Chapter 11
Internet of Things and Cyber-Physical Systems at the University

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ABSTRACT

This chapter describes proposals for organizing university programs on the internet of things (IoT) and cyber-physical systems. The final goal is to provide a structure for a basic educational course for the internet of things and related areas. This base (template) could be used both for direct training and for building other courses, including those that are more deeply specialized in selected areas. For related areas, the authors see, for example, machine-to-machine communications and data-driven cities (smart cities) development. Obviously, the internet of things skills are in high demand nowadays, and, of course, IoT models, architectures, as well as appropriate data proceedings elements should be presented in the university courses. The purpose of the described educational course is to cover information and communication technologies used in the internet of things systems and related areas. Also, the authors discuss big data and AI issues for IoT courses and highlight the importance of data engineering.

INTRODUCTION

In our works, we addressed several times the topic of education in the field of the Internet of Things and related areas. Here you can see articles devoted to computer science and Internet of Things (IoT) education (Namiot, 2016), our paper presented on The 20th Conference of Open Innovations Association FRUCT and ISPIT 2017 seminar (Namiot, Sneps-Sneppe, & Daradkeh, 2017), and its extended version published in IJERTCS (Namiot & Sneps-Sneppe, 2017).

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Naturally, the situation in computer science is changing rapidly. Changes should be reflected in the curriculum. One of the moments of criticism of university education now is just a weak reaction to changes and large inertia. This means, of course, that there is a need to periodically update the content of the curriculum. Also, already based on the conducted training, assessments of learning outcomes appear, both from graduates and from the industry where graduates went to work. In Russia, for example, a state program for the development of the digital economy has emerged, where the training of specialists on these issues is directly put in the forefront (Sneps-Sneppe, Namiot, & Alberts, 2018). Accordingly, this article presents our current vision on this issue.

Currently, the issues related to the Internet of Things and Machine to Machine communications (M2M) are attracting a lot of attention and IoT (M2M) skills are in high demand. At the same time, many existing presentations of IoT applications and systems contain only futuristic descriptions. They are more concentrated on the public effects and their impact on everyday life and completely ignore technical details. However, all the above-mentioned acronyms (IoT, M2M) have nowadays a full line of standards, frameworks, development tools, etc. In our opinion, it is very important to study the technical aspects of IoT (M2M). By 2020, the global demand for IoT developers is estimated at 4.5 million people (Asay, 2014). This demand naturally raises the questions of deep learning for IoT technologies.

In our opinion, currently, we cannot mention a single course on the Internet of Things that covered all the aspects discussed below. Actually, there are no even unified approaches to its content and structure. Naturally, both of these technologies – IoT and M2M (or more accurately - both of these directions) did not arise in a vacuum. They are reusing and incorporating many disciplines related to information and computer technology (Computer Science). For example, network technologies are present in the curriculum and without any connection to the Internet of Things.

However, of course, we can talk about the development of specific programming architectures and models for IoT (M2M), etc. For example, some of the top-level models for IoT and M2M programming models have been published in our papers (Namiot & Sneps-Sneppe, 2014). It seems that, at least, the navigation tool for the audience (students) in the current situation in IoT (M2M) could be very useful. In our opinion, the understanding of the architectures is a key moment for development.

In the current state of our project, we are talking about a semi-annual and an annual course (depends on the educational program) which aims to introduce students to modern information technology, standing for such areas as the M2M and IoT. In this case, it refers to students studying in areas related to Computer Science. In our practice in Russia, for example, such a course could be a part of the master's program in Faculty of Computational Mathematics and Cybernetics Lomonosov Moscow State University. Ventspils University of Applied Sciences looks for some post-graduate education. Consequently, the minimum requirements are a bachelor's degree in IT technology. Also, a significant recent trend is courses that are prepared for specific corporate customers. They can be considered as customizations of basic courses.

The big question here is debatable - it is necessary or not to include here the materials for the Smart City. Very often, it is considered in conjunction with IoT, for example. In our vision, at least for now, we should not include Smart City related questions into IoT courses. Firstly, in many aspects, it seems still more related to the processes of the organization, rather than information technologies. At the same time, our idea was to stay in computer science and computer engineering domains, which include precisely IoT and M2M. In general, Smart Cities' themes should be closer to the general sections of the digital economy. On the other hand, borders are often blurred. For example, we can mention here such a popular direction as cyber-physical systems (CPS - Sanislav, Miclea, 2012). As per definition, they are engineering systems based on the interaction of software algorithms and physical objects. CPS are