link)
- Kyriakakis E, Sparsoe J and Schoeberl M. InterNoC: Unified Deterministic Communication For Distributed NoC-based Many-Core. In Junior Researcher Workshop on Real-Time Computing (JRWRT). November 2019. (link) *Best Junior Paper Award*
- De Donno M, Tange K, Dragoni N. Foundations and Evolution of Modern Computing Paradigms: Cloud, IoT, Edge, and Fog. In IEEE Access. October 2019. 15(7). (link)
- Tsigkanos C, Avasalcai C, Dustdar S. Architectural Considerations for Privacy on the Edge. In IEEE Internet Computing. October 2019. 23(4). (link)
- Struhár V, Ashjaei M, Behnam M, Craciunas SS, Papadopoulos AV. DART: Dynamic Bandwidth Distribution Framework for Virtualized Software Defined Networks. In Annual Conference of the Industrial Electronics Society (IECON), October 2019. IEEE. (link)
- Desai N, Punnekkat S. Safety-oriented flexible design of Autonomous Mobile Robot systems. In International Symposium on Systems Engineering (ISSE). October 2019. IEEE. (link)
- Cervin A, Pazzaglia P, Barzegaran M, Mahfouzi R. Using jittertime to analyze transient performance in adaptive and reconfigurable control systems. In International Conference on Emerging Technologies and Factory Automation (ETFA). September 2019. IEEE. (link)
- Meixner S, Schall D, Li F, Karagiannis V, Schulte S, Plakidas K. Automatic Application Placement and Adaptation in Cloud-Edge Environments. In International Conference on Emerging Technologies and Factory Automation (ETFA). September 2019. IEEE. (link)
- Bakhshi Z, Balador A. An Overview on Security and Privacy Challenges and Their Solutions in Fog-Based Vehicular Application. In International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC Workshops). September 2019. IEEE. (link)

be presented in EMSOFT 2020 and the goal is to compare the synchronization of computation tasks with communication tasks with asynchronized task execution.
We are now working on extending this framework into a multi-core implementation. We are also searching for distributed real-time benchmarks to evaluate its scalability and performance.