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ScienceDirect

Procedia Computer Science 28 (2014) 26 – 33

Procedia Computer Science

Conference on Systems Engineering Research (CSER 2014)

Eds.: Azad M. Madni, University of Southern California; Barry Boehm, University of Southern California; Michael Sievers, Jet Propulsion Laboratory; Marilee Wheaton, The Aerospace Corporation
Redondo Beach, CA, March 21-22, 2014

Increasing Systems Resilience through the Implementation of a Proactive Technology Refreshment Program

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Abstract

Systems resilience has become a growing need and concern over the last decade. Systems are designed to meet requirements and maintain operational characteristics over long operational lives, frequently plagued with uncertainties regarding operational environments and profiles. Meeting requirements along is no longer sufficient. Resilience is the capability that systems have to mitigate the severity and the likelihood of failures or losses; that is, it is the system's capability for adapting to changing needs and conditions by responding appropriately to them. Systems have to exhibit such resilient capability but it is difficult to ensure it, in the face of so many uncertainties in the evolution of the needs, in the intended operational life and system utilization profile. Nevertheless, technology refreshment programs offer a valuable help to attain the so desired level of resilience. Through the continuous assessment of the evolution of the need or opportunity that triggered the design of the system, the monitoring of the performance of the system and the screening of new technologies and capabilities becoming available, technology refreshment programs allow for the performance of resilience-growth programs. This paper presents a detailed technology refreshment methodology and illustrates how through its application a resilience-growth program can be implemented and conducted during the entire operational life of a system.

Keywords: *system; resilience; technology; refreshment; program*

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doi:10.1016/j.procs.2014.03.004

1. Resilience and technology refreshment programs

Resilience is the ability of systems to mitigate the severity and likelihood of failures or losses, as well as to be able to adapt to changing needs and conditions, by responding appropriately. That is, resilience is the capability of a system for coping with sources of change, whether internal or external. For most authors a system is said to be adaptable when it exhibits the capability for accommodating internal sources of change, whereas it is flexible if those sources of change that can be coped with are external[1]. Coping with internal sources of change, that can to a reasonable extent be anticipated, is mainly achieved in the requirements definition and design phases, materializing in the appropriate architecture, the right selection of the elements and the pertinent identification of the interfaces. On the other hand, external sources of change cannot be anticipated in the same way and tackling satisfactorily them poses higher challenges. Here is where technology refreshment programs come into the picture, as they allow systems to evolve either in response to the growing needs or to benefit from the availability of more advanced and reliable elements and/or technologies. A number of authors have stated the need for technology refreshment programs to be an integral part of systems engineering efforts, especially for very costly and complex systems with very long operational lives[2,3,4,5,,6,7]. Many expensive and complex systems have long operational lives during which they exhibit a performance degradation that, coupled with new requirements or demands coming from the user that the system cannot fulfill, yields the so-called performance capability gap, yielding them truly obsolete or inadequate from a functional perspective[8,9]. The need for an effective system design that allows for system evolvability has since long been recognized[10] and use of Commercial-off-the-Shelf (COTS) elements have been traditionally seen as a key opportunity for inserting technology into operational systems[11] although technology refreshments do not necessarily have to be focused on technology alone, as motivating personnel operating and maintaining systems is also key to successful technology refreshment initiatives[12]. The upper part of the capabilities gap (the fraction above the initial performance level) can be diminished through the implementation of a technology refreshment program[13], whereas the lower one (the fraction below the initial performance level) can be reduced with a better management of the logistics support resources, especially through the implementation of performance-based logistics (PBL) contracts, as depicted in Fig. 1. The successful implementation of PBL initiatives requires a solid contractual framework[14]; furthermore, such initiatives are substantially leveraged by the so-called transition contracts[15].

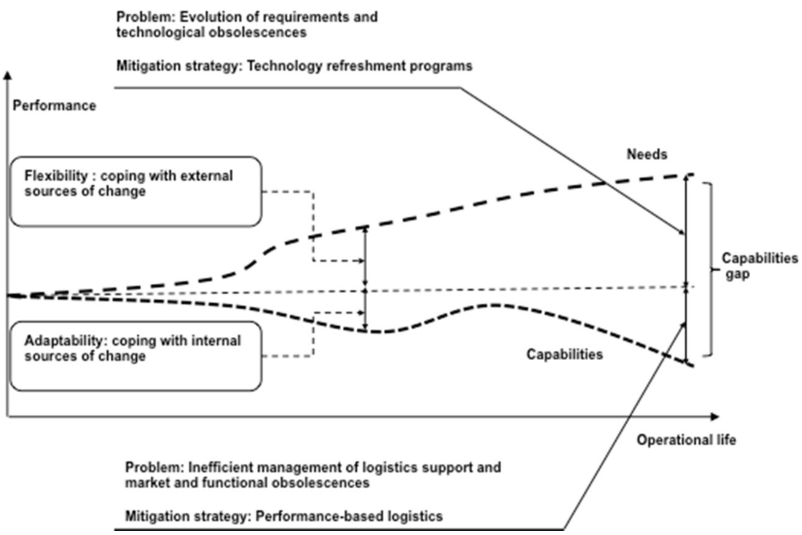

Fig. 1 - The capabilities gap as an indicator of lack of resilience.

Even if systems are satisfactorily commissioned, the beginning of their operational lives represents both opportunities and challenges in the engineering and business domains. Maintaining a constant level of performance