

prof. Ing. Antonín Kavička, Ph.D.

Univerzita Pardubice, Fakulta elektrotechniky a informatiky, Katedra softwarových technologií
Studentská 95, 532 10 Pardubice

E-mail: Antonin.Kavicka@upce.cz

PhD-THESIS REVIEW

PhD-thesis title: **Dynamic software architectures for distributed embedded control systems**

PhD-student: Ing. Tomáš Richta

Study programme: Výpočetní technika a informatika (*Computer Science and Informatics*)

1. Review assignment

The review was prepared on the basis of the assignment (no.: 007/1493/2022) made by prof. Dr. Ing. P. Zemčík – dean of FIT VUT Brno.

2. Basic information

The PhD-thesis is structured into eight basic chapters, in which the author firstly defines the professional focus of the subject of the presented thesis and reviews the current state of the art, especially in the areas of embedded and operating systems, higher-level languages and the dynamic reconfigurability within embedded systems. Next, the attention is paid to the description of theoretical foundations related to Petri nets, Reference nets and Workflow nets. The author's concept of dynamic software architecture for distributed embedded control systems is presented in the *Design of the Solution* chapter. Then the problems of implementation of the architecture are discussed. From the point of view of verification of the author's solutions, application scenarios (or case studies) and the results of concrete experiments are demonstrated. The last chapter recapitulates the achieved results of the solution and outlines the possibilities for further research and development.

3. Analysis of the thesis

The present thesis demonstrates the author's good understanding of dynamic software architectures (applicable to distributed embedded control systems), as well as formalisms for specifying system dynamics. After studying the thesis, I have come to the following evaluation.

3.1 Originality of the thesis

In the thesis the author focused on the presentation of his own architecture design for dynamically reconfigurable distributed (embedded) control systems. The given design is also combined with a methodological procedure for building specific systems in the respective application domain. The mentioned architecture has been verified with case studies. I consider the presented architecture and the corresponding methodological procedure to be original.

3.2 Scientific level of the thesis

I evaluate the thesis positively in terms of scientific level. In this sense, I particularly appreciate the following results of the author's R&D activities (related to the above-mentioned architecture): (i) operating system based on Petri nets (determined for the application on the nodes of distributed control systems), (ii) flexible modular-oriented method for creating control applications and (iii) support for simulation-based testing.

3.3 Relation of the thesis to the study programme

The topic of the thesis clearly belongs to the relevant PhD-study programme, i.e., *Výpočetní technika a informatika (Computer Science and Informatics)*.

3.4 Relevance of the thesis in terms of the state-of-the-art

I consider the thesis to be up-to-date in terms of the current state-of-the-art. The results of the research are very applicable, for example, in the rapidly developing field of IoT (Internet of Things) or Industrial IoT.

3.5 Thesis contributions

The thesis presents the original concept of a PN-based operating system, which is designed to operate within the nodes of distributed control systems. Next, the methodology for creating control applications (using a modular approach) has been designed and verified in relevant case studies and prototype implementations. The mentioned methodology has good preconditions for use in practice by other authors (since the thesis provides a relevant prototype, which can be adapted for a specific application domain if needed).

3.6 Formal aspects of thesis document


I evaluate the overall formal aspect of the thesis document as very good. Occasional typos can be found in the work.

3.7 Questions and comments

I have the following questions or comments on the submitted thesis:

- a) In the context of testing the proposed architecture, were hardware platforms other than Arduino and Raspberry Pi tested?
- b) Would it be potentially necessary to modify certain solutions (and associated procedures) that are part of the presented architecture in terms of the cybersecurity principles?
- c) In the case studies, what were the specific experiences with simulation testing within the Renew simulation tool?
- d) I rate the author's publication activity as relevant to the focus of the thesis. It should be noted that the PhD-student's publication activity took place mainly in the years 2012-2018 (one additional publication is registered within the Scopus and Web of Science databases still in 2020).

4. Conclusion of the review

After a detailed study of the thesis and its analysis and evaluation (reflecting the law 111/1998 Sb. on Universities), I conclude that the thesis has fulfilled the stated objectives and I recommend, in the case of a successful defence, to award Mr. . Richta with the academic title "philosophiae doctor" ("Ph.D.").

Pardubice,
February 28, 2022

 Antonín Kavička
reviewer