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## PhD Thesis Review

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| Thesis: | Generic Decentralized Self-Adaptive Context-Aware Architecture Model |
| PhD Student: | Ing. M. Mohanned Kazzaz |

The thesis written by M. Mohanned Kazzaz brings an approach to migrating web services based on assessing the context information using multicriteria decision making, specifically, the analytic hierarchy process. This is supported by a context ontology (meta and instance level) and mobile web service migration framework architecture and implementation. The approach is demonstrated on two implementation studies.

With respect to its ability to make decisions on redeployment and to realize it, the approach proposed in this thesis qualifies as capable of producing self-adaptive systems. The approach even goes beyond the usual cloud computing by transferring service execution to the end nodes, which is known as edge computing and fog computing. The implementation studies are nontrivial. The thesis includes an extensive description of the state of the art. It is sufficiently backed by six papers published at relevant international scientific venues and one paper published at a local student conference.

The thesis exhibits several deficiencies. First of all, the author does not make it easy to understand the purpose of his thesis. Despite the thesis contains the sections named Aim of the Thesis, Thesis Objectives, and Problem Statement, the thesis itself—or thesis statement—is not explicitly presented. These three sections (with the latter being put at the end of the description of the state of the art) unnecessarily attempt to justify and explain big issues falling into some oversimplified statements. Thus, Aim of the Thesis speaks of software architecture as a blueprint, while there are other, more natural and inclusive views of this notion (consider Lean Architecture: for Agile Software Development by J. O. Coplien and G. Bjørnvig, Wiley, 2011). It also includes the following claim, which is not well explained, nor it is supported by a reference:

> From an architectural point of view, Service-Oriented Architec-

ture (SOA) [26], Component based development (CBD) [12], and Microservice Architecture [63] are the state-of-the-art approaches introduced to provide a formal architecture design style for modern information systems and to cope with their distributed nature by supporting software system components reusability, communications and interoperability.

All parts of the approach are more or less well explained, along with the implementation details, but the overall picture is, as with the thesis, left upon the reader to devise it. Also, the notation used to depict the system core ontology in Figure 3.2 is not explained. This holds also for the ontologies in Figures 5.2 and 7.1. The notation used to depict the mobile web service migration architecture in Figure 5.4 uses UML elements wrongfully with unclear relationship and types connections, and packages within components. Probably, this was not intended to be a UML diagram, but then again, why use UML elements and where is the explanation of the notation?

The two implementation studies do not completely illustrate the usefulness of the approach as the evaluation focuses on a proof of concept and demonstrating a satisfactory level of efficiency for the approach to be used in practice. The first study, a traffic jam detection service migration, just migrates a web service that collects the location and speed information between mobile devices in order to determine whether there is a traffic jam. The second study, a travel company subscription service migration, just migrates a web service that provides the tour, sightseeing, and video editing capabilities from one mobile device to another one depending on the available memory. Why is the implementation according to the approach proposed in the thesis better than a common implementation would be?

One might expect a more philosophical treatment of self-adaptivity within the state of the art analysis within the thesis. This notion is open to different interpretations with respect to how substantial changes in the system it assumes. Also, some relatively recent publications on self-adaptivity, like Self-Adaptive Systems: A Survey Of Current Approaches, Research Challenges and Applications (F. D. Macías-Escrivá et al., Expert Systems with Applications, 40(18): 7267–7279, Expert Systems with Applications, Elsevier, 2013, `https://doi.org/10.1016/j.eswa.2013.07.033`) or Managing Trade-Offs in Adaptable Software Architectures (I. Mistrik et al. (Eds.), Elsevier, 2017, `https://doi.org/10.1016/C2014-0-03664-7`), are not mentioned. Edge computing and fog computing are not mentioned either.

There are lots of quotations throughout Sections 2.1–2.2.4. In Section 2.1.3, more than half page of service attributes is quoted. The quotations are never analyzed, nor discussed. Why are they introduced at all? Section 2.2.5, which brings a discussion on the limitation of existing approaches, is underdeveloped, i.e., the limitations are not clearly explained. For example, limitation denoted as L1 mentions an adaptive design pattern without ex-

plaining what this is. This notion is mentioned nowhere else in the thesis. Furthermore, Section 2.4 summarizes some approach, but no approach is defined in previous sections.

In the author's effort to quote as much as possible from the state of the art, there are three small cases of plagiarism. The first one is in Section 2.1:

> Service Oriented Architecture (SOA) is a paradigm for organizing and utilizing distributed capabilities that can be under the control of different ownership domains. It provides a uniform means to offer, discover services and use their capabilities to produce desired effects consistent with measurable preconditions and expectations [56].

The second:

> The central objective of a service-oriented approach is to reduce dependencies between "software islands" which basically comprise the services and clients accessing those services [83].

and the third one:

> The main drivers for SOA-based architectures are to facilitate the manageable growth of large-scale enterprise systems, to facilitate Internet-scale provisioning and use of services and to reduce costs in organization to organization cooperation [56].

are in Section 2.1.1. These sentences are quoted from the publications they refer to, but this is not indicated that these are quotations with an additional problem for the first sentence in the first excerpt not referring to the publication it is quoted from, However, I consider this rather to be a mistake than an intentional plagiarism.

Related to the correctness of quoting, according to the reference provided in the text, Figure 3.1 seems to be quoted, too, but this is not indicated in the figure itself as it should have been.

A chapter on related work that would clearly position the approach proposed in the thesis is missing. It could have been easily compiled out of the pieces of the information on related work presented throughout the thesis with the addition of the explanation of how this approach relates to edge computing and fog computing.

The publication track includes no publications in journals with the impact factor, nor it seems there are ongoing efforts to make one.

To conclude, despite deficiencies, the author of the thesis proved to have an ability to perform research and to achieve scientific results. I recommend the thesis for presentation with the aim of receiving a Ph.D. degree.

Bratislava, December 23, 2019