

SPACE SYSTEMS SYMPOSIUM (D1)  
System Engineering Tools, Processes and Training (2) (6)

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SYSTEM OF SYSTEMS ENGINEERING WITH THE ESA ARCHITECTURAL FRAMEWORK

**Abstract**

This paper presents an overview of the ESA Architectural Framework (ESA-AF) and supporting tools which have been developed by the European Space Agency (ESA). A new activity has just started to consolidate and improve ESA-AF and the supporting tools, based on the initial feedback of the different stake-holders. The work is being performed for ESA by VEGA.

System of Systems (SoS) Engineering addresses the development and operations of evolving programs that comprise a collaboration of diverse sets of system assets. SoS engineering has its roots in the defence domain and is increasingly being applied in other complex domains such as air transportation, healthcare and global communication networks. In comparison to systems engineering of monolithic systems, SoS engineering is often performed under some level of uncertainty regarding the requirements and the constituent systems, and involves considerations at multiple levels and domains. While traditional systems engineering seeks to optimise individual systems, SoS's engineering normally seeks to optimise a network of various interacting legacy and new systems brought together to satisfy multiple objectives of the programme. SoS engineering enables the decision-makers to understand the implications of various choices on technical performance, costs, extensibility and flexibility over time.

In order to master the analysis and assessment of existing systems as well as the optimisation of future systems, new methods and technologies must be introduced in the ESA environment. To support the definition of these system-of-systems ESA has performed a number of studies in the area of Architecture Frameworks. One of these activities has resulted in the development of ESA-AF, which is based on existing frameworks, such as the UK's Ministry of Defence Architectural Framework (MODAF).

ESA-AF has now been applied in pilot activities on a number of large programmes. These include the Global Monitoring for Environment and Security (GMES), Space Situational Awareness (SSA) and Galileo global navigation systems. All of these programmes consist of large complex system of systems for which ESA-AF is able to support. The pilot activities have provided valuable feedback on the application of ESA-AF and this experience is being fed back into the ESA-AF consolidation activity.

In the paper we present the ESA-AF meta-model, its governance model and the tools that have been developed to exploit SoS models. We then introduce some of the areas that users of ESA-AF have

identified for improvement and how this is driving the current activity to consolidate ESA-AF to better meet ESA's future requirements.