MANTECH'S SMART PORTFOLIO SOLUTION (MSPS) FOR PORTFOLIO MANAGEMENT

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EXECUTIVE SUMMARY

Mantech's Smart Portfolio Solution (MSPS) is an innovative, web-based solution designed to optimize and modernize portfolio management. Built upon Mantech's Engineering Data Fabric (EDF), MSPS utilizes an ontologically-backed digital thread architecture to allow users to access and analyze complex data across information systems. Key functionalities include a natural language chatbot for intuitive data interaction, automated obsolescence management, technical debt detection, and portfolio management optimization. By integrating data from tools like Cameo Systems Modeler, Windchill, Jira, and GitLab, MSPS offers real-time insights and supports decision-making with machine learning-driven analyses. Our LLM and systems engineering tools integrate with DoDAF models to deliver AI solutions for optimizing logistics systems.

TECHNICAL APPROACH

To address the challenge of component obsolescence management we propose MSPS, a web-based, client-server architecture integrated with our ontologically-backed digital thread solution, the Engineering Data Fabric (EDF). This solution is a novel capability that opens the door for more profound and insightful analyses during system development, management, and optimization. MSPS offers the core functionalities of a data interaction chatbot and the ability to conduct an analysis using enterprise architecture data defined using the Department of Defense Architecture Framework (DoDAF). The analyses provided by MSPS includes, but is not limited to, obsolescence management automation, technical debt identification, and capability optimization. Additionally, given that the framework of the MSPS is the EDF, it is capable of supporting a wider array of analyses, including lifecycle management, risk assessment, and performance monitoring. Each function of the MSPS allows users to continuously provide feedback for enhancement and refinement of the machine learning algorithms.

The Defense Acquisition University (DAU) defines a digital thread as an extensible and configurable analytical framework that facilitates the controlled interaction of technical data, software, information, and knowledge within the digital engineering ecosystem. The integration of an ontology provides a structure for the data to be organized in. In other words, an ontologically-backed digital thread solution is a framework that utilizes an ontology to connect data throughout a product's lifecycle by establishing semantic relationships between data from desperate engineering tools. With this framework, MSPS is designed to allow users to upload their data directly from the authoritative source of knowledge such as Cameo Systems Modeler, Windchill, Jira, GitLab, and MATLAB. In addition, users can upload structured and unstructured documents generated outside of digital engineering tools or legacy programs that may contain relevant engineering data. MSPS will then automatically detect and extract these elements, align them to relevant classes in the ontology and create instances for each element. These instances will also contain relevant metadata and relationships to other instances.

MSPS contains two primary functionalities. The first, referred to as the digital thread chatbot, allows users to query their data using natural language. This innovative solution significantly lowers the barrier of entry for interacting with digital engineering data. Users will also have the ability to query information stored in artifacts, such as PDFs, containing system data. Following the integration of data from the digital thread and uploaded artifacts, we leverage Microsoft's technical adaptation of Graph RAG to connect a large language model (LLM) to the resulting knowledge graph. Graph RAG is an advanced implementation of retrieval augmented generation (RAG), a natural language processing (NLP) technique that utilizes LLMs in conjunction with information retrieval systems to generate relevant and accurate responses for users. This implementation enables users to ask both local questions, which pertain to specific entities by exploring neighbors and local concepts, and global questions, which relates to overarching topics concerning the entire data corpus by utilizing community summaries.

The second functionality comprises numerous analyses that can be tailored to the users' needs. With the focus of portfolio optimization and modernization, one key analysis pertains to obsolescence management. To enhance success rates for capturing end-of-life (EOL) data, we automate the extraction of obsolescence information for system components. This is achieved by extracting data from resources uploaded by users or by searching the web. When a component within a system has an approaching EOL date, users will receive a notification about the potentially impactful EOL event. The system then assesses the risk associated with this component by analyzing its connections to other components, its type, and its role within the system. Additionally, the system suggests potential replacement parts and provides associated costs, if available, which aligns with the fifth challenge use case. Users can also conduct system-level analyses to identify components approaching obsolescence within a specified time range.

Another critical analysis is the detection of technical debt, which refers to technical trade-offs that offer short-term benefits while potentially compromising long-term system integrity. In the context of DoDAF architecture, we employ machine learning algorithms, such as random forest, to identify technical debt across different architectural views and layers. This detection is based on established methods for identifying technical debt, such as code complexity, code smells, and architectural issues. The results of this analysis will be presented to the user through an intuitive dashboard that highlights areas of concern and provides actionable insights for mitigation. This ensures that users can make informed decisions to maintain the long-term integrity and performance of their systems.

Furthermore, MSPS offers users the ability to optimize system capabilities within the context of DoDAF. Using NLP techniques like named entity recognition (NER), components of a DoDAF model are annotated with functions and requirements linked to specific capabilities. Subsequently, the system uses optimization algorithms, such as linear programming, to determine an optimal set of components that fulfill the required capabilities while minimizing system costs. This system will also identify potential gaps in capabilities to ensure a comprehensive optimization process. Users will be able to explore optimized component sets, cost analyses, and identified capability gaps for assistance in making data-driven decisions for system enhancement, which meets the criteria of the fourth challenge use case. The DoDD on Capability Portfolio Management links policy, missions, acquisition and budgets. MSPS synchronizes generative AI with reasoning AI to model budget decisions and deliver the fifth challenge use case.

To ensure secure and flexible access, each user in the MSPS will be assigned an account with varying levels of permissions managed through a role-based access control (RBAC) system. This system leverages a variety of control paradigms, including identity access management (IdAM), policy-based access control (PBAC), relationship-based access control (ReBAC), and attribute-based access control (ABAC). Within this framework, users are assigned specific roles that determine their permissions and access within this application. Additionally, users have access to select scopes within the EDF, with scopes defined as subgraphs of the knowledge graph that contains the data from the digital thread. This structured access to the EDF allows users to interact with data in a controlled environment that is tailored to their role and specific responsibilities while also maintaining data integrity and security across the entire system.

A successful implementation of the minimum viable product (MVP) for MSPS requires several architecture components, tools and technologies. Central to this implementation is the EDF, which serves as the foundational framework. Detailed reference and deployment architectures have been completed for the EDF. In the current state, an MVP of the EDF utilizes the following applications: SBE Vision (digital thread curator), SBE Vision Adapters, GraphDBs (digital thread interrogation), Oso (PBAC/ReBAC, dynamic data masking), Okta (Authentication), Prometheus/Grafana (observability), and various Smart Agents that are developed and deployed based on customer needs for interaction with digital threads. A complete solution of the EDF will include additional applications such as Elasticsearch (digital thread indexing), Kafka (message bus), TSS Perspective/Tableau (digital thread visualization), PostgreSQL (data cataloging, data subscription), and IncQuery Labs (digital thread analysis).

In addition to the tools and technologies required to support the EDF, the application leverages Python 3.11 for machine learning capabilities and Java for executing JAR files for various Cameo plugins. For customers using SysML models along with DoDAF to design and manage system architecture, MSPS ensures that their data integrates seamlessly for the Cameo Systems Engineer products versioned from 2019 to 2024. If users wish to generate natural text for purposes such as a chatbot or report generation, an LLM must be utilized.

ALIGNMENT

MSPS is designed to align with the Department of Defense's (DoD) Business Enterprise Architecture (BEA), which serves as a blueprint for business transformation. By adhering to BEA principles, MSPS ensures that capabilities, resources, and information are efficiently managed and operated to support mission-critical needs. A key feature of this alignment is the implementation of a knowledge graph, which organizes and scales data from individual components to the enterprise level. This allows for targeted analyses, system-wide assessments, and management of complex interaction between systems, supporting BEA's end-to-end framework, which meets the criteria of the seventh challenge use case.

Community detection within knowledge graphs provides a powerful way to visualize and understand relationships across various levels, from individual system components to the larger enterprise landscape. By uncovering these connections, large software and technology firms can gain critical insights about capability interactions and overlaps. This approach supports optimized resource allocation to ensure that all efforts are in line with BEA standards. Through MSPS's integration of BEA-aligned processes, MSPS supports the continuous improvement of decision-making by grounding it in data that meets the DoD's strategic objectives. This alignment enables organizations to navigate the complexities of managing large portfolios, scale operations, and support mission readiness and business transformation objectives.

Data Integration

MSPS's EDF is designed to support a wide range of data types and sources, addressing the needs of the seventh challenge use case. A key feature of the EDF is the integration of the data into a knowledge graph to enable efficient organization, querying, and analysis of data critical to decision-making processes. Thus, integrating real naval data into the MSPS environment can be achieved once the Authority to Operate (ATO) is secured for deployment within the Naval Integrated Modeling Environment (IME) or any other approved Navy environment.

Through the knowledge graph, EDF can transform SysML/DoDAF or any data elements into structured instances that align with MSPS's broader ontological framework. To extend this capability and fully incorporate naval data, we introduce a DoDAF plugin designed to handle DoDAF-specific data structures. This plugin will streamline the ingestion of diverse naval data formats, including sources like PBIS, JOPES and DRRS, mapping them into the knowledge graph and thus allowing users to perform optimized management, investment and divestment decisioning and analyses for system architecture. By integrating real-time naval data within the EDF, MSPS provides an environment where authorized users can access and analyze valuable insights derived from up-to-date information on naval systems.

User Experience

MSPS is designed to enable an intuitive and accessible environment for non-experts with minimal training. As a web-based application, MSPS offers a user-friendly interface that simplifies complex analytical tasks so that users can effectively utilize the platform without requiring extensive technical knowledge. This accessibility is essential for supporting both experimental and experiential research, where users can explore new approaches and interact with real data in a controlled, low-barrier environment.

The platform's design emphasizes ease of use so that users can focus on data insights and analysis without experiencing technical complexities. MSPS achieves this through its interactive interface that guides users through tasks and analyses step-by-step. MSPS will also offer comprehensive training and detailed documentation. These resources ensure that users can quickly become proficient with the platform, regardless of their technical background. The training programs are designed to cover all essential aspects of the application, while the documentation provides detailed guidance and support for users at every level. This combination of intuitive design, role-based access, training, and documentation ensures that MSPS is accessible and effective for all users.