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System of Systems Operational Availability Modeling

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Abstract
Operational availability (Ao) is a Department of Defense (DoD) Key Performance Parameter (KPP) required for all major DoD acquisition programs by a mandatory sustainment metric. The sustainment metric consists of an Availability KPP and two supporting Key System Attributes, reliability and ownership cost. Ao is an operational requirement representing the operational capability being purchased through the acquisition program. As a KPP, Ao requirements are assessed for all program milestones and at various points throughout the acquisition program. For a system of systems (SoS), Ao is described as the percentage of time the SoS is "up" over a specified time interval involving defined system operations. Ao is often viewed as being a straightforward metric, but its calculation can involve numerous subtleties, complexities, and assumptions. SoS Ao adds an additional layer of complexity due to system interdependencies and complex interrelated sustainment operations that must be accounted for in system and SoS downtimes. SoS Ao is further complicated by intermittently used systems whose utilization is considerably less than 100% over the mission duration. Simulation modeling is required to capture the complex operating, operable, and downtime hours and to be able to accurately roll up the individual system availabilities to higher SoS levels. This brief explores some of the complexities involved in SoS Ao modeling and presents some simulation results from a modeled SoS application.

Biographies
Dennis J. Anderson is Distinguished Member of the Technical Staff in the Military Systems Analysis Programs Department at Sandia National Laboratories where he has worked for 21 years. He is currently Principal Investigator for a large system-of-systems (SoS) logistics modeling and analysis project for the U.S. Army and for a complex U.S. Navy SoS acquisition program. Mr. Anderson received an M.A. in Mathematics (Applied Statistics option) from Arizona State University and a B.A. in Mathematics from St. John's University.

Tamara Brown is Senior Member of the Technical Staff in the System Readiness and Sustainment Technologies Department at Sandia National Laboratories, where she has worked for 7 years. She is currently Principal Investigator for a complex U.S. Navy System of Systems (SoS) acquisition program involving reliability and availability modeling, analysis, and optimization. Ms. Brown received an M.S. in Statistics from Iowa State University and a B.S. in Mathematics from University of Nevada.

Charles M. Carter is Senior Member of the Technical Staff in the System Readiness and Sustainment Department at Sandia National Laboratories. For the past 20 years, he has performed reliability assessments of large complex systems. He worked for SAIC as a payload safety engineer at Johnson Space Center, performing safety analysis on Space Shuttle and International Space Station payloads. Mr. Carter developed the simulation engine for ARINC's Raptor™ reliability engineering software tool and has used simulation to evaluate reliability and availability. Mr. Carter received a B.S. in Aeronautical and Astronautical Engineering from the University of Illinois and an M.S. in Systems Engineering from AFIT.