Petri nets for reliability modeling (in the fields of engineering safety and dependability)

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This book is a nice introduction to Petri nets (PN), stressing the modeling viewpoint. Its presentation is tutorial rather than theoretical and is a good example of how PNs can be used in dependability field. This monograph is clearly written and well structured. It includes many illustrative examples and exercises with their detailed solutions. This makes it more attractive for practitioners and students. The author, who has a long experience in teaching reliability engineering, has organized his book in 13 well-balanced chapters and two appendixes devoted, respectively, to the basic vocabulary of graph theory and dependability modeling. The author presents in the preface some interesting viewpoints. First, he reminds us that, in spite of numerous papers, theses and books already published on Petri nets, they are still not widely used in dependability field, though they are one of the best graphical tools for reliability modeling. Second, he claims reliability engineers are able to helpfully handle PNs, even if they have not a deep knowledge of the related theory. Third, he states several important (from a theoretical viewpoint) properties of PNs, such as ‘conservation’, ‘liveness’, are not relevant for availability, reliability and production purposes. In the same way, the author is right when he writes that the term stochastic Petri net should encompass any randomness in a PN. The above opinions are true but, concerning the first point, some readers of this book could be surprised to find in its preface and references no mention of French pioneers (the reviewer was not among them) who used, since the early 80s, PNs to model system behaviour and to assess their performances in terms of reliability, instantaneous availability, average availability and production availability.

In the introductory chapter and the second one, a preliminary description and the basics of PNs are given in a concise and clear manner. Some people will be bewildered by the fact that transitions are graphically expressed by small squares (instead of the usual bars) in which the corresponding delay is inscribed, but this option is not an obstacle for a good understanding of figures and it agrees with the chess board pattern chosen by the author for drawing PNs. In this first part, one can appreciate the high modeling power of PNs, which has equally recourse to auxiliary places or to inhibit edges (inhibit arcs or arrows) to model some priority constraints. Some special aspects of PNs with reliability modeling are presented in chapter 3, in particular the fact that PNs encompass fault trees and state graphs, and then can model them. But, one must keep in mind that if a fault tree (or state graph) approach is sufficient to model and to assess a given system, it is not necessary to use PNs to do that.

There is no doubt that the three following chapters make up the core of the book because chapter 4 deals with the non-repairable systems while repairable systems are the topic of chapters 5 and 6.

The modeling of systems without redundancy is shown first by means of a non-repairable n-out-of-n: G module. Then systems with successively cold and hot standby are presented with several didactic examples, which illustrate different modeling options offered by PNs. The basic aspects of repairable systems are treated in chapter 5 which is strongly maintenance oriented. It is also shown, in this chapter, ‘that for a systematic embedding of places for ‘system up’ an ’system down’, respectively, the success tree and the fault tree, i.e. their PNs, are indispensable’. This is the author’s viewpoint, but a question arises: is this systematic embedding option relevant in the case of real-size systems? An answer will be given in chapter 10. Chapter 6 is devoted to the repairable systems with advanced aspects of maintenance including limited maintenance, preventive maintenance, repair priorities and more complex cases. It is a key-chapter of the book, which will interest all the dependability engineers. Nevertheless further information, as in Section 5.2, is needed to understand well the case of the unit’s repair submitted to periodic interruptions: is the delay of the concerned transition reinitialized after each interruption or not?

The cost/benefit aspects are often and unfortunately omitted in the books centered on systems dependability. This is why chapter 7 is worth reading. The treated examples clearly illustrate the discrete option (one token for one unit of profit) retained by the author to model this kind of problem. Another option lies in the computing of sojourn times in the places which correspond to working an failed states of the modeled system, but it is out of the scope of this book.

The author defines ‘timeliness’ as the ability to complete missions or tasks on time and as a subcase of reliability/-dependability. This unusual topic is treated in chapter 8 on the basis of several simple examples.

Phased missions are a theme often studied in reliability field by means of boolean (e.g. fault tree) or Markovian
approach. Chapter 9 gives a new insight into this topic including phased repairs, via PN modeling.

The remainder of this book concerns successively the design of large Petri (chapter 10), some comments on the theory of PNs (chapter 11), some information on tools for PNs applications (chapter 12), and comments on limits of the presented modeling approach (chapter 13). As the previous ones, these chapters are also worth reading because all the subjects treated inside interest both engineers and students. However, one can regret that no practical information is given on the way to obtain or to estimate (if Monte–Carlo simulation is used) the main indicators of system performances, i.e. its reliability, instantaneous and average availability and related mean times (MTTF, MUT, MDT, etc.). Moreover, some specific aspects of PNs modeling, such as messages emitted or received by transitions and transitions with memory, are not mentioned. The above omissions are certainly intentional and can be explained by the fact that this book is devoted to PNs modeling and not to their exploitation.

Overall, this is a fine and well structured book that deserves the attention of people concerned by the oriented dependability modeling of systems. Thus, it can be used with benefit as textbook in engineering universities and technical institutes.

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