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From Fault Classification to Fault Tolerance for Multi-Agent Systems

Springer

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ISSN 2191-5768 ISSN 2191-5776 (electronic)
ISBN 978-1-4471-5045-9 ISBN 978-1-4471-5046-6 (eBook)
DOI 10.1007/978-1-4471-5046-6
Springer London Heidelberg New York Dordrecht

Library of Congress Control Number: 2013932457

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

This book presents a summary of the research achieved by Katia Potiron during her Ph.D. Thesis defended on 14 April 2010 at the University Paris 6. This thesis was co-supervised by Patrick Taillibert, expert engineer at Thales Airborne Systems and Amal El Fallah Seghrouchni, Professor at the University Paris 6 (University Pierre and Marie Curie, France).

The intuition of this research is that, thanks to the Multi-Agent Systems (MAS) approach, fault tolerance property might be achieved naturally for complex software and should be complementary with classical existing approaches. This book, as a one-year "night work" by Katia Potiron after her thesis defense, tries to summarize the thesis contributions and to provide a comprehensive view of this research. The book contains additional explanations to make accessible to those not familiar with the subject the ideas sustaining the thesis propositions.

From a research point of view, this work is a cross-disciplinary attempt between the well-established field of fault tolerance and the emerging field of MAS issued from distributed artificial intelligence. Indeed, the MAS paradigm plays today an important role in complex software development. The associated technology offers a large panel of original concepts, architectures, interaction protocols, and methodologies for the analysis and the specification of complex systems built as MAS. One of the driving motivations for this work is the observation that MAS, as a technology, still lacks mechanisms to guarantee robustness and fault tolerance properties. These properties are crucial from a software perspective, especially when MAS are built for critical or military applications where dependability is vital. The expected properties vary according to the effects of the abnormal behavior of the software on the system safety, what is represented, for example, by design assurance level for software in civil airborne systems but this aspect is not studied here since it is related to a third domain that would be safety assessment. Hence, this book tries to emphasize the characterization of MAS with regard to existing studies in fault tolerance domain.

For classical systems, a fault classification exists and allows defining faults. So that, when dependability is at stake, such a fault classification may be used, from the beginning of the system design, to define fault classes and specify which types of faults are expected for the system and the software. Thus, one may tend to use such a fault classification for MAS, but the fact that agents are autonomous and

proactive may come into consideration on the faults potentially occurring in the system. As a matter of fact, this kind of behavior is not taken into account in the present fault classification. Moreover, autonomous and proactive agents are primarily "intelligent agents". Does this "intelligence" have a role to play with regard to fault tolerance? Is it possible to take advantage of an agent property to obtain a more effective fault handler? Or are the agent properties an impediment to fault tolerance?

In addition, the field of fault tolerance provides numerous methods adapted to handle different kinds of faults. Some handling methods had been studied in the Multi-Agent System domain, adapting to their specificities and capabilities but at the same time increasing the large amount of fault tolerance methods to consider. Therefore, unless one is an expert in fault tolerance, it is difficult to choose, evaluate, or compare fault tolerance methods. This prevents many applications from using these methods and, consequently, to be tolerant to common faults. That is the reason why this book also tries to answer the important question of how to derive some guidelines and fault handlers based on the fault classification and the MAS studies (for instance from the properties specification phase).

Finally, the authors would like to thank Gilles Klein for his insightful review of this book, Costin Caval for his review and future work on handling unforeseen faults, and Nicolas Viollette for his long-term support to Katia Potiron. We also address a special acknowledgment to Professor Karin K. Breitman who made possible the publication of this thesis.

December 2012

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