Keynote

Accelerating Application Development in the Internet of Things using Model-driven Development

Pankesh Patel

SFI Confirm Centre for Smart Manufacturing, Data Science Institute, NUI Galway, Ireland

The application development for the Internet of Things poses a challenge as it deals with heterogeneity very commonly found in both the Physical world and the Cyber world. Further, application developers have to get a good grip on the varied life cycles that range from initial design and implementation to ultimate deployment. Keeping this in mind, this research talk showcases our work on two projects where we implemented an approach based on Model-driven development to realize our goals.

The first project is on IoTSuite, which is a Model-driven Toolkit for Prototyping Internet of Things Applications. Development of applications in the field of the Internet of Things (IoT) is a huge challenge as it has to tackle various interconnected issues like non-existent separation of concerns as well as abstractions for addressing both the heterogeneity and the large scale involved. Besides, developers have to fix issues found in different phases of the application life cycle. It starts with the analysis of the application logic and goes on to its separation into a distributed task set for the inherent network. Afterwards, there comes the process of implementation of tasks for a particular hardware. On top of these, developers have to be prepared for unpredictable aspects of the life cycle like a change in the requirements of the application and the devices deployed. To address the above challenges, in general, multiple approaches have been suggested spanning the interlinked areas of pervasive computing, software engineering and wireless sensor network. Nonetheless, current approaches can take care of only a few subsets of the challenges mentioned above when deployed in the context of IoT. What this research work does is propose an integrated approach to address the challenges mentioned above. This works primary contributions are: (1) a development methodology which subdivides the overall application development for IoT into a variety of concerns and lends a framework based on concepts for developing the application, (2) a development framework which focusses on implementing the development methodology to endorse stakeholder actions. The development framework offers a group of modelling languages to address each and every development concern and excerpts the complexities of both scale and heterogeneity. It brings together task-mapping, linking techniques and code generation for ensuring automation. It is in the application development phase that code generation jumps in and shines through by ensuring a programming frame-

work which enables stakeholders to stay focussed on just the application logic part. In the deployment phase, our mapping and linking techniques join hands together to produce a device-specific code. This results in a collaborative distributed system which the individual devices host. Our evaluation stemming from two very realistic situations demonstrates that using our approach leads to an improvement in the productivity of various stakeholders who develop such applications.

The objective of the second project is to close the gaps between technical experts and software solutions, leveraging model-driven tools and technologies. Rapid delivery strategies try to strike a balance between critical performance qualities and bridging the amount of time it requires for an idea to go from its inception to its software implementation. In the case of industrial software solutions which command great expertise over deliverable components, Subject Matter Experts (SMEs) with ideas, knowhow and requisite knowledge have partnered with development teams as specific requirement providers. Such human processes are not always fast optimally and are very much vulnerable to errors during translation or interpretation of requirements. They are not scalable when the software teams bring together different SMEs under one roof and try to integrate their knowledge for use in other software solutions and deployments later. For addressing such limitations, We have worked, at ABB Corporate Research, on a research initiative to produce innovative SME toolkits focusing on two objectives: (1) To fasten the process of creation, evolution, reuse, and delivery of algorithms by domain experts. (2) Streamlining algorithm deployment into various releases and fielded solutions. The fundamental idea of this initiative is empowering the SMEs as "end-user developers" to turn their domain expertise into reusable software components. It will do away with the need to learn and partner on traditional software development, integration, or deployment. The talk summarizes our experiences and the lessons we learned until now from this initiative, the important challenges which still remain and some viewpoints on how SMEs goes hand in hand with the emerging approaches for rapid development, delivery, and evolution.

Pankesh Patel *is an applied research scientist and educator in the area of system and software engineering. He focuses on building software development methodologies and tools to easily develop applications in the cross-section of software engineering, Internet of Things, and Industrial Internet of Things. Currently, he is a Marie-Curie Senior Researcher at SFI Confirm Centre for Smart Manufacturing, Data Science Institute, NUI Galway, Ireland. Before joining this position, he was a Senior Research Scientist at Fraunhofer USA Center for Experimental Software Engineering (CESE) from August 2017 to January 2019. At Fraunhofer USA, his focus was on implementation of Industrial Internet of Things (IIoT) techniques and methodologies in commercial environments. He worked as a Research Scientist in Industrial Software System (ISS) group at ABB Corporate Research-India from 2014 to 2017. He obtained his Ph.D. in Computer Science from the University of Paris VI (UPMC), France with a "highest honors" ("Tres Honorable" in French) title. His PhD was funded by the French National Institute for Research in Computer Science and Control (INRIA)–Paris, France.*