White Paper for Software Defined Infrastructure / Software Defined Exchange Workshop

Michael Zink, University of Massachusetts Amherst

One major research area I am particular interested in and which I believe is of significant importance in the future is the support of Cyberphysical Systems (CPS) through SDI. With SDI not only the network, but also computation and storage, are software defined and thus important components that are required by CPS can be composed via SDI. (Examples for such CPS are autonomous vehicles, drones, smart grids, and sensing systems.) We have demonstrated the benefits of such an approach in our GENI Engineering Conference (GEC) 19 plenary demo "Towards Software Defined Infrastructure", where we gave a conceptual demo of an SDX and showed the potential benefits for CPS. During the implementation of this demo we already realized the power of prototype SDX implementations (in this case the GENI prototype implementations at StarLight and SoX). Without such prototypes it is unlikely that SDI/SDX research will ever "leave the simulator". Such prototype SDX are especially important when it comes to CPS where many research projects use real systems that in turn use real networks. Research problems that have to be addressed to support CPS through SDI/SDX are the interconnection of software-defined networks and NFV with other types of resources and the evaluation of potential solutions in SDX prototypes. This would potentially require the integration of one or several SDX with actual CPS to build a full-fledged end-to-end system. Furthermore, it has to be investigated to what extent SDI/SDX-based infrastructures can meet the real-time constraints of CPS. I am in particular interest in investigating how SDI can support cloud-based signal processing as in the case of CRANs.

An additional research area that is of great interest to me is the question to what extend SDI/SDX can support the vision of a "sliceable Internet". I believe that an SDI infrastructure supported by SDX will be another step towards reaching the vision of a fully sliceable Internet in which several network architectures (e.g., TCP/IP and ICN) co-exist in isolated slices. I am, in particular, interested in researching the interplay between SDX and the individual layer 3 protocols to achieve such large-scale (potentially global), performance-isolated slices. To work towards this vision a solution has to be found that supports the operation of different network stacks on top of the same physical hardware. One important research topic for this approach is the slicing of resources for multi-domain infrastructures. In this case, this does not only include network resources but also computation and storage, since they support in-network storage and computation (e.g., NFV). Resources like SDX/SDI prototypes and cloud testbeds (e.g., Chameleon or CloudLab) will greatly support research in this area.

Since 2007, I have been involved in the NSF GENI initiative as PI and co-PI for four different GENI projects. I started in GENI whit a project on sensor virtualization that introduces the concept of "slicing" all the way to the edge (sensors in this case). In our second project (Data Intensive Cloud), we developed a complete environment for researchers to conduct data-intensive experiments in GENI from start (the data collection point) to finish (processing and archiving). As part of the GIMI project, we developed a measurement and instrumentation architecture that allows experimenters to orchestrate and instrument their experiments on GENI testbeds. I'm currently leading a project that creates course modules that can be executed on top of GENI testbeds and be used by teachers in computer networks and distributed system classes. In addition, I am a member of the GENI architects group. Outside GENI I serve as the co-Director for the NSF Engineering Research Center for Adaptive Collaborative Sensing of the Atmosphere (CASA) which has the goal to improve severe weather forecasts and warnings. I am also a co-PI for the NSF CloudLab project.
I wish to be reimbursed for the cost that arise from attending the workshop.