12TH ICCRTS
Adapting C2 to the 21st Century

Using System-of-Systems Methodologies to Investigate New C2 Concepts

Topics: Modeling & Simulation, Networks, and C2 Concepts & Transformation

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Abstract

Command and Control capabilities have evolved as new techniques, technologies, and threats have emerged. This process continues today as the network-centric warfare paradigm is integrated into modern warfare. What is particularly challenging in the current situation is the dynamic and complex operating environment in which this evolution is progressing.

In order to capture this complexity, a robust framework is necessary in order to understand the interrelated, and often emergent, behavior of systems as they interact in a system-of-systems. Developing such a framework has been the focus of recent research into system-of-systems methodologies and has produced some innovative techniques. These techniques enable complex system-of-systems to be defined, abstracted, and implemented in simulation environments in order to better understand their behavior. As a result, new methods for designing new systems such that their impact and incorporation into existing system-of-systems can be more effectively captured. This paper presents this process and incorporates a simple case study to illustrate the power and potential of these methodologies. The result is greater understanding of how to incorporate revolutionary C2 concepts into an evolving architecture of fielded systems.

Outline

1. Background & Motivation
2. Introduce new system-of-systems methodologies
    a. Explain strengths
        i. Flexible lexicon
        ii. Trans-domain applicability
        iii. Capability for capturing emergent and evolutionary behavior
        iv. Natural extension into modeling & simulation
    b. Note weaknesses
        i. New methods = little validation
        ii. Stochastic processes
    c. Discuss applicability to C2
3. Develop model for introducing new technologies into an existing system-of-systems.
    a. Legacy systems will always be present (at the very least, in the formative stages of the system-of-systems)
    b. Interaction between legacy and new systems may produce unexpected results—both positive and negative (emergent behavior)
    c. Time dependence and dynamic processes effect system-of-systems performance and capabilities
4. Introduce “case study” simulation
    a. “Barebones” system-of-systems
        i. Simple design allows quick reconfigurability for multiple studies
        ii. Complex behaviors often arise out of low-level interactions

   b. Use case study to show effect of introducing a new system/policy/standard into an existing system-of-systems.
      i. Results may not conform to initial estimates
      ii. Outliers may provide greatest insights into mechanics of the system-of-systems.
   c. Demonstrate expandability to improve simulation resolution
5. Conclusion
   a. Draw together lessons learned from case study into conceptual framework
   b. Show parallels between incorporation of new systems into an existing SoS and the adaptation of C2 in the 21st century

Preliminary Sources

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