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THE TARDEC ADVANCED SYSTEMS ENGINEERING CAPABILITY (ASEC) FRAMEWORK

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ABSTRACT

The Advanced Systems Engineering Capability (ASEC) developed by TARDEC Systems Engineering & Integration (SE&I) group is an integrated Systems Engineering (SE) knowledge creation and capture framework built on a decision centric method, high quality data visualizations, intuitive navigation and systems information management that enable continuous data traceability, real time collaboration and knowledge pattern leverage to support the entire system lifecycle.

The ASEC framework has evolved significantly over the past year. New tools have been added for capturing lessons learned from warfighter experiences in theater and for analyzing and validating the needs of ground domains platforms/systems. These stakeholder needs analysis tools may be used to refine the ground domain capability model (functional decomposition) and to help identify opportunities for common solutions across platforms.

On-going development of ASEC will migrate all tools to a single virtual desktop to promote a more seamless and consistent user experience. The capability to read data stored in remote DOORS databases will be added to enable broader collaboration across RDECOM and the Army.

This paper will provide an overview of the current state of the Advanced Systems Engineering Capability (ASEC) framework, highlight the growth and diversity of the ASEC user base and its applications to the Army/DoD and explain the roadmap for continued ASEC development and deployment.

INTRODUCTION

The Advanced Systems Engineering Capability (ASEC) developed by TARDEC Systems Engineering & Integration (SE&I) group is an integrated Systems Engineering (SE) knowledge creation and capture framework built on a decision centric method, high quality data visualizations, intuitive navigation and systems information management that enable continuous data traceability, real time collaboration and knowledge pattern leverage to support the entire system lifecycle.

TARDEC began development of ASEC in 2011 and deployed the first application in January 2012. The framework currently includes the following families of applications:

- Stakeholder Needs Analysis – Capture and analyze stakeholder needs from multiple sources.
- Capability Analysis – Decompose operational and system requirements.
- Decision Management – Plan/make decisions and manage their consequences and roadmaps.
- Project Recon – Manage project risks, opportunities and issues.

The Stakeholder Needs Analysis and Capability Analysis tools provide a platform for defining the Problem Space as an explicit and traceable requirements baseline. The Decision Management tools facilitate the design team's innovation and analysis that transforms these requirements into a solution concept and presents this solution and the rationale behind it to stakeholders and decision authorities. Project Recon supports the realization of this solution concept by the implementation team through management of system/project risk, opportunities and issues.

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TOOL OVERVIEW / STATUS AND APPLICATION EXAMPLES

The sections that follow describe the capabilities of each ASEC tool, elaborate on how the tools have been used, highlight key principles and lessons learned from their use and identify the next steps planned for their development or expanded usage.

LESSONS LEARNED

The ASEC Lessons Learned tool supports real-time online capture of soldier feedback in the form of Observation Reports (ORs). The tool has been used by the Stryker TRADOC Capability Manager (TCM) to facilitate two soldier forums in which feedback from soldier in-theater experience was captured, analyzed and translated into recommended actions and best practices. This feedback may then be mapped to requirements that address the full range of DOTMLFP enablers that create enhanced warfighter capabilities.

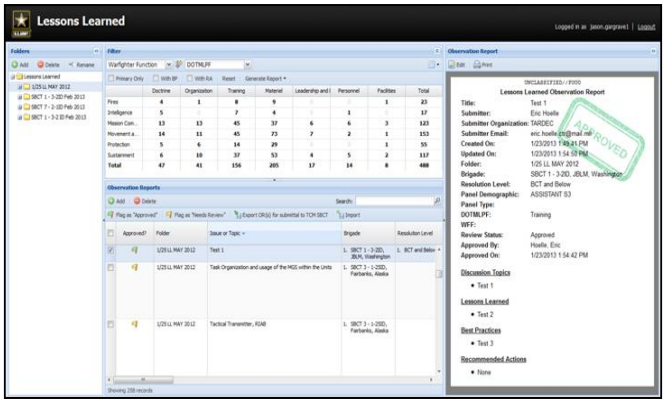

Figure 1: ASEC Lessons Learned Tool

To date, Stryker TCM has used the Lessons Learned tool to capture 385 ORs that address warfighter functions such as Fires, Intelligence, Mission Command, Movement, Protection and Sustainment. According to Stryker TCM, the Lessons Learned tool reduced the time and effort to capture and analyze ORs by at least 5X.

This experience illustrates the benefits of transforming a forms-based paper process into a seamless thread of linked class-based knowledge objects. These objects may then be filtered (sliced & diced) and analyzed from multiple perspectives to find useful and actionable nuggets of knowledge.[1]

A generalized Lessons Learned tool with organization-level tailoring of workflow and attributes/fields is planned for FY14.

PM 1-N NEEDS

The ASEC PM 1-N Needs tool supports capture, prioritization, analysis and decomposition of needs associated with families of vehicles/systems. This tool provides a collaboration environment to improve communication between TARDEC's PEO/PM customers and the TARDEC Ground Domain Planning and Integration (GDP&I) organization to provide inputs to TARDEC's ground domain capability gap analysis and portfolio analysis processes.

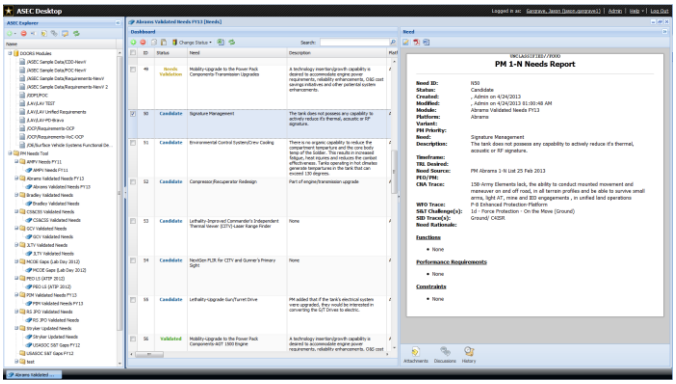

Figure 2: ASEC PM 1-N Needs Tool

The PM 1-N Needs tool replaces the batch process of populating Needs spreadsheets based on an annual data call to the ground domain PMs. Instead of sending out a spreadsheet form to populate, GDP&I uses the Needs tools to send out email requests for periodic or as-needed validation of a current baseline set of needs. The designated POCs at each PM may then perform an online review of their legacy needs and update these needs as desired to reflect current priorities.

This approach overcomes the lack of year-to-year continuity/traceability and high degree of redundancy that comes from annual "fire & forget" data calls. With PM 1-N Needs there is always a baseline set of needs that are refined periodically so that the PM's priorities may be communicated through the smallest possible number of independent, non-overlapping need statements.

The PM 1-N Needs tool provides a Needs Dashboard that facilitates gap analysis and supports linking of needs to other sources such as ARCIC's Capability Needs Analysis (CNA) Gaps and Warfighter Outcomes (WFOs). The tool also supports an initial decomposition of needs statements into functions, performance requirements and constraints to clarify stakeholder intent.

The PM 1-N Needs tool supports "downstream" traceability to the ground domain capability model stored in the ASEC Capability Analysis tool (see below). These linkages assist TARDEC in identifying needs that are common across multiple platforms/systems.

The PM 1-N Needs tool is undergoing final testing and data conversion and will be deployed for production use in August, 2013.

CAPABILITY ANALYSIS

The ASEC Capability Analysis (CA) tool supports analysis and decomposition of operational capabilities and system requirements. The tool is guided by a recursive methods engine that can be applied at any level of system context. For example, an operational capability may be decomposed into use cases (mission scenarios). Each use case may be further decomposed into lower-level use cases or actions/steps. Each use case or action may be clarified by creating performance requirements and constraints that define "How well?" and "Limits on how" in measurable terms. System capabilities such as mobility or survivability may be decomposed into a rich hierarchy of functions; each function may be further specified by child performance requirements, interface requirements, lifecycle requirements and constraints.

The CA tool has been piloted against two S&T programs: Occupant-Centric Protection (OCP) and Advanced Propulsion On-board Power (APOP). In both cases, the tool was used to define/decompose system requirements, trace these requirements from upstream requirements sources (e.g. Voice of the Customer needs) and to facilitate the program's System Requirements Review (SRR). The SRR process leveraged the tool's online discussion thread feature to capture and resolve comments from stakeholders. This approach yielded improved requirements quality and stakeholder buy-in by providing simple, convenient web-based access to system requirements to a broader set of stakeholders.

The CA tool is also being used by GDP&I as the basis for ground domain portfolio analysis. By maintaining a common functional decomposition model that spans all ground vehicle systems, the unique performance requirements and constraints associated with each system may be compared side-by-side (as children of the same parent function). This is one example of ASEC's use of knowledge patterns to improve consistency and support commonality analyses.

The CA tool is currently being enhanced to support data stored in multiple backend repositories (e.g. SQLServer or remote DOORS databases), to enable project-level tailoring of attributes and to add a custom traceability report wizard.

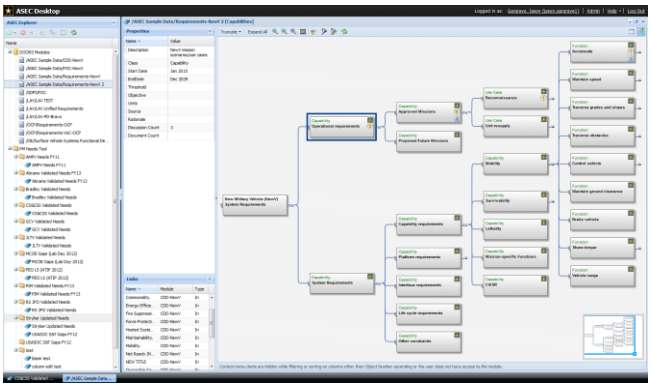

Figure 3: ASEC Capability Analysis Tool

COMPLIANCE EVALUATION

TARDEC is extending the ASEC framework to include a Compliance Evaluation (CE) tool to capture and summarize the level of compliance provided by contractor solutions against Army requirements for a system, such as those developed in the Capability Development Document (CDD) or Capability Production Document (CPD). The CE tool will simplify the complex task of collecting, documenting, organizing, visualizing and analyzing compliance data while maintaining the data security required for open competitions.

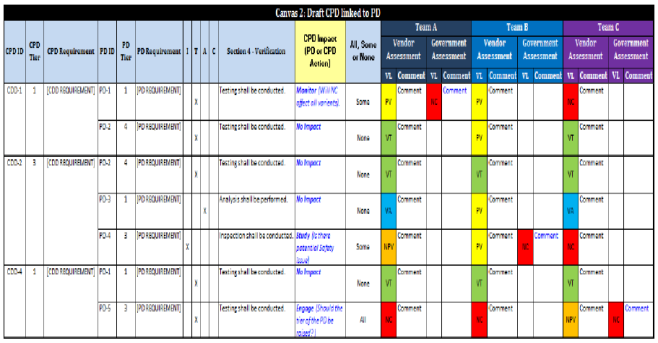

Figure 4: ASEC Compliance Evaluation Tool

The CE tool will facilitate CDD/CPD-level requirements tradeoffs by identifying compliance problems with the system requirements derived from Key Performance Parameters (KPPs) and Key System Attributes (KSAs). This will be accomplished by importing conformance data from contractor and government analysis and testing and mapping this conformance data to specific performance requirements.

This conformance data may be filtered and rolled up into graphic visualization tools such as spider and tornado charts in order to facilitate analysis of overall conformance.

DECISION MANAGEMENT

The ASEC framework uses decisions as the integrative mechanism for Systems Engineering knowledge. In the context of ASEC, each decision represents a fundamental question/issue that demands answer/solution.[2, 3]

The ASEC Decision Management (DM) capability is comprised of four tools. The Decision Breakdown Structure (DBS) tool enables a project/product team to frame the project DBS to create a decision analysis (aka trade study) plan. The DBS may be used to capture legacy decisions and prioritize open decisions so that appropriate analysis resources (SMEs, modeling, simulation, prototyping or testing) may be assigned to the most critical choices.

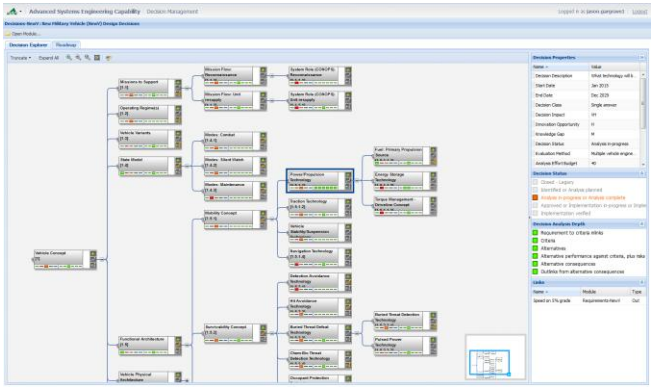

Figure 5: ASEC Decision Management Tool

The Decision Trace tool supports the definition of stakeholder criteria, traceability of these criteria from source requirements (maintained in the ASEC CA tool) and definition of alternatives and the consequences that flow from them. The Decision Trace tool provides a unique visualization of how requirements are transformed into solutions, which then create new derived requirements.[4]

The Decision Analysis tool supports the Analysis of Alternatives (AoA) process including scoring of alternatives (solutions) against criteria, comparing the relative effectiveness of these alternatives (through spider, tornado and tradeoff charts) and capturing the selection/rejection rationale for each alternative.

The Roadmap tool visualizes the evolution of each decision through a series of states, i.e. fast forwards the decision so that solution gaps may be anticipated and resolved proactively. The Roadmap tool also supports alignment of solutions across decisions, e.g. visualizing how a new technology enables a new product/subsystem design that enables a new use case (mission scenario) to be supported in the future.

The ASEC DM tools are being used on the OCP program to create and refine a DBS pattern for ground vehicle design based on use across three vehicle demonstrators. This DBS captures the design process to achieve occupant protection as an explicit set of decisions and will form the superstructure for a proposed vehicle design standard/guide.

The DM tools have also been used on the DARPA GXV program to rapidly frame the system concept for a vehicle demonstrator as an explicit decision model. The GXV pilot validates that it is possible to quickly frame the design decisions for a concept vehicle beginning with a ground vehicle decision pattern. Appropriate focus may then be placed on high-priority technology decisions of particular value to the demonstrator program. The DM tools also enabled the GXV project team to concurrently develop/evaluate early vehicle conceptual designs and capture the decision logic (rationale) behind the GXV vehicle design.

The ASEC DM tools are currently being migrated to a SQLServer database to improve their scalability for large-scale enterprise use.

PROJECT RECON

Project Recon is an integrated suite comprised of three tools:

- Risk Recon: Supports risk identification, prioritization and mitigation planning.
- Opportunity Recon: Supports opportunity identification, prioritization and growth planning.
- Issue Recon: Support risk-to-issue traceability, issue identification, prioritization and corrective action.

All three tools share a common user interface design as part of a "learn-once, use everywhere" training model.

Project Recon is widely used across the Army and USMC for risk management on ACAT programs and S&T projects. The current user base exceeds 600 across 15 PEOs and RDECs. Opportunity Recon and Issue Recon were deployed in early 2013 and are adding users weekly.

TARDEC plans to integrate the ASEC DM tool with Project Recon in early FY2014 so that risks and

opportunities identified in the decision analysis process may be automatically fed into Project Recon.

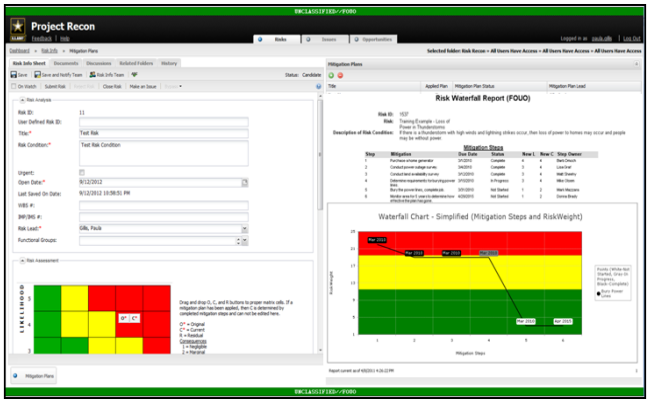

Figure 6: ASEC Project Recon Tool

INTEGRATED APPLICATIONS

The value of SE knowledge grows as it is connected to form a broader, holistic view of a complex system. As more tools are added to the ASEC framework and more links are made between the data managed through these tools, decision-makers are enabled to better understand and anticipate the complex interactions between their decisions.

TARDEC Systems Engineering & Integration is currently planning for FY14 support of two such multi-tool enterprise-level applications of ASEC. These high-value use cases represent more complex, formerly intractable problems that require seamless and continuous alignment of multiple types of SE knowledge.

TARDEC will use ASEC to capture and manage its 30 Year Strategy and associated capability, vehicle/platform, product and technology roadmaps.[5] This use case will leverage at least three ASEC tools:

- PM 1-N Needs: Capture and prioritize capability gaps in ground domain systems. Trace these needs from ARCIC's CNA Gap database through a planned software integration.
- Capability Analysis: Populate the ground domain function model with vehicle-specific performance requirements and constraints to search for opportunities for common solutions.
- Decision Management: Roadmap and evaluate in-progress technologies and solutions for their ability to fill capability gaps in the near-, mid- and long-term. Align technologies and solutions with vehicle/system roadmaps. Manage technology, solution, platform and capability dependencies.

TARDEC also plans to use ASEC to support ASA(ALT)'s Systems of Systems Engineering (SoSE) process, specifically the design/management of Capability Set 18 (CS-18) work products. This application will leverage the PM Needs, CA and DM tools to provide an integrated view of aligned requirements, decisions and roadmaps that spans multiple levels of system context.

ASEC DEVELOPMENT ROADMAP

The ASEC development team is currently focused on improving the integration between all ASEC tools by implementing them within a single virtual desktop that runs within a web browser. Within this user interface framework, all ASEC tools will share many common components such as folder/module administration, attribute/workflow tailoring, tabular dashboard, graphics presentation, object editors, link management/ navigation, filtering, import/export utilities, history, discussions and attachments. The role of these common components in the ASEC software architecture is shown in Figure 7, below.

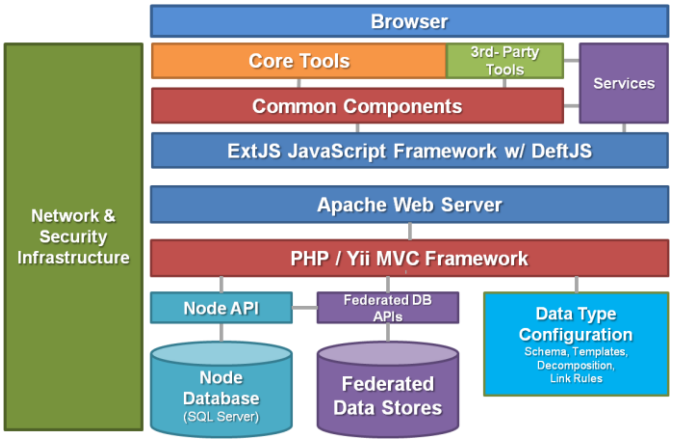

Figure 7: ASEC Software Architecture

The ASEC development team is also completing the definition of the ASEC Application Programming Interface (API) to facilitate numerous integrations with Commercial Off-the-Shelf (COTS) and Government Off-the-Shelf (GOTS) applications and federated databases that are planned for FY14. This is consistent with the ASEC strategy of avoiding duplication of COTS/GOTS tool functionality and data and design for enterprise scalability.

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