

# The fast Monte-Carlo simulation of approximate semi-Markov reliability models of complex systems

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Methods for evaluating telecommunication systems reliability are becoming increasingly more important, especially in the case of critical applications. With the increasing complexity and requirements of highly reliable systems, evaluation task during design and operation is becoming more crucial. Reliability models of such systems are often based on analytical or numerical methods, but developing of adequate mathematical models of such systems is the complex task, because in practice computer systems comprised of the large number of components with various configuration and distinct reliability, all elements are repairable and have high reliability with rare fails. Components of a system may have high built-in redundancies, all failure and repair times are non-exponentially distributed, so that systems can't be modeled by a Markov models. Therefore, analysts and designers turn to simulation for the evaluation of these models. Now only the simulation techniques for Markov models is well studied, its application to reliability estimation doesn't give the accurate results, since failure and repair times of real systems are non-exponentially distributed, and the number of states in simulation models usually grows exponentially with the number of components in the system, only relatively small systems may be analyzed using standard simulation method. Therefore the standard simulation is impractical for the evaluation of such systems. For accurate estimation of reliability measures of these models simulation approach must be combined with probabilistic modeling and using semi-Markov or non-Markov models. The paper presents the approximate semi-Markov model for effective evaluation of the reliability of large-scale repairable systems with different distribution of time to failure and non-exponentially distributed recovery time. The model is based on the condition that all components in the system are highly reliable and mean time between failures is much greater than mean recovery time. Then we review some of the fast simulation technique that allows to efficiently estimate the reliability measures for semi-Markov and non-Markov reliability models and its application for computer systems. One semi-Markov reliability model of a many-components telecommunication network is examined. The results of computing experiments and its comparison with the results obtained for the same system by a standard simulation show that approach presented here gives the accurate estimation of reliability for much less time and without constructing a complex simulation model.