

# Mathematical Models of Emergence in Complex Systems-of-systems

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**Abstract.** This paper presents an analysis of five mathematical models of systems-of-systems (SoS) illustrating the potential for emergent behavior. Each case is examined to determine whether or not the resulting system behavior meets the challenge of \_essential unpredictability\_ which would serve as a critical factor in defining the SoS as complex. We conclude that three of the cases provide examples of systems which meet all the criteria for System-of-system definition, but do not exhibit emergent behavior, while at least one, and perhaps two, of the cases lead to emergent behavior meeting the \_essential unpredictability\_ test, thereby demonstrating the difference between complicated systems-of-systems and complex ones. Further examination of this relationship is proposed, and further questions for study are defined.