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Implementation of the Sustainment Key Performance Parameter and Related New Reliability, Availability, and Maintainability Policies in DoD Acquisition Programs

by Grant R. Schmieder & Gordon M. Kranz

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Over the past decade a disturbing trend has emerged in Major Defense Acquisition Program (MDAP) evaluations: An increasing number of MDAP programs have been judged not operationally suitable or not operationally effective during Initial Operational Test and Evaluation (IOT&E). In addition, programs are experiencing higher than anticipated ownership costs for fielded systems. The Department of Defense (DoD) has identified inadequate reliability as the major cause of IOT&E failures and unanticipated costs. In an effort to reverse these trends, the Under Secretary of Defense for Acquisition, Technology, and Logistics [USD(AT&L)] has initiated significant activities to correct the underlying problem of inadequate implementation of Reliability, Availability, and Maintainability (RAM) during system design and development. This article details some of these efforts from the perspective of the Systems and Software Engineering (SSE) office within OUSD(AT&L).

SSE supports the DoD acquisition process by assisting in the development of policy, assessing progress of programs throughout their life cycle, and helping to shape systems engineering (SE) and test and evaluation (T&E) efforts of MDAP programs through involvement in SE and T&E Working Integrated Product Teams (WIPTs). Program assessment efforts mainly take the form of Program Support Reviews (PSRs) performed 6 to 9 months prior to major program milestones, Assessments of Operational Test Readiness (A_OTRs) prior to IOT&E, and assessments and analysis in support of the certification process for programs that have breached the Nunn-McCurdy thresholds for cost and/or schedule. During these reviews, team members assess program progress against established criteria documented in the Defense Acquisition Program Support (DAPS) Methodology, which is based on DoD Instruction 5000.02, "Operation of the Defense Acquisition System."

Joint Staff Sustainment Key Performance Parameter

Through the Defense Acquisition System, DoD acquires materials that meet capabilities put forth by the Joint Staff in accordance with documents in the Chairman of the Joint Chiefs of Staff (CJCS) Instruction 3170.01 series, "Joint Capabilities Integration and Development System" (JCIDS). The May 2007 CJCS Instruction (CJCSI) 3170.01F and Manual (CJCSM) 3170.01C implemented a mandatory Sustainment Key Performance Parameter (KPP), Materiel Availability (denoted by A_M), and two supporting Key System Attributes (KSAs), Materiel Reliability (RM) and Ownership Cost (OC).

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The Weatherman and the RMS Engineer

by Dr. Jason Cook, Reliability Branch ARDEC

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In this cold and bitter climate, at least in most of the US, a profession of much influence and focus is the weatherman. The unfortunate sole charged with predicting the unpredictable. The variables influencing weather are many and complex and very slight, undetectable changes can cause a forecast to be grossly inaccurate. However, the job is his (or hers) and endure he will for it is a vocation about which the incumbent is usually passionate.

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Many programs that SSE has reviewed since the release of the CJCS documents have had problems implementing RAM considerations. The programs have inadequate RAM requirements, use unrealistic RAM assumptions, lack reliability growth programs, or establish success-driven schedules that allow little or no time to correct identified reliability deficiencies.

RAM-C Rationale Report Manual

In response to the CJCS release, SSE developed the Reliability, Availability, Maintainability, and Cost Rationale Report (RAM-C Rationale Report) Manual, currently in coordination, to assist requirement developers and program managers in performing the analyses and trade-offs required to implement the Sustainment KPP.

Materiel Availability versus Operational Availability

One issue that has arisen during coordination of the RAM-C manual is an Army objection to the way Materiel Availability (AM) KPP is defined in CJCSM 3170.01C and in the RAM C Manual. The Army asserts that requirements based on Operational Availability (A_O) are sufficient to meet the Materiel Availability (A_M) KPP. SSE maintains that although A_O is immensely important to the warfighter and should be retained as a system requirement, A_O does not provide the systemic metrics required to balance acquisition and sustainment costs, as required by CJCSM 3170.01C. SSE also believes that A_M is not inherently an operational metric. Rather, it is a system design metric that is affected by numerous non-operational considerations. A_M is not a metric that requires maximization; instead it should be optimized on a system-by-system basis with the trade-offs and assumptions involved documented in the RAM-C Rationale Report now required at Milestones A, B, and C.

Figure 1 suggests key activities necessary to properly develop and rationalize a Sustainment KPP and supporting KSAs throughout the program life cycle.

According to the CJCS developers, A_M is intended to ensure that programs include system support considerations in early design trade-offs (a RAM best practice common in commercial industry). Programs must balance mission reliability, A_O, basic (logistics) reliability, system maintainability, system support (in particular maintenance down time (MDT) through mean time to repair (MTTR), logistics downtime, and administrative downtime), acquisition costs, and ownership costs in order to optimize A_M. Life cycle costs are included in the metric because there is an inherent trade-off between system reliability levels and the resulting acquisition and ownership costs.

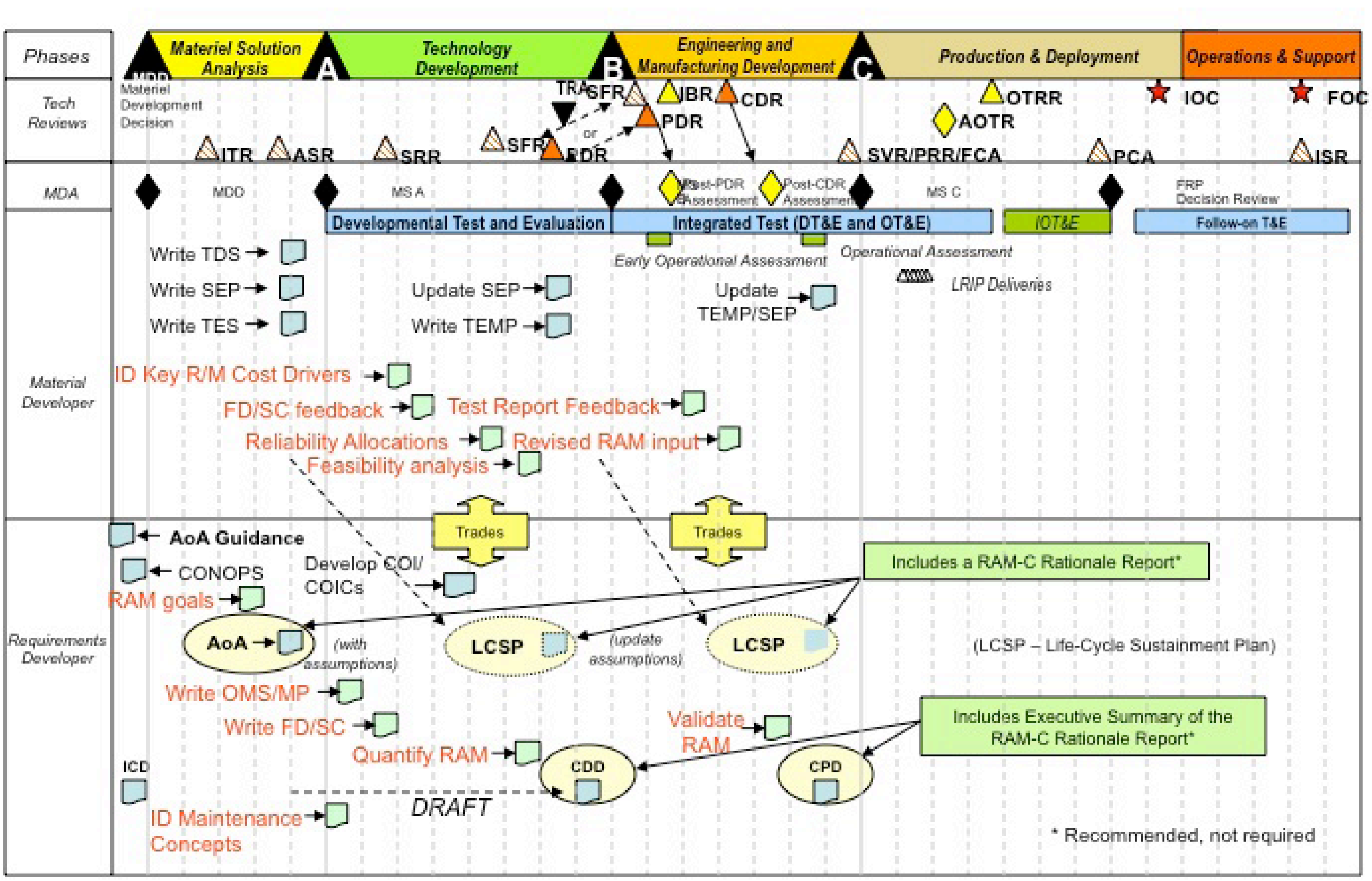

Figure 1 - RAM-C Activities

Systems with lower reliability, although they may be less expensive to acquire, will require more sustaining support (maintenance and spares) and will have an inherently lower maximum A_O value. Simply basing acquisition decisions on Average Per Unit Cost (APUC), which is the current overriding practice, will almost always result in exceeding planned ownership costs. The program manager must apply A_M to the entire population of the system and not just to the operationally assigned sub-set in order to evaluate all applicable system costs. A_O is limited by how systems are used, as identical systems will show different RAM performance—and thus different A_O values—in extreme environments or on high optempo missions versus the same system in a benign environment or low optempo. Environment is not an issue for A_M, because the basis of A_M is whether or not the system is ready to perform its assigned mission at any point in time. This definition allows the incorporation of varied environments, optempos, and missions into the metrics across all possible applications of the system under development. The definition of A_M for systems with spares is (number ready for tasking)/(total population) and thus is independent of the assigned missions.

Using the RAM-C Manual to Establish Metrics

The process of developing the sustainment metrics using the RAM-C Rationale Report Manual starts with establishing reasonable and achievable mission reliability requirements that meet the user's needs. Completing the mission is the most important factor to the warfighter, as a highly available system that cannot finish the assigned mission with high probability is unsuitable for field use. The Materiel Reliability (R_M) KSA is then developed from the user's mission reliability requirement(s). To support A_M, R_M must be a hybrid of mission reliability and basic reliability. The RAM-C manual definition of R_M for repairable systems is based on the Mean Time Between Maintenance (MTBM) for those maintenance actions during which the system is rendered unavailable for operational use—leading to the "hybrid" definition of R_M, as not all system failures will prevent system operation and not all maintenance actions will require the system to be taken offline.

The AM calculation, unlike that of A_O, includes periods of downtime (i.e., requiring the system to be taken offline) related to scheduled maintenance, depot repairs, non-operational assignments, and float conditions. Programs may define float conditions as up or down, but setting them as "down" is recommended in the RAM-C manual because it enables simpler measurement of the A_M achieved once the system is fielded. Using the RM value and proposed support approaches, the program manager (or requirement developer if applicable) then determines the resulting fleet support costs, the total acquisition quantities required to meet anticipated military needs, and the spares required to support those military needs. The support costs are incorporated into determining the appropriate values of the Ownership Cost KSA for each of the materiel solution/support approach combinations under consideration. The preferred system is selected from the field of potential candidates at the Alternative System Review (ASR) and the sustainment metrics are documented in general terms in the RAM-C Rationale Report at Milestone A.

The program refines the proposed sustainment metrics during the Technology Development phase and documents the updates in the RAM-C Rationale Report and the draft Capabilities Development Document (CDD) at Milestone B. After the system enters development (post-Milestone B), the KPP and KSAs are continuously refined, using demonstrated system performance during Developmental Test (DT) and Operational (OT) events, subsystem testing, maintainability demonstrations, and competitive prototyping, as applicable, until final values are incorporated into the RAM-C Rationale Report and Capability Production Document (CPD) at Milestone C. After fielding, the achieved values of the sustainment metrics are periodically evaluated from field data and the results are recorded in the RAM-C Rationale Report.

Other RAM Issues Affecting Defense Programs

Implementation of the Sustainment KPP is not the only RAM issue currently affecting DoD acquisition programs. As previous RMS Partnership Newsletters (April and July 2008) have discussed, the Department is taking policy steps to address RAM shortcomings in acquisition programs.

A May 2008 report of the Defense Science Board (DSB) Developmental Test and Evaluation (DT&E) Task Force stated that "in recent years, there has been a dramatic increase in the number of systems not meeting suitability requirements during IOT&E. Reliability, Availability, and Maintainability (RAM) deficiencies comprise the primary shortfall areas." Approximately 57% of the programs tested recently have been judged as not suitable. The acquisition community must solve the underlying problem in order to support the warfighter's needs. The task force identified several reasons for suitability problems, including:

- **Acquisition workforce reductions mandated by multiple Defense Authorization Acts in the late 1990s.** These reductions have led to a loss of experienced management and technical personnel throughout government and industry. The loss of "corporate knowledge" must be overcome if we are to reestablish the discipline throughout industry.
- **Significant increases in program complexity.** Increases in software lines of code, incorporation of off-board sensor data, integration problems for systems-of-systems, etc., are all sources of additional uncertainty entering IOT&E leading to higher risk during testing.
- **Elimination or reduction of Military Standards from contracts.** Acquisition reform efforts encouraged the use of performance-based contracts and commercial specifications/

standards. Reliability standards have been allowed to atrophy or have been cancelled outright, leaving little direction for system development reliability activities.

- **De-emphasis of Reliability Growth during system development.** This change has led to low system MTBFi (Mean Time Between Failures—Initial) at DT initiation. Low system MTBFi values limit the growth potential of a system, while increasing the effort required to grow reliability. The task force reported: "Lack of failure prevention during design leading to low initial MTBF and reduced growth potential are the most significant reasons for systems failing to meet operational reliability requirements."

The task force report also noted evidence of "…short-sighted attempts to save acquisition funds at the expense of increased life cycle costs."

To implement recommendations from the DSB DT&E Task Force, the Department established the Reliability Improvement Working Group (RIWG), chartered by the Director, Operational Test and Evaluation (DOT&E) and the Deputy Under Secretary of Defense for Acquisition and Technology [DUSD(A&T)], in February 2008. RIWG participants included representatives from throughout the acquisition, test, and Service communities. SSE participated on Team 1 of the RIWG and at general RIWG meetings.

In coordination with RIWG efforts, SSE supported the wording of the RAM Policy memo of July 21, 2008, which states, "effective immediately, it is Department policy for programs to be formulated to execute a viable RAM strategy that includes a reliability growth program as an integral part of design and development."

The policy requires a "viable RAM strategy" with "a reliability growth program." This wording was specifically crafted to ensure that the policy included a consideration of the Sustainment KPP. The policy calls for a reliability growth "program"—not just a reliability growth curve—and this distinction was also intentional.

Conclusion

When combined with the May 2007 release of CJCSM 3170.01C, which instituted the Sustainment KPP (Materiel Availability) for all ACAT ID and Joint Requirements Oversight Council Special Interest programs, the interpretation of a viable RAM strategy must include both reliability and supportability considerations. SSE's approach to RAM includes supportability and logistics as major factors in any healthy system development process.

Implementing the Sustainment KPP and reliability growth at the earliest possible time in program development, while labor intensive on the front end, will ensure that "system performance and program cost are properly balanced leading to the materiel capability developed being operationally effective, suitable, and affordable for the warfighter" (RAM-C Rationale Report manual). Developing the system sustainment approach and establishing any needed reliability growth efforts early in program development are two necessary steps to mature system RAM before formal system operational test and evaluation begins. Systems that are more mature when entering operational test will have a higher probability of success—and will be much more operationally suitable for the warfighter when fully mature.

(The RIWG and DSB reports are available from the SSE website at *http://www.acq.osd.mil/sse/dte/spec-studies.html*.) ★

About the Authors

Mr. Grant R. Schmieder is a senior reliability engineer currently supporting the Systems and Software Engineering (SSE) organization in the Office of the Deputy Under Secretary of Defense (DUSD) for Acquisition and Technology (A&T). Mr. Schmieder has 24 years of experience in logistics and reliability engineering, including 17 years in defense. He spent 16 years with Hughes (now Raytheon) Missile Systems, working as a logistics engineer on the Maverick, AMRAAM, ESSM, AIM-9X, and Phoenix missile programs. He transitioned to reliability engineering, while obtaining his masters degree in systems and industrial engineering, and served as the reliability engineer on the Stinger missile system and for a short time on Tactical Tomahawk. He is an American Society for Quality Certified Reliability Engineer and holds the Professional Certificate in Reliability and Quality Engineering from the University of Arizona.

Mr. Gordon M. Kranz was appointed to the Senior Executive Service and now serves as the Director, Systems and Software Engineering in the Office of the Deputy Under Secretary of Defense (DUSD) for Acquisition and Technology (A&T). Mr. Kranz is the Department of Defense focal point for all policy, practice, and procedural matters relating to systems and software engineering, and their key elements to include test and evaluation, technical risk management, software engineering, manufacturing and production, quality, system assurance and related disciplines. Mr. Kranz has more than 26 years of defense acquisition experience including 10 years as an acquisition program manager for the United States Air Force and 16 years in private industry as a senior technical lead and program manager. He has worked on a wide variety of major acquisition programs across all services. The programs he was involved with include: tactical communications, joint service acquisition, Communications System Segment Replacement for Cheyenne Mountain and fighter programs including the F-22 development, and the F-18E/F upgrade. Mr. Kranz most recently was a Senior Program Manager on the Future Combat Systems Integrated Computer Program, where the use of unattended ground sensors and unmanned vehicles is being more tightly integrated into the current Army combat vehicles force.