

Context Based Configuration Management

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Abstract—¹² The commercial state-of-the-art tools for configuration managements (CM) systems are very mature for asset, hardware and software development systems. These tools are very good for tactical management for daily issues. However, strategic management and decisions also have a requirement for configuration management but unfortunately the traditional Commercial Off The Shelf (COTS) tools are not adequate for those requirements.

They come up short in 5 major ways: 1) User interface: engineering/tactical CM systems have minimum interface support and are usually focused to only select groups of technical users, vs. the broader strategic planning communities: budget, policy, legal, and administrative users.

2) COTS CM tools provide minimum support for the context of the change environment. The implications of implementing or not implementing a change is well documented, but the broader forces at play, the environment, and other important contextual facets are not well supported. Those parameters are not usually critical for the tactical engineering management, but they are potentially key lessons learned, and corporate knowledge components that are very important to capture at the strategic planning levels;

3) Items that need to be tracked at the strategic planning levels often don't fit well within COTS CM systems. They include unofficial or implicit changes that on the surface aren't considered baselines, but in reality have very large impacts into the operations of an organization. In particular organization parameters such as: beliefs, agreements, goals, priorities, values, disconnects, etc. to name a few.

4) Agility – formal CM processes and systems require significant discipline and direct human involvement.

Change boards and auditing processes require significant time and attention. Strategic planning must have a tracking system that is fast and agile with preloaded components that make inputs very efficient and provide the context that is key to improving the overall process.

5) Change Management affects entire organizations and enterprises, but the nature of human processing and time limits the amount of participation members can have on a particular component Change Request (CR) with traditional tools.

Using those shortcomings as requirements drivers our team has developed a hybrid tool-suite that directly supports the dynamic, distributed strategic planning and decision making environments. The Context Based Configuration Management (CBCM) system marries Decision Map technology with COTS configuration management work flow (Xerox DocuShare), embedded component models (events models, configuration item models, and feedback models) all on top of a web based online collaboration technology (NASA/Xerox Netmark [3] middleware engine).

This paper will document the rapid prototype that has been developed to meet those requirements using this design and highlight the initial pilot results at NASA Headquarters with the Aeronautics Research Mission Directorate.

TABLE OF CONTENTS

1. INTRODUCTION	2
2. BACKGROUND	2
3. ARMD IMPLEMENTATION IMPLICATIONS	3
4. CBCM DESIGN	3
5. PILOT TEST CASES	5
6. CONCLUSIONS	6
7. ACKNOWLEDGEMENTS	7
8. REFERENCES	7
9. BIOGRAPHY	7

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² IEEEAC paper #1001, Version 6, Updated November 28, 2005

1. INTRODUCTION

The purpose of this on going pilot study is to determine the feasibility of capturing and managing enterprise strategic decisions and baselines. NASA, as a civilian exploration, science, aeronautics, and engineering R&D agency, not only pushes the frontiers in technology and mission concepts, but it also must operate within the very dynamic and often turbulent management world as a federal institution serving the discretionary strategic goals of the American public at the direction of the White House.

This management environment plus the unexpected nature of NASA's missions often require significant unplanned course corrections, complex negotiations, and structural adjustments. The traditional method for capturing and managing this process (the non hardware/software/asset portions) has relied on simple briefing packages and minutes recording. Given the complexity, however, of the operating environment this method falls short in several categories: user interface, context, decision artifact compatibility, agility, and broad and inclusive agency participation.

A pilot system has been developed to address and further study the challenges noted above. Using those challenges as requirements drivers our team has developed a hybrid tool-suite that directly supports the dynamic, distributed strategic planning and decision making environments. The Context Based Configuration Management system marries Decision Map technology with COTS configuration management work flow (Xerox DocuShare), embedded component models (events models, configuration item models, and feedback models) all on top of a web based online collaboration technology (NASA/Xerox Netmark middleware engine).

2. BACKGROUND

The CBCM project had it's origins in the NASA Engineering for Complex Systems (ECS) program in the Aeronautics Research Mission Directorate (ARMD). This program was formulated to address NASA mishaps and engineering challenges. Part of the formulation and gap analysis process for prioritizing the program investments relied on analyzing past NASA and Air Force space launch mishaps [1].

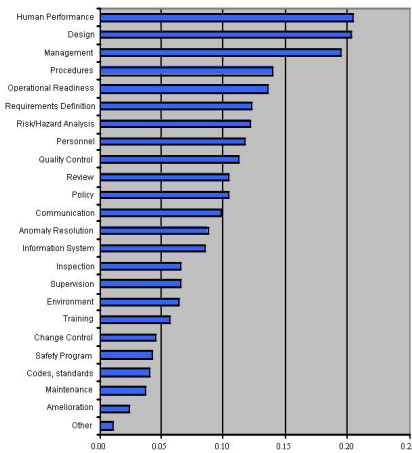


Figure 1: ECS Mishap Analysis Chart (y axis causal factors, x axis % of time identified as a contributing factor)

The analysis of the top 10 contributing causal factors had 8 entities (design, management, procedures, operational readiness, requirements, risk/hazard analysis, review and policy) that officially enter the project lifecycle stream through configuration management control boards. In particular decision packages and disposition of change requests incorporate those factors. The impact of the dispositions may be explicit or implicit depending on the thoroughness of the control board and the complexity of the given lifecycle factor.

The mishap analysis cited Human Performance as the most often cited contributing causal factor to mishaps at over 20% of the time. The ECS program also invested significantly in human and organizational risk analysis. Additionally, the CAIB report [2] also highlighted key factors in NASA's decision making process. Based on both the ECS organizational research and CAIB board analysis the pilot team generated a list of quality/performance parameters to address:

Ability to Capture/Present:

- (1) Uncertainty Levels
- (2) Quality/Pedigree
- (3) Formal & Informal Agreements
- (4) Unwritten Conventions/Procedures
- (5) Unwritten Goals
- (6) Active Estimates/Options
- (7) Beliefs/Issues
- (8) Values
- (9) Disconnects

(10) Waste/Rework

(11) Background/Context

These quality/performance parameters are not supported well in traditional configuration management systems for inventory, hardware and software type applications. In particular, these performance parameters often need to be represented between configuration items in order to give decision makers and analysts the appropriate situational awareness. Also, some of these performance parameters do not fit the traditional decision/change package format for configuration management systems.

3. ARMD IMPLEMENTATION IMPLICATIONS

The analysis based on ECS and the CAIB report indicated that control board processes needed to be improved in order to capture the full impacts of decisions and provide global context in order for decision makers and analysts to make better decisions.

As part of the pilot study we assessed operational challenges of the ARMD's configuration management environment:

- (1) Many different sets of data make up the organization's baseline.
- (2) The complete set of data for that baseline is undefined.
- (3) The known sets are in many different systems and are not easily accessible as a baseline.
- (4) There's an over reliance on the mentality that "whatever's currently in the system is the baseline." The "system is the baseline" approach often lacks formal controls, integrations, documentation and therefore it is hard to maintain integrity.
- (5) Configuration management control boards are key entry points for risks. Many reviews don't take place that should – explicit decision gaps.
- (6) Based on past ARMD decision requirements (reference, validation, justifications, and analysis to internal and external customers) additional contextual information should be tracked in regards to decisions.
- (7) Given the complexity of ARMD decisions a broader and more inclusive input process would be helpful.
- (8) The rate of change within the organization occurs in short, concentrated bursts, distributed across divisions, centers, and contracts.

The pilot design was based on three levels of requirements:
1) Context requirement improvements over traditional CM

tools 2) Quality/Performance parameters based on organizational research 3) Functional interface/data requirements based on traditional CM specific environment challenges. These 3 levels can be summarized into the following Level I requirements:

- (1) Standard configuration management workflow capabilities
- (2) Standard documentation management capabilities linked to the CM processes
- (3) Efficient and agile user interface
- (4) Unobtrusive, diverse, and secure (anonymous) participation
- (5) Ability to capture the full context of the decision environment.
- (6) Multidimensional baselines

4. CBCM DESIGN

The CBCM design process focused on using as much COTS as possible (especially for the core configuration management process and document control) and then developed/integrated new modules as needed to address the additional requirements.

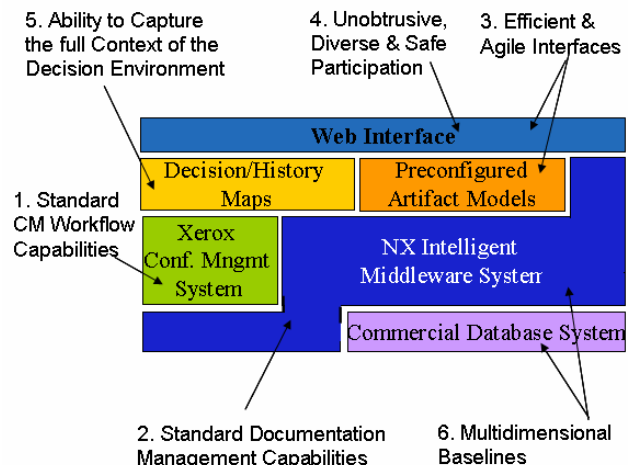


Figure 2: CBCM System Architecture

For Level I requirements #1 and #2 we choose to use the Xerox/NASA Docushare system called NX. This augmented COTS toolset provides state-of-the-art configuration management workflow, document control, and online collaboration support.

For requirement #3 we developed preconfigured CM artifacts. To address the full context and feedback requirements we devised two additional artifact classes not

traditionally found in CM systems: an event and a feedback class artifacts.

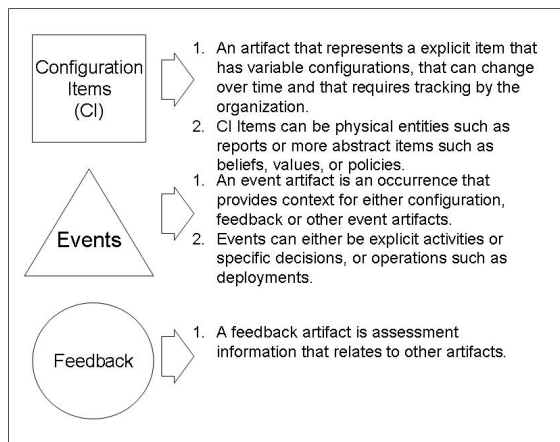


Figure 3: CBCM Artifact Classes

Based on past project and program management experience within ARMD an initial set of key CM artifact objects were created for each class type.

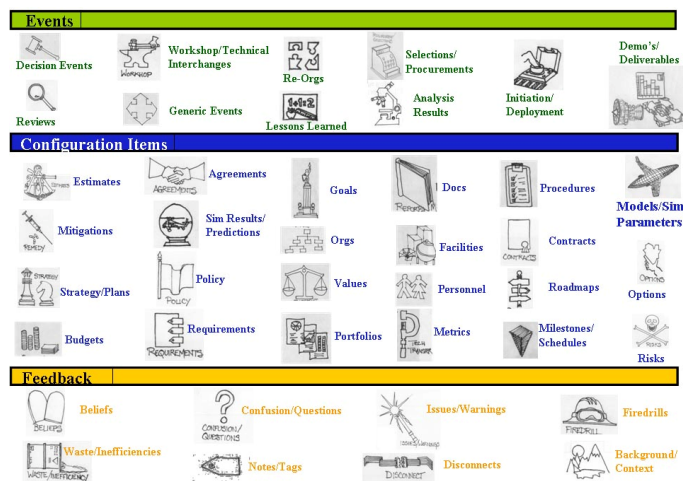


Figure 4: CBCM Artifacts

These artifacts are then available as a pick list from a library menu to populate the Configuration Maps. In order to meet the agility and ease of use performance parameters these preconfigured artifacts have the following features:

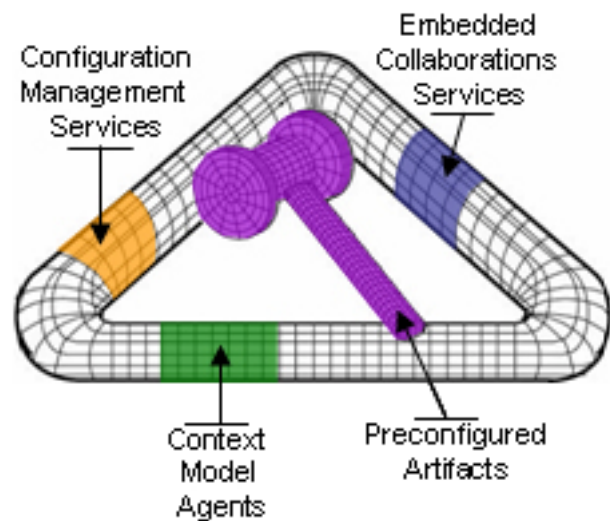


Figure 5: Example: Decision Event CBCM Artifact

- 1) Each artifact provides a seamless interface to configuration management workflow process
- 2) each artifact has collaboration services built in
- 3) intelligent agents provide automatic context checking and
- 4) each artifact has preconfigured metadata to expedite data capture.

The configuration management services include the basic workflow steps [4] of: submission, threshold checks, board scheduling, impact analysis, review inputs, board review, disposition, tracking, updates, status accounting, verification, audits, and closure. Additionally, the artifact manages appropriate documentation control.

The embedded collaboration services include polling/voting, bulletin board discussions, notification services, and advanced reports.

The context model agents will conduct pattern matching to catch scenarios that are similar to past configurations and project future impacts based on those matched patterns. The agents will also make linkages to the organizations other applications as appropriate: risk artifacts to the risk management system, budget artifacts to the budget system, lessons learned to the knowledge management system, etc..

The preconfigured artifacts have metadata fields customized for the type of class and particular instance instantiated. They will also have checklists and hints that will help users check for linkages and processes based on NASA standards or customized triggers developed by the organization.

For requirements #4 and #5 we implemented a web based decision map system that allowed for easy, quick, and distributed configuration maps to be built as a front end to the COTS CM and documentation toolsets. The web interface also allows unobtrusive linking from multiple levels, organizations, individuals allowing for community based interactions, especially in the form of linking

feedback artifacts or adding event or configuration item artifacts.

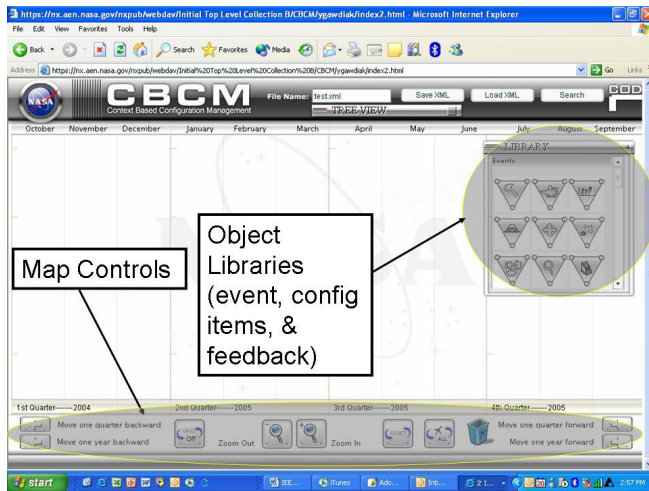


Figure 6: Web based configuration map interface

Figure 6 shows the web-based interface that provides the artifact libraries for drag-and-drop construction of a configuration map. The user also has various options on scale, dates, and linkages between artifacts.

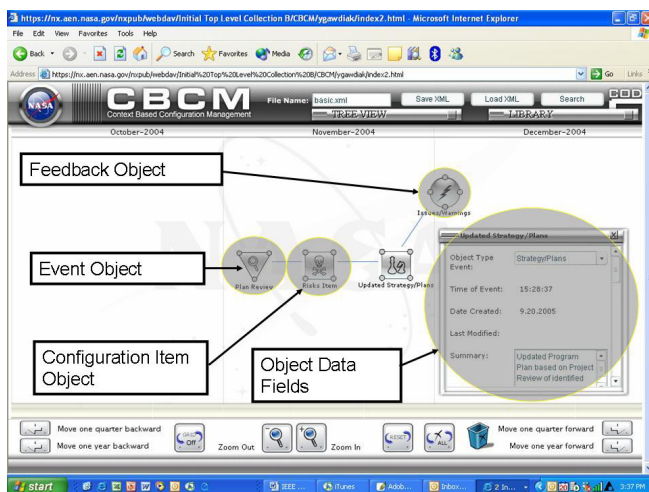


Figure 7: Basic CBCM Components

Figure 7 shows the basic features of the CBCM system in an example scenario. Four artifacts have been located into a configuration map in November 2004: A review event generates a risk configuration item that drives a project update and an issue feedback artifact has been linked to the updated program artifact. Additionally, a data window has been opened on the program artifact that provides access to various metadata fields as well as other configuration and collaboration services.

For requirement #6 the NX/Database architecture allows ARMD to track several baselines and dimensions in order to

allow multiple configuration map levels as well as multiple baselines to address multi-year budget planning as required by Congress.

5. PILOT TEST CASES

We have conducted three informal interface pilots of the tool suite to evaluate the ability to capture, organize, and represent decisions that the mission directorate has recently undertaken. These test runs are in the process of being evaluated and validated by the key decision makers and participants in the events/decisions. This includes budget personnel, technology managers, and program analysts who were directly involved in the decision processes as well as external consultants on configuration and organizational management.

The test presented here is on how the tool tracked the decision process for a review of ARMD programs and their strategies to meet agency level goals and constraints.

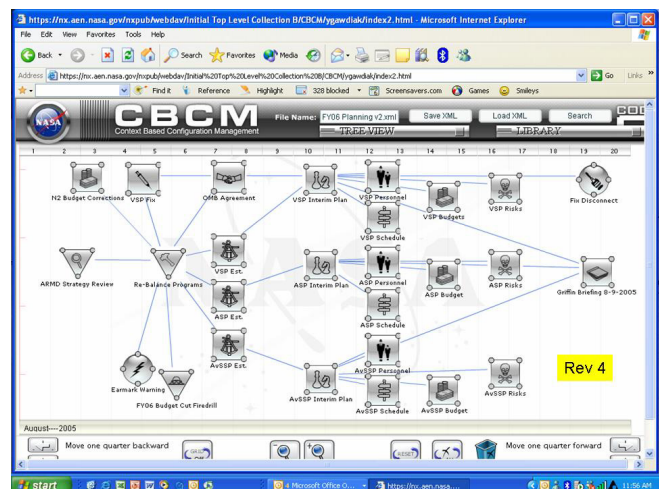


Figure 8: Test 1- Agency Review & Plan Update Scenario

Figure 8 shows the complete decision process from initial event to intermediate decisions and products to final out. In this case it was a budget replanning exercise done under a very short time frame.

Figures 9-13 highlight the key objects on the map, including events, decisions, and feedback icons, their relationships both in terms of sequence and impact and the relevant information/context to the decision processes and ultimate product produced.

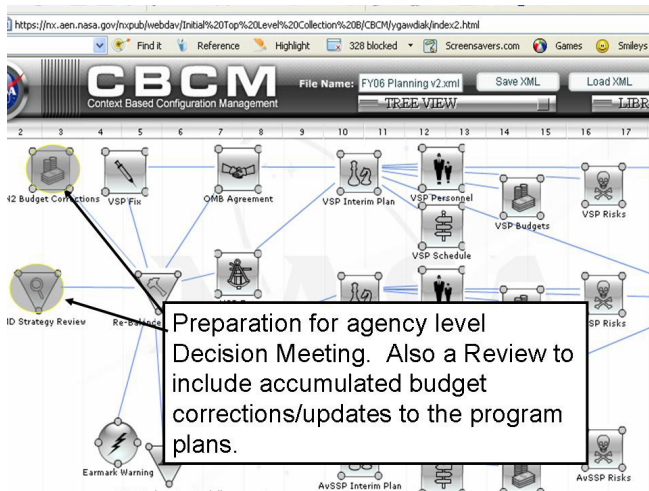


Figure 9: Test 1- Review Event & Budget Updates

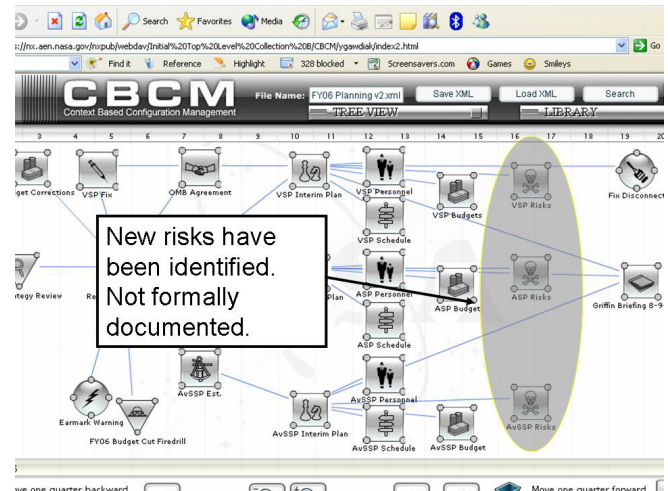


Figure 12: Test 1 – Implicit Risks Identified

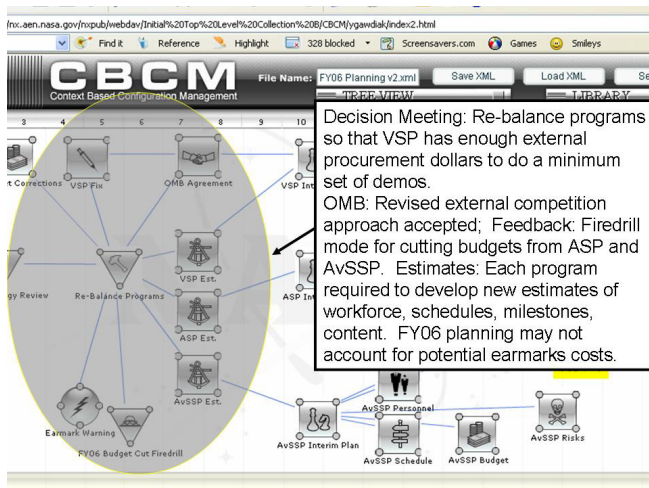


Figure 10: Test 1- Decision Event & Estimate Inputs

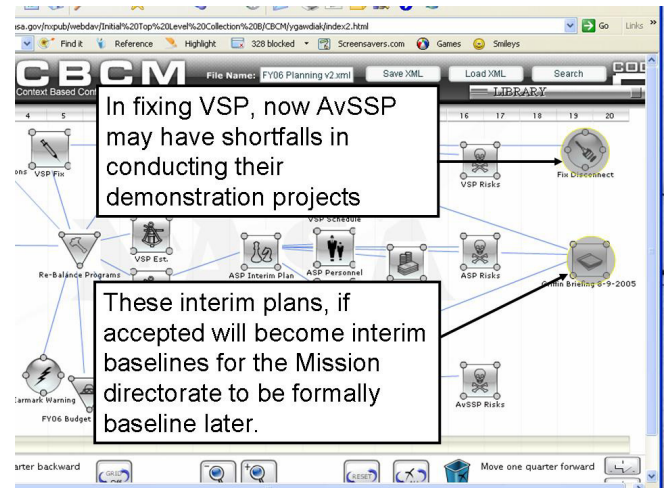


Figure 13: Test 1- End Results

6. CONCLUSIONS

The initial tests on the user interface have shown several promising results:

- (1) Ability to quickly and easily document decisions and configuration changes, especially with the preconfigured artifacts.
- (2) The artifact library pop up window and organization not only provides convenient access it also serves as a visual prompt to record often implicit key decision activities.
- (3) Easy to map and link even complex decision sequences. Updates and modifications are rather simple to implement as well.

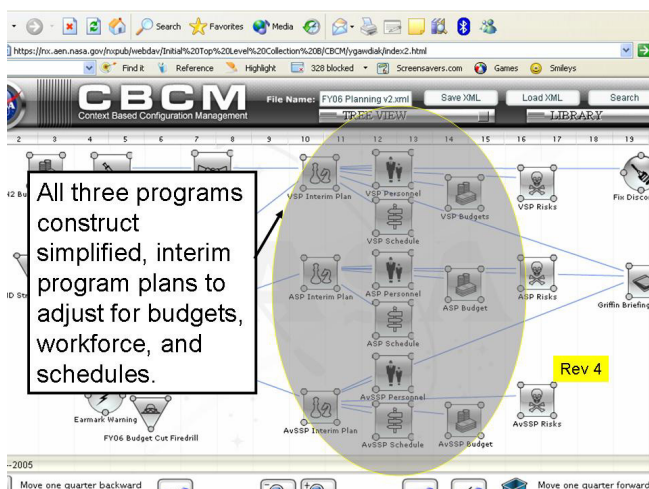


Figure 11: Test 1- Plan Updates

- (4) Feedback artifacts add to the context and understanding of the decision rationale and/or the state of the mission directorate

Several challenges have also been identified that will need to be addressed before the tool can be operationally deployed:

- (1) Organizational comfort levels: exposing the decision management processes semi real-time have various sensitivity levels that may require significant culture changes.
- (2) Some configuration item artifacts, such as plans, are complex components and representing their subcomponents (budget, schedule, risks, etc.) may be problematic to represent consistently.
- (3) Linking and managing enterprise level configuration maps may become very complicated.
- (4) There are many status indicators that would be useful for the configuration map to represent: disposition status, uncertainty, quality, pedigree, risk levels, and other factors. Devising an efficient, consistent, and user friendly way to represent these factors will be a key goal.

Next steps will address the artifact subcomponent issues as well as testing the integrated configuration management services. Once the CM workflow processes are validated the next significant test will be on the embedded collaboration services. Especially interesting will be testing the concept of voting and polling as a means to validate feedback artifacts to give decision makers and analysts better situational awareness of the enterprise position relative to a given decision scenario.

7. ACKNOWLEDGEMENTS

Although much of the conceptual work and initial software for this pilot was done as part of the ECS program, the initial pilot testing was done under a contract with LMI Government Consulting with a subcontract to NXAR LLC. We wish to thank Shahab Hasan, Denise Duncan and Joanna Gribko from LMI for the concept pilot task management as well as state-of-the-art research on current configuration management systems and requirements analysis for the ARMD organization. We would also like to thank Randy Nickel from NXAR for the current pilot software upgrades and test support.

8. REFERENCES

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9. BIOGRAPHY



Yuri Gawdiak is a program integration manager for NASA's Aeronautics Research Mission Directorate and has been working advanced information systems and strategic planning for twenty years. He has worked in industry, academia, and government covering space, aeronautics, and engineering research. At NASA he has worked at Johnson Space Flight Center on the Space Station program including principal investigator for the Wireless Network Experiment on STS-76/Mir-21. In aeronautics at Ames Research Center he was the build manager for the Surface Movement Advisor at Atlanta Hartsfield International Airport. At NASA headquarters Mr. Gawdiak was the program manager for the Engineering for Complex Systems program and has worked both in the Exploration Systems Mission Directorate as well as in the Aeronautics Research Mission Directorate. He earned his BS in information systems with a concentration in ergonomics at Carnegie Mellon University. For his work in Personal Satellite Assistant as well as other programs and projects Mr. Gawdiak has been awarded both the NASA Outstanding Leadership and Exceptional Achievement medals.



Mohana M Gurram is a computer scientist for Universities Space Research Association at NASA Ames Research Center. He has worked with Mars Exploration Rover mission and has been presented with awards like TGIR, Honors Award at NASA. His area of interest is Data Visualization especially context-sensitive data. He earned his Masters in Computer & Information Science.



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