



## OFFICE OF THE DEPUTY ASSISTANT SECRETARY OF DEFENSE SYSTEMS ENGINEERING

### System of Systems Engineering Collaborators Information Exchange (SoSECIE)

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#### A Fuzzy Evaluation Method for System of Systems Meta-architectures

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##### **Abstract**

A method is proposed for evaluating a range of Systems of Systems (SoS) meta-architecture alternatives. SoS are created by combining existing, fully functioning Systems, possibly with minor functional changes but generally by using the Systems collaborating (interfacing) in new ways, to achieve a new capability not available from the Systems alone. A binary meta-architecture encompasses how all possible subsets of Systems and their mutual interfaces could be combined to create a SoS.

The quality of a proposed architecture, however determined, is normally simplified to linguistic terms such as unacceptable, marginal, or excellent. These terms are normally mapped onto consensus intervals of performance, cost, or other attributes such as “ease of use,” “mission effectiveness,” or “affordability” over life cycle. This approach lends itself strongly to fuzzy logic methods for combining evaluations in several attribute areas to an overall SoS evaluation. If an architecture can be evaluated, that can be used as the fitness function in a genetic algorithm to find the best, or at least very good, architectures for the SoS.

The method shows how to identify the fuzzy concepts and establish rule sets to produce an overall SoS evaluation for any set of participating individual Systems and interfaces within the meta-architecture. A genetic algorithm is then used to find better SoS among the many possible arrangements. An application of the method is discussed within the framework of developing and evaluating a hypothetical Intelligence, Surveillance and Reconnaissance (ISR) SoS capability.

##### **Biography**

Mr. Pape is an INCOSE Certified Systems Engineering Professional, and a Boeing Associate Technical Fellow and Designated Expert working as a systems architect in the Phantom Works division of Boeing Defense, Space & Security.

Mr. Pape’s recent experience is in model based systems engineering and designing netcentric systems. Previously, he worked on satellite laser communication systems, and on aircraft mission computers, displays and communications. He also worked on the Global Positioning System at the Pentagon and in the Joint Program Office as a satellite contract management and in user equipment integration. While in the Air Force, he worked on design, integration and test of high energy laser systems, on basic research, and logistics staff. His doctoral studies are in Systems of Systems Engineering, partly supported through the SERC research tasks 37, 44c, and 109.

Mr. Pape is a candidate for a PhD in Systems Engineering at Missouri Science & Technology. He graduated from the U.S. Air Force Academy with a BS in Physics; the University of Arizona with a MS in Optical Sciences; and California State University, Dominguez Hills with an MBA. He retired as a colonel from the Air Force Reserve, and is a graduate of the Air War College and the Industrial College of the Armed Forces.