

System reliability when components can be swapped upon failure

Aesha M. Najem

Abstract

Resilience of systems to failures during functioning is of great practical importance. One of the strategies that might be considered to enhance reliability and resilience of a system is swapping components when a component fails, thus replacing it by another component from the system that is still functioning. This thesis studies this scenario, particularly with the use of the survival signature concept to quantify system reliability, where it is assumed that such a swap of components requires these components to be of the same type. We examine the effect of swapping components on a reliability importance measure for the specific components, and we also consider the joint reliability importance of two components. Such swapping of components may be an attractive means toward more resilient systems and could be an alternative to adding more components to achieve redundancy of repair and replacement activities.

Swapping components, if possible, is likely to incur some costs, for example for the actual swap or to prepare components to be able to take over functionality of another component. In this thesis we also consider the cost effectiveness of component swapping over a fixed period of time. It is assumed that a system needs to function for a given period of time, where failure to achieve this incurs a penalty cost. The expected costs when the different swap scenarios are applicable are compared with the option not to enable swaps. We also study the cost effectiveness of component swapping over an unlimited time horizon from the perspective of renewal theory. We assume that the system is entirely renewed upon failure, at a known cost, and we compare different swapping scenarios. The effect of components swapping on preventive replacement actions is also considered.

In addition, we extend the approach of component swapping and the cost effec-

tiveness analysis of component swapping to phased mission system. We consider two scenarios of swapping possibilities, namely, assuming that the possibilities of component swapping can occur at any time during the mission or only at transition of phases.