Decomposition Problems in the Development of Complex Information Systems

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INTRODUCTION

System decomposition, in other words, architecture selection, is an essential decision that determines the success of the system created. The problem is critical as modern information systems (IS) expand in scope and complexity. This means that decomposition must be justified and quantitatively evaluated. However, this is not the usual rule in practice, especially in the information systems early architecting stage.

This is the position paper and summarizes the results of research on the decomposition, covering not only the area of information systems, but area of systems as well. It highlights the problems which should be addressed and resolved by the developers of complex information systems. Some from these problems were identified as a result of the study of scientific literature, others – through an in-depth analysis of the gained experience. The paper contributes to information systems decomposition theory by proposing a holistic view to IS decomposition problems.

OBJECTIVE

Understanding and managing the complexity of today's information systems is becoming increasingly important, in particular during the early stages of their development. The objective of this paper is to give a high-level conceptual overview of the IS decompositions problems.

RELATED WORKS

The decomposition is critical in modern information systems development as they expand in scope and complexity. However, there are not many published results on the IS decomposition problem. The authors of the paper [1] also pointed this out that very few researches have been published in this regard. (To avoid discrepancies, we explicitly note that this statement does not apply to IS architectural design stage issues.)

The situation is different in engineering branches with a much longer history and in systems theory. Mentioning a few, a multi-attribute optimization framework for complex system decomposition is proposed in [1]. A detailed analysis of modularity in the design of complex engineering systems is given in [2]. The findings presented in [3] will have important implications for how modules are selected in the early design process and how future decomposition methods should be developed. However, those results cannot be used directly in IS engineering, they should be adapted to the specifics of information systems.

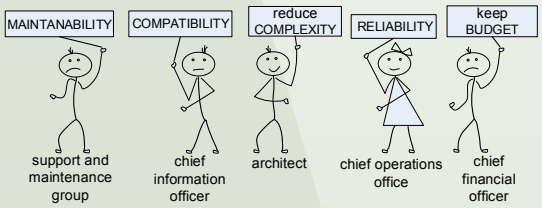

Fig. 1. The attributes of stakeholders at the same and at the different levels of the enterprise system

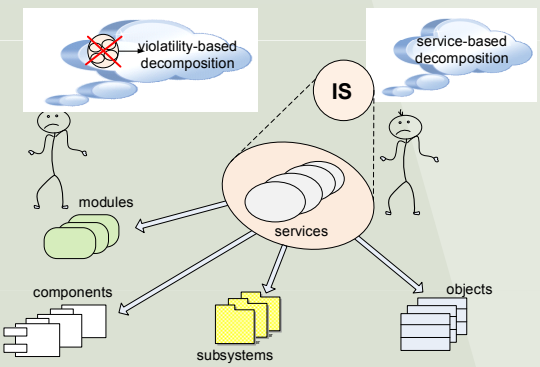

Fig. 2. Different sets of decompositions to implement a negotiated set of stakeholders' attributes

RESULTS

Problem 1.

The problem is related to the methodological aspect of decomposition. The question to be answered is "Whether the decomposition will be determined from a conceptual point of view or whether the decomposition will begin in the classic manner - choose the style of the system architecture?". Decomposition at the conceptual level is based on an analysis of the effects that the IS should produce in the world and the identification of the types of problems addressed by the IS. In other words, IS should be decomposed into the sub-problems it solves, the sub-problems' solution algorithms selected and combined into a cohesive ensemble [4].

Problem 2.

Negotiating the different needs of stakeholders is a classic problem in system development, i.e. the stakeholders seek to optimise multiple different attributes. The development of information systems requires to take into account not only the attributes of stakeholders at the same level of the enterprise system, but also the needs of stakeholders at different levels of that system. In other words, IS stakeholders live in different but related worlds. (See Fig. 1, where the roles of stakeholders represent these worlds.) So, the question to be answered is "How to set an agreed group of attributes and how to choose a decomposition method that does not restrict the required attributes of lower-level systems?".

Problem 3.

Modern information systems are also referred to as cyber-physical social systems to draw attention to the fact that they are omnipresence, deployed in heterogeneous environments, that interoperability and coexistence are among their most important attributes. This means that the characteristics defined in a set of attributes are flowed-down to interoperable heterogeneous components that may be substantially different (e.g., an IS user with a required work place and an IoT element). Therefore, the question "How to choose and combine a set of decompositions to implement a negotiated set of stakeholders' attributes?" should be answered. The problem discussed is illustrated in Fig. 2.

Problem 4.

There is a dominant view that decomposition reduces the complexity of the system and enables the creation of constituent parts in parallel. In addition, it is also known the fact that decomposition can increase complexity and even substantially. Interface creation, functional allocation, and second-order effects are examples of mechanisms for adding complexity to the decomposition process' results [3]. Thus, the question to be solved in this context is "What are the undesirable effects of IS decomposition methods, what mechanisms cause them, and what decomposition methods, including those new ones which require to be developed, would prevent them?".

Problem 5.

Stakeholders work for different goals and therefore seek to implement different attributes of the information system. Thus, the set of attributes should be negotiated and optimised. The solution to this problem overlaps with the solution to the decomposition problem. So, the question to be answered is "How to integrate optimisation and decomposition problem solving in IS architectural design?".

CONCLUSIONS

This article has demonstrated that modern information systems' architectural design, especially its early stages, is not easy to deal with, and there are many unanswered questions. Despite a sufficiently long history of IS systems, their design theory should be rethought. The next step – to find answers to the questions defined in this paper would significantly add to this theory.

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