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THE NATIONAL AIR INTELLIGENCE CENTER SOFTWARE PROCESS IMPROVEMENT EFFORT (NAIC SPI)

Harris Technical Services Corporation

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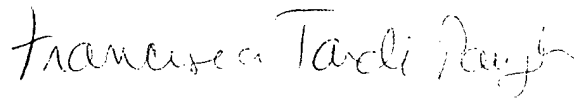
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13. ABSTRACT (Maximum 200 words)
This report summarizes the requirements, methods, procedures, and accomplishments of the National Air Intelligence Center (NAIC) Software Process Improvements effort. The objective of this effort was for the contractor to provide engineering and software process improvement for NAIC/SCD to reach SEI's CMM Level 2 in process maturity. While working to reach CMM Level 2, the goal was to develop policies and practices that would lead directly to and support CMM Level 3. Work included estimation, software subcontract management, software configuration management, software quality assurance, metrics and measurements, and training.

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1. INTRODUCTION

1.1. Executive Summary

This report summarizes the requirements, methods, procedures, and accomplishments of the National Air Intelligence Center (NAIC) Software Process Improvements effort. Harris Technical Services Corporation (HTSC) performed the work as a subcontractor to Harris Corporation under Rome Laboratory contract F30602-94-D-0055, TOA Task #5. This report satisfies data item A005 of this task.

1.2. NAIC Overview

NAIC acquires, collects, analyzes, produces, and disseminates foreign aerospace intelligence. It conducts integrated analysis programs to meet the intelligence production requirements of the Air Intelligence Agency; the Air Force Assistant Chief of Staff, Intelligence; and the Defense Intelligence Agency. It provides finished aerospace intelligence to the operational commands of the USAF and JCS and serves as the single Air Force intelligence production center. To meet its intelligence mission, NAIC operates an intelligence data handling system and collaborates with other organizations to improve the collection, acquisition, and use of aerospace intelligence. In addition, the NAIC assesses the capabilities and intentions of foreign aerospace forces, weapon systems, and technologies - both current and future. NAIC determines the implications of these capabilities and the intentions of operational, acquisition, and policy-making customers.

To accomplish this mission requires significant automation capabilities. NAIC/SC is the focal point for that information technology. NAIC/SC designs, implements, operates, and maintains the technical production infrastructure necessary to support the NAIC mission. This includes providing technical computing services, internal and external communications, and research and development of production systems. NAIC/SC provides production support for NAIC intelligence products and computing needs. It does so by acquiring, developing, implementing, and maintaining application software and technologies necessary to support its analytical processes and automated information handling requirements.

NAIC/SC is currently migrating its existing legacy systems to provide near term enhanced information technology capabilities to its customers and, based upon a detailed strategic plan, a long term goal of providing an environment to increase customer productivity and customer satisfaction. This migration of legacy systems is being accomplished by reengineering existing systems into an open systems architecture using relational database technology, consistent user interfaces, standard development architecture, and standard hardware platforms. To be able to meet NAIC

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software migration goals, NAIC/SC has undertaken an extensive effort to improve its software development capabilities.

NAIC/SCD is a small software support division, 50 people total supporting the intelligence community. 6 people manage problem domains and projects, 36 people develop software and data base systems and 8 people provide software support. Projects are small and developed quickly. The small projects and limited project staff size bring special problems in tailoring the Software Engineering Institute's (SEI) Capability Maturity Model (CMM). Some activities that are needed and necessary for large development and maintenance organizations are overkill on small projects.

1.3. Objectives of the Effort

Provide engineering and software process improvement support for NAIC/SCD to reach SEI's CMM level 2 in process maturity. While working to reach CMM level 2, the goal was to develop policies and practices that would lead directly to and support CMM Level 3. Work included estimation, software subcontract management, software configuration management, software quality assurance, metrics and measurements, and training.

Dr Phil Koltun, Harris Engineering Productivity Group, conducted a self-assessment workshop from 3 through 6 Sept 96. Following the self-assessment workshop, efforts focused on correcting weaknesses identified at the September workshop. The plans called for a Software Engineering Institute's CMM Based assessment for Internal Process Improvement (CBA-IPI) in October of 1997.

1.4. Report Overview

The remainder of this report is as follows:

- Section 2, Contractual Requirements, summarizes the program objectives and SOW requirements.

- Section 3, Approach, Methods, & Results, describes the approach taken and any special methods use and the results.

- Section 4, Recommendations, document HTSC recommendations to NAIC/SCD.

- Section 5, Lessons Learned, documents a few lessons from the NAIC SPI effort.

- Appendix A, Contract Deliverables, list the documents developed by HTSC in chronological or deliver order.

- Appendix B, Workshop Findings, summarizes the findings from the workshop conducted by Dr, Phil Koltun.

- Appendix C, Summary of "A Guide to Achieving SEI CMM Level 2 at NAIC"

- Appendix D, Acronym Listing

2.   Contractual Requirements

2.1.   Summary

This section contains a summary of the program objectives and SOW requirements. The SOW required HTSC to provide software process improvement (SPI) support plus system and software process training. The first priority of HTSC was to concentrate on assisting NAIC/SCD in establishing sound CMM level 2 practices as they applied to NAIC and the CMM. This support manifested itself as:

- Reviewing and commenting on current NAIC/SCD software development practices

- Researching industry solutions to SPI related problems relevant to NAIC/SCD

- Assisting in the design, implementation, and training of process improvements

Upon completion of analyzing, designing, implementing, and training CMM level 2 processes, HTSC focused on the CMM level 3 practices to the extent allowed by the effort and as directed by the Software Process Improvement Steering Group (SPISG) and the Software Engineering Process Group SEPG.

This effort was be documented in monthly program progress reports (A001) and other specified reports. The specified reports include:

- An assessment plan and follow-up recommendations report (CDRL A002)

- Presentation material to educate NAIC/SCD personnel on the benefits of the SPI effort (CDRL A003, CDRL A006, CDRL A008)

- A guide to achieving SEI CMM level 2 at NAIC (CDRL A004)

- A final scientific and Technical report (CDRL A005)

- A NAIC/SCD PnP Configuration Management Chapter (CDRL A007)

The remaining parts of this section document the individual requirements of these reports.

2.2.   Monthly Program Progress Reports

HTSC ensured progress was consistent with the requirements of the SEI CMM Level 2 and consistent with future goals of attaining SEI CMM Level 3. HTSC provided a monthly report with status of the effort and reported progress toward accomplishment of contract requirements.

2.3. Assessment

HTSC assessed on going NAIC/SCD work and improvement efforts to determine requirements for reaching Level 2 of the Software Engineering Institute's (SEI's) Capability Maturity Model (CMM). The purpose of this assessment was to determine the maturity of the unit's software processes.

2.3.1. Assessment Plan

HTSC created an Assessment Plan that would provide NAIC/SC with guidance for performing SEI CMM self-assessment. The plan contains sufficient detail so that government personnel can repeat the assessment process on future projects. Topics covered include:

- On-going Software development and maintenance projects
- Determining the current level of NAIC/SC plans and policies for process improvement.

2.3.2. Conduct a CMM assessment

HTSC conducted a SEI CMM assessment of projects designated by the Software Engineering Process Group (SEPG). Two Government representatives participated in the assessment to learn the proper procedures and methods used in conducting an assessment.

2.3.3. Document Assessment Results

Upon completion of the assessment, the assessment team documented the following areas:

- Strengths
- Weakness
- Inconsistencies, gaps and duplication of efforts
- Improvement suggestions

Additionally, HTSC provided recommendations to NAIC/SCD for meeting the SEI CMM Level 2 requirements. These recommendations should be consistent with a long-term goal of attaining SEI CMM Level 3.

2.4. Presentation material

HTSC provided presentation material for NAIC/SCD to educate the Center's personnel on the benefits of the SEI efforts. The goal of this familiarization was to create awareness, within NAIC, of the commitment and resources required to effect software process improvement in the following critical areas:

- Developing and documenting software policy and procedures.

- Managing software activity requirements.

- Developing and executing a software development plan for future projects.

- Developing and executing configuration management and software quality assurance plans

- Developing and executing a commitment process.

HTSC developed and delivered process training on NAIC/SCD's standard lifecycle models. This training included high-level overview training and detail level process training. The detail level training modules are intended for "just-in-time" training at the beginning of each lifecycle phase. The deliverable was in the form of training presentation sides, training aids, and instructor's notes.

2.5. A guide to achieving SEI CMM level 2 at NAIC

HTSC developed a guide to achieve the SEI CMM Level 2 goal. For each of the following policies and processes: recommend areas for improvement that will allow NAIC/SCD to move toward SEI CMM Level 2 compliance; and recommend areas that can be automated.
The areas they reviewed were:

- Contract Procurement and Management

- Project Planning and Tracking

- Change and Status Accounting

- Procedures for coordination and guidance of the Software Development and Maintenance Process

2.6. A final scientific and technical report

HTSC documented all technical work accomplished and information gained during performance of this effort. This document includes all pertinent observations, nature of problems, positive and negative results, and design criteria established where applicable. It documents procedures followed, processes developed, "Lessons

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Learned", etc. It documents the details of all technical work to permit full understanding of the techniques and procedures used in evolving technology or processes developed. It also cross-references separate design, engineering, and process specifications which were delivered in order to permit a full understanding of the total acquisition.

2.7. A NAIC/SCD PnP Configuration Management Chapter

HTSC developed a NAIC/SCD PnP chapter on configuration management. This chapter includes policy and processes to inject configuration management activities into current NAIC/SCD standard lifecycle models.

3. Approach, Method, & Results

This section describes the approach taken, any special methods, and results.

The overall method to process improvement was to investigate and document current procedures. Then study current procedures and look for improvements. Where procedures did not exist, SCD's SEPG would create a team to collect information then suggest and develop a new procedure.

3.1. Orientation & Background Information

Mr. Don Blankenship, HTSC, started the NAIC SPI effort on 15 April 1996. The Government Furnished Equipment and office in the NAIC holding area were adequate to begin the task.

Capt. Fulton provided newcomers orientation and brief history of NAIC SPI efforts. Mr. Blankenship met many members of NAIC/SCD and studied the provided NAIC Policy and Procedures manual and other process related information.

3.2. Contract Issues & Plan to meet Deliverables (CDRL List)

While studying the process artifacts, Mr. Blankenship studied the contract and built a work breakdown structure (WBS). From the WBS, Mr. Blankenship scheduled the contract deliverables (CDRL).

Maj. Dan Burke (SCDQ), Capt. Greg Fulton (SCDQ), Ms Tandi Paugh (Rome Lab), and Mr. Blankenship (HDSC) met on 3 May 96 to discuss contract issues. Draft copies of the TIM slides were reviewed and discussed. Issues and concerns were identified and solutions agreed to by all parties.

HTSC conducted the first Technical Interchange Meeting (TIM) on 7 May 96. Mr. Roger Beauman started the presentation with information on software process improvement. He gave reasons for doing process improvement and results from Harris's software process improvement effort. CDRL milestones were presented and the customer agreed to the plan of attack and expected results. Customer requested the next TIM be held on 10 July 1996. HTSC's goal was "Total Customer Satisfaction". HTSC planned to meet the goal with 100% on-time delivery of CDRL products and delivery of value-added support to NAIC/SCD's software process improvement effort.

CDRL delivery status, milestones and short term goals were presented at the 10 July 1996 Technical Interchange Meeting. Col. H. Wayne Wolfe (SC), Maj. Dan Burke (SCDQ), and Capt. Greg Fulton (SCDQ) attended for the government. Mr. Don Blankenship, Mr. Roger Beauman and Ms. Debbie Crow from Harris attended.

Discussions were had that more concentration needed to be focused on the Configuration Management Working Group rather than the Estimation Working Group.

HTSC presented CDRL delivery status, milestones and short term goals at the 15 October 1996 Technical Interchange Meeting. Attendees included: Col. H. Wayne Wolfe and Capt. Greg Fulton from NAIC/SC, Ms. Tandi Paugh from Rome Lab, and Mr. Roger Beauman from Harris. Ms Paugh provided some changes to "A Guide to Achieving SEI CMM Level 2 at NAIC" technical information report (CDRL A004). These changes were made before the report was delivered.

CDRL delivery status, milestones and short term goals at the 20 January 1997 Technical Interchange Meeting. Major issues discussed were Mr. Blankenship security clearance and the engineering change proposal.

HTSC presented CDRL delivery status, milestones and short term goals at the 23 September 1997 Technical Interchange Meeting.

Appendix A list the critical document deliverables in the order they were completed.

3.3. Assessment

3.3.1. Assessment Plan

Planning started by coordinating a date with NAIC/SCD and Dr Phil Koltun, Harris Engineering Productivity Group. The assessment workshop was scheduled for 3 September 1996 through 6 September 1996. Mr. Blankenship outlined a workshop plan. Dr Koltun and Mr. Blankenship met at the SEPG conference in Atlantic City, NJ to plan and coordinate the workshop. Dr Koltun and Mr. Blankenship completed more of the Assessment Workshop plan and discussed more details of the conduct and activities when Mr. Blankenship traveled to Melbourne, FL from 24 through 26 June. Dr. Koltun reviewed Mr. Blankenship's pre-workshop questionnaire and modified the level of information to collect. The questionnaire was developed from the issues identified in NAIC's 1994 assessment.

The draft plan was delivered on 15 August 1996. The outline of the workshop plan follows:

1. INTRODUCTION

2. OBJECTIVES

3. DESCRIPTION
3.1. PREPARATION
3.1.1. QUESTIONNAIRE

Mr. Blankenship distributed the Pre-Workshop Questionnaire, Appendix B. of the Assessment Workshop Plan, to Capt. Fulton. NAIC/SCD's Software Process Improvement Steering Group (SPISG) approved Mr. Blankenship's requested for all of SCD to complete and return the questionnaire to Mr. Blankenship by 12 August 1996.

3.3.2. Assessment Workshop

Mr. Blankenship captured the comments and responses from the Pre-Workshop Questionnaire (Appendix B. of the SPI Workshop Plan). He received back 36 of the 50 distributed to SCD personnel. The comments and responses were analyzed and used in the September Assessment Workshop.

Dr. Phil Koltun, Harris EPG, led the September SPI Assessment Workshop from Tuesday, 3 September 1996 through Friday, 6 September 1996. The workshop team consisted of 9 NAIC members, Mr. Blankenship and Dr. Koltun. In addition, 8 other members of NAIC attended and participated in the workshop.

Dr Koltun started the Assessment Workshop on Tuesday with an In-Brief. The In-brief was provided to Col. Wolfe Mr. Lush, Mr. Beigel, Mr. Mosley, Mr. Leasure, Maj. Burke and the Workshop Team Members. The Software Process Improvement Steering Group (SPISG) and the Software Engineering Process Group (SEPG) sponsored Dr. Koltun to speak at the Software Process Improvement Open Forum, to maximize organizational access to Dr. Koltun. At the open forum Dr. Koltun presented a briefing on "17 Practical Ideas for Improving How We Do Software" to the entire Systems Development Division.

The actual workshop started Wednesday morning with the first key process area (KPA) Requirements Management (RM). Dr. Koltun started the investigation into SCD RM practices by discussing the KPA and describing what was expected to satisfy a CMM Level 2 assessment. Then Dr. Koltun opened the workshop for comments, from the attendees, on SCD policies and practices in the RM area. Then Dr. Koltun started asking specific questions to gather additional and specific process and practices information. To cover the remainder of the KPAs, Dr. Koltun started the investigation with the specific questions and closed each KPA with the general discussions about the KPA and the CMM expectations. At the end of each KPA session, Dr. Koltun asked each team member to write down SCD's strengths and weakness for the KPA discussed during the session. The high priority CMM Level 2 and Level 3 KPAs were covered on Wednesday and Thursday with a general discussion of the remaining KPAs on Thursday afternoon. Thursday night Dr. Koltun collected the data gathered, created findings, and arranged the information into a briefing for Friday. Dr. Koltun presented the findings to the workshop team to validate the information and get feedback for any corrections needed. Dr Koltun closed out the workshop with an outbrief Friday afternoon to Col. Wolfe, Mr. Lush, Mr. Beigel, Mr. Mosley, Mr. Leasure, Maj. Burke and the Workshop Team Members.

NAIC/SCD's strengths and weaknesses were discussed and briefed to Col. Wolfe, Mr. Lush, Mr. Beigel, Mr. Mosley, Mr. Leasure, and Maj. Burke on Friday afternoon. Participants commented the workshop was very successful. Appendix B summarizes the workshop findings.

3.3.3. Assessment Report

Following the workshop, Capt. Fulton and Mr. Blankenship took the weakness identified and the suggestions provided during the workshop and created a requirement queue of activities to fulfill the Level 2 KPAs goals. Capt. Fulton and Mr. Blankenship prioritized and estimated the resources needed to work the items in the requirement queue. Capt.

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Fulton briefed the SPISG on 19 September 1996. The SPISG decided to delay the SEI assessment, a CMM Based Appraisal for Internal Process Improvement (CBA-IPI), from March 1997 until October 1997. Capt. Fulton used the process improvements requirements queue and estimates to create a project proposal and project plan for the SPISG and SRB approval.

On 27 September 1996, HTSC delivered the draft Assessment Workshop Report from the September SPI Workshop. HTSC then worked with the SEPG to categorize the responses to the 4 open-ended questions from the Pre-Workshop Questionnaire. Mr. Blankenship provided the SEPG the responses then sorted them into the categories supplied by the SEPG. Capt. Fulton presented the results to the SPISG. Col. Wolfe, SC Director, and Mr. Lush, SCD Division Chief has addressed some of the issues brought-up at the workshop. This allowed the SPISG to address any outstanding issues.

Since the U.S. Air Force submitted no changes, the Assessment Workshop Plan and Report were accepted as final, on 13 December 1996.

3.4. A guide to achieving SEI CMM level 2 at NAIC

The areas of concern, as specified in the SOW (see Section 2.5 on page 5), for study included but was not limited to:

- Contract Procurement and Management

- Project Planning and Tracking

- Change and Status Accounting

- Procedures for coordination and guidance of the Software Development and Maintenance Process

To investigate the areas of concern in the SOW, Mr. Blankenship started with the "Contract Procurement and Management" (the CMM calls this area Software Subcontract Management).

3.4.1. Software Subcontracting Management

Mr. Blankenship and Capt. Fulton were identified as the Software Subcontracting Working Group. They were chartered to study subcontract management. They began by creating an interview script with questions about managing contractors.

The next step was to interview the major players involved in managing contractors. The major players included Mr. Don Quigley (SCX), Mr. Dave Leasure (SCDD), Mrs. Sharon Cain (SCDD), and Mr. Joe Schmalhofer (SCD).

The Subcontracting-working group completed the initial interviews and delivered the draft report on Software Subcontractor Management on 14 June 1996. This was the first deliverable for the guide to achieving CMM level 2.

The next step was to review SCD's Policy and Practices (PnP) documentation on project management and configuration management. Additionally, continue to work with chartered working groups to learn more about NAIC/SCD.

3.4.2. Estimation Working Group

Mr. Blankenship met with the Estimation working group to define the scope of the working group and the requirements to satisfy. The Estimation working group decided to review past work on estimating and look at current tools and procedures available.

Mr. Blankenship contacted Mr. Daniel Ferns, AFIT professor, researching estimating tools and procedures. Mr. Ferns is a noted author and researcher on estimating tools and their use. Mr. Blankenship described NAIC/SCD and their project size and duration and Mr. Ferns agreed current tools and procedures were developed for much larger projects. In order to use these tools, NAIC/SCD would need to gather data to customize the tools to SCD's project size.

The Estimation working group defined the project lifecycle model and identified the points estimation activities occurs. Each member was assigned to document estimation activities and develop process descriptions. Mr. Blankenship provided guidelines and suggestions for developing and documenting their process descriptions.

Emphasis on the work with the Estimation Group was reduced based upon recommendations made by the SEPG and the SPISG.

3.4.3. Configuration Management Working Group

The SEPG and SPISG chartered a Configuration Management working group. The Configuration Management Working Group defined its scope and decided to call itself the CM process team (CMpit). The CMpit was chartered to define and document the CM processes needed and select a CM tool to support the CM processes. At the first meeting with the SPISG, the SPISG stressed the need to acquire a CM tool.

The CMpit generated a list of requirements for a CM tool and performed the subsequent review. General Research Corporation International personnel gave a demonstration of Atria's Clearcase to the CMpit. Atria personnel also gave a demonstration of Clearcase and answered questions. SQL personnel gave a demonstration and training session on SQL's PCMS CM tool. Sharon Otto, AMC/CPSS PPSC, sent Mr. Blankenship a copy of their CM tool selection findings. The CMpit briefed the SPISG on their progress and was directed to acquire a copy of Atria's Clearcase and test for an 80 percent solution.

At the 19 September 1996 SPISG meeting, the CMpit was directed to focus on CM processes and procedures and make the CM tool a long-range objective. CM went ahead and purchased the tool but will wait until someone is trained and the tool is installed on hardware before changing the processes and procedures to use the tool. A CM tool is not necessary to achieve CMM Level 2.

Mr. Blankenship developed and provided draft copies of Configuration Management activities across the SCD project lifecycle to the CMpit.

Mr. Blankenship developed and provided draft copies of guidance on Configuration Control Board (CCB) and CM audits to the CMpit. The CM audits include Physical Configuration Audit (PCA) and Functional Configuration Audit (FCA).

After full review by the CMpit and SEPG, Mr. Blankenship updated draft copies of Configuration Management activities across the SCD Standard Project Lifecycle to the CMpit. He then developed a new high-level model of the SCD Standard Lifecycle and developed multiple models to show CM activities and interfaces to other processes.

3.4.4. Project Planning, Tracking, & Oversight

Mr. Blankenship reviewed and provided comments on SCD's Policy and Practices (PnP) Chapter 5, Project Planning Tracking & Oversight. Mr. Blankenship looked for weakness as compared to the CMM and two of the KPAs. Suggestions were documented and provided to the SEPG.

3.4.5. Guide to CMM Level 2

Mr. Blankenship reviewed the findings from the 1994 SPA and documented changes in the report.

Mr. Blankenship delivered the draft of "A Guide to Achieving SEI CMM Level 2 at NAIC" (CDRL A004) on 15 August 1996. This guide covered three areas: Subcontract Management, Project Planning and Tracking, and Configuration Management.

Mr. Blankenship delivered the Final "A Guide to Achieving SEI CMM Level 2 at NAIC" technical information report (CDRL A004) on 15 October 1996. This report is summarized in Appendix C.

3.5. Presentation or Background Material

3.5.1. Requirements & Design

Mr. Blankenship conducted two lead developers interview sessions on how NAIC manages requirements. Then worked with Capt. Fulton to engineer changes to the project initiation to include more discipline on requirement management. Capt. Fulton provided examples of documented requirements.

Mr. Blankenship developed some guides to use for modeling requirements. This included an introduction to structural analysis and provided some NAIC standards for data flow diagrams (DFDs), entity relationship diagrams (ERDs), and state transition diagrams (STDs). Mr. Blankenship also provided an introduction to Concept Maps (CMAPS) for object oriented problem analysis. Additionally, some sample problems with DFD, ERD, STD, and CMAPS were included. These guides were provided in draft form to provide SCD analyst a starting point. SCD analyst should modify and include the object-oriented method of choice and any other standard analysis or modeling methodology.

3.5.2. SEI

HTSC worked with other NAIC/SCD contractors to supply a coordinated effort.

Capt. Coquillard, Capt. Fulton, Capt. Carlin (all of NAIC/SCDQ), Mr. Blankenship (HTSC), and Mr. Lynn Carter (SEI) met to plan future efforts for NAIC/SCD's process improvements.

Mr. Blankenship met with Dr. Lynn Carter (SEI), Mr. Dan Green (SEI), Capt. Ed Coquillard, and Capt. Greg Fulton. SEI planned to work with NAIC/SCD and HTSC to define management processes to prioritize work requests and manage a set of projects. The most important would be a System Resources Board chapter.

3.5.3. SRB Chapter

Mr. Blankenship worked with Capt. Greg Fulton and Capt. Ed Coquillard to create the first draft of a working paper on the SRB. SEI used the working paper and worked with NAIC/SCD and HTSC to define management processes to prioritize work requests and manage a set of projects.

3.5.4. Process Briefing

Mr. Blankenship worked with Capt. Greg Fulton and Capt. Ed Coquillard to create, and prepare a briefing on NAIC/SCD's process architecture for the 1997 HQ AFCA Software Process Improvement (SPI) Workshop.

This briefing was a great beginning for an introduction to the NAIC/SCD process. It provides background and future of the process.

3.5.5. Training Program

Mr. Blankenship created a high-level template for process overview training. This training has three levels. 1) A single page showing the process architecture with phases, milestones, and major review points. 2) A page per phase with the key things that occur in the phase with inputs, outputs, and high-level activities. 3) One or more pages containing details on the activities for a given phase identifying the individual responsible to complete the activity.

He then participated in developing and delivering process overview training for version 3.1 of the Application Development Process. In addition, Mr. Blankenship and Capt. Fulton developed and delivered training on risk management, requirements management, and software estimation.

Mr. Blankenship developed orientation-training outlines for Software Quality Assurance, Configuration Management, and System Testing. This standard template provides guidance to the functional areas when developing their own process training.

ompleted reviews and revisions of orientation training slides for three of the software service branches. This orientation training was for version 3.2 of NAIC/SCD Policy and Practices (PnP). This provided orientation training on Software Quality Assurance, Software Configuration Management, and System Testing.

Mr. Blankenship created a survey to collect information on training received by SCD personnel. This was a beginning for creating a SCD training program.

3.5.6. Risk Management

Mr. Blankenship developed and delivered a briefing to introduce risk management. Col. Wolfe requested additional information. Mr. Blankenship researched prior issues of STSC's Crosstalk and found the information for Col. Wolfe.

3.5.7. Software Life-Cycle Model

Mr. Blankenship developed and provided background information and an introduction to software life-cycle process models with the advantages and disadvantages.

NAIC/SCD tends to think in terms of a project life cycle and not a system. Mr. Blankenship suggested SCD investigate a system software life-cycle process model.

3.5.8. Metrics

Mr. Blankenship developed an outline for metrics spreadsheet for project data. Each System has a worksheet with multiple project tables containing key project information for each phase of the lifecycle. Then a summary worksheet for all systems sorted into tables for small, medium, and large systems. The key project information includes effort (hrs), duration (days), document defects, product defects, document quantity (pages), product quantity (LOC), product productivity (LOC/hr), document productivity (pages/hr), and defect rate (defects/LOC & defects/pages). From this outline, Capt. Fulton developed a working prototype to demonstrate the concept to project managers.

Mr. Blankenship developed a metrics spreadsheet with pivot tables on time accounting data. These tables allow managers to evaluate individuals or projects across time periods looking for trends. One pivot table pivots on projects and shows time charged by person for each month from April 1997 through November 1997. The second pivot table pivots on people's names and shows the time charged to project codes for each month from April 1997 through November 1997.

Mr. Blankenship developed an additional metrics spreadsheet with pivot tables from time accounting data. These tables have trend information on cost of projects by phase. This information will be used by future projects to improve phase estimation. This was the first step to gather the information to populate the project metrics spreadsheet.

Mr. Blankenship developed an 'awk' language script to clean up and standardize the data from the time accounting database for the information by phase pivot tables. He demonstrated good programming practices by using a program header complete with usage information and change history.

3.5.9. Application Classes & Artifacts

Mr. Blankenship started collecting information to develop application classes to determine standard artifacts. The standard artifacts were to be used in program management to plan code and unit test phase to address project planning and tracking weaknesses found in the assessment. After interviewing multiple people, Mr. Blankenship canceled the effort. Lack of robust designs limited developers understanding and need for a defined set of standard artifacts.

3.6. A final scientific and technical report (CDRL A005)

The method used to develop this report was to gather all pertinent information and document the major efforts at NAIC. Then document the lessons learned and any recommendations for the future.

3.7. A NAIC/SCD PnP Configuration Management Chapter

Mr. Blankenship took the individual aids he developed for the CMpit and drafted an outline for a NAIC/SCD Policy and Practices Chapter on Configuration Management. He incorporated the Configuration Management project lifecycle activities, the guidance on Configuration Control Board (CCB) and CM audits, high-level models of the SCD Standard Lifecycle, and multiple models with views of CM activities and interfaces to other processes. Additionally, Mr. Blankenship outlined a CM handbook. The PnP chapter documents what activities must occur and the handbook documents how to perform the activities.

He worked with project managers and configuration managers to solve a project artifact numbering problem. He documented the problem and a configuration management solution then participated in a training session.

He delivered the draft Configuration Management chapter in January of 1997. The final NAIC/SCD PnP Configuration Management Chapter was delivered on 23 October 1997.

3.9. Additional Support

This section includes other efforts that were not directly tied to deliverables.

3.9.1. PnP Review

Mr. Blankenship reviewed and provided comments on SCD's Policy and Practices (PnP) Chapter 5, Project Planning Tracking & Oversight and Chapter 10, Quality Assurance Plan.

Mr. Blankenship and Capt. Fulton conducted an in-house desk audit of the NAIC/SCD development processes with Mrs. Suzanne Zampella (HTSC, Scott AFB). The audit was to ensure existing processes fully comply with the CMM. The Audit provided SCD with improvements and long term suggestions. These suggestions were added to the requirement list for the next version of the process.

3.9.2. Final Push Project

The SEPG and SPISG chartered Capt. Fulton and Mr. Blankenship to head a team to address the weakness found in the September Assessment Workshop. They attended the Formal Project Kick-off for the final push project and started to work on the weakness from requirements management. After developing guides for requirements and design, they started to work on configuration management weakness. They then drafted post-project questionnaires for conducting Project Post-Mortems, by project managers and project team members. They also generated tables to aid the planning efforts of a project.

3.9.3. SQA

Mr. Blankenship modified SQA's problem resolution process. The modified process allows individuals to solve problems at the lowest levels.

He then completed formatting the Software Quality Assurance chapter with version 3.2 style changes to identify policy and process artifacts. Additionally, he rewrote the quality assurance reporting process and redesigned the compliance resolution process.

3.9.4. Technology Adoption Plan

Mr. Blankenship developed a plan to implement v3.2 of NAIC/SCD Policy and Practices (PnP) to utilize the technology adoption curve and pilot projects to work out problems and improve the process-training suite. He presented a briefing to the SRB on technology adoption and the new plan.

3.9.5. CBA-IPI Assessment

To prepare for the CMM Based Appraisal for Internal Process Improvement (CBA-IPI), Mr. Blankenship developed a project information table of current and past SCD projects for assessment preparation. The information was used to select representative projects for the assessment. He validated and verified the information against SQA records. He delivered the project information table to Mr. Joe Beigel, SCDS, to modify and maintain for a project status table. Additionally, he reviewed cross-reference between the Capability Maturity Model (CMM) and the PnP, chapters and artifacts, for version 3.1 of NAIC/SCD development process.

Mr. Blankenship then proctored the software process maturity questionnaire for the project leaders selected for the software process assessment.

Mr. Blankenship concluded preparations for the software process assessment by reviewing organizational information needed for the software process assessment and preparing process binders.

He then attended the assessment team member training.

Mr. Blankenship participated as a coach and team member of the CBA-IPI. The software process assessment compared NAIC/SCD's policies and practices against the Capability Maturity Model from Software Engineering Institute at Carnegie Mellon University.

Mr. Blankenship developed and provided input for the software process assessment final report. In addition, Mr. Blankenship developed further information on the common thread between weaknesses and issues found in the assessment.

Mr. Blankenship developed a set of tactical activities to address the weaknesses and issues found in the assessment.

4. Recommendations

There were three main issues found in the CBA-IPI:
- Granularity of activities supplied by project plans (limited insight of actual progress by development teams)
- Lack of product standards and evaluations
- Limited evidence of configuration management

NAIC/SCD was able to satisfy the first two by adopting the personal software process (PSP). Two trained instructors should be able to teach PSP to the remaining personnel. With the increased discipline from PSP, developers will have better planning and estimating skills. Additionally, PSP teaches peer review techniques that will help with the product standards and evaluations. SCD must enforce current PnP on configuration management; create and maintain baselines; and place all systems under configuration control.

In the final days of this effort key people involved with software process improvement retired or separated from the Air Force. A software process improvement program is a long-term commitment. In order to sustain a long-term effort, Air Force units need to find a way to recruit and retain trained software process improvement engineers and qualified software engineers. In order to sustain a long-term effort and commitment, the reward and punishment system must have clear goals and reward those individuals that support and advance software process improvement.

5. Lessons Learned

5.1. Security Clearance

The time it took to investigate and grant his clearance (approximately 11 months) limited Mr. Blankenship's access to NAIC/SCD personnel. This strained the time needed to learn the people and culture and limited the return on investment for improvements.

5.2. Individual Vs Team Approach to Process Improvement

NAIC/SCD's principal individual involved with process improvement was the Chair of the SEPG. While an individual can make progress it usually takes longer to get everybody else involved. If teams are used then the team members have buy-in to the team suggestions and more people are involved in spreading the word to non-team members.

5.3. "As-is" Process or "To-be" Process

NAIC/SCD had some of the typical problems associated with software process improvements. Total Quality Management theory teaches to document the current practices (As-is) then look for improvements, document the future practices (To-be) and plan the transition. SCD always documented the "To-be" state and did not always define the "As-is" or the transition.

5.4. Most Difficult Problems

The most difficult problems were the culture barriers to change. While management was stressing the need to improve, the people did not hear or agree with the need and direction of the government.

Appendix A: Contract Deliverables

This appendix lists the final critical contract deliverable documents developed by Harris Technical Service Corporation. Documents are listed in chronological order.

1. CDRL A004, A Guide to Achieving SEI CMM Level 2 at NAIC, Harris Technical Services Corporation Document Reference # 1070-011, Fairview Heights, IL. 15 October 1996

2. CDRL A002, Assessment Workshop Plan and Report , Harris Technical Services Corporation Document Reference # 1070-014, Fairview Heights, IL. 13 December 1996

3. CDRL A007, NAIC/SCD PnP Configuration Management Chapter, Harris Technical Services Corporation Document Reference # 1070-025, Fairview Heights, IL. 23 October 1997

4. CDRL A005, Final Scientific and Technical Report.

Appendix B. Workshop Findings

This appendix contains the findings from the workshop team. The team collected information on SCD's practices and compared them to the CMM KPAs. The first section shows a summary of the rating for each KPA. The following sections contain the actual findings with the strengths and weaknesses.

B.1. KPA Rating Summary

KPA Rating Summary	
Level II KPAs	**Rating**
Requirements Management	PS
Project Planning	PS
Project Tracking & Oversight	PS
Quality Assurance	S
Configuration Management	PS
Software Subcontract Management	N/A
Level III KPAs	**Rating**
Organizational Process Focus	PS
Organizational Process Definition	PS
Software Product Engineering	NS
Training Program	NS
Peer Reviews	PS
Intergroup Coordination	Not Evaluated
Integrated Software Management	Not Evaluated

Legend
    NS - Not Satisfied
    PS - Partially Satisfied
    S - Satisfied	

B.2. GENERAL OBSERVATIONS

Environmental factors that drive software organizations to greater process discipline and to greater product standardization are lacking for the most part at NAIC:

- multi-version software installed at geographically dispersed sites
- interoperability with external software systems
- interoperability with hardware (embedded, etc.)
- large projects with complex interactions amongst team members and amongst system components
- hard response time or throughput requirements or constraints on memory, bandwidth, etc.
- customers with fixed and demanding schedules
- sharing of staff across application domains and projects
- pressure to accumulate reusable component assets

- requirement to support customers with older versions of software

B.2.1. STRENGTHS

New process elements have been defined and documented

B.2.2. WEAKNESSES

Adoption of the new process by the projects is still in process

B.3. REQUIREMENTS MANAGEMENT (PS)

B.3.1. STRENGTHS

Change requests are entered in CARMS, analyzed according to defined criteria, and commissioned by the SRB and/or domain managers

System requirements are documented in the Consolidated Systems Document

Appropriate functions are involved in review of project requirements

B.3.2. WEAKNESSES

Some confusion in terminology exists in distinguishing software requirements from statements of need

Hard requirements may not always be separated out from customer wish lists

A perception exists that "requirements creep" still occurs

Procedures and tools have not been established to ensure that tractability occurs from requirements to design to code to test

B.4. SOFTWARE PROJECT PLANNING (PS)

B.4.1. STRENGTHS

A standard is in place for SDP content

A standard basis of estimate is in place for estimating QA and CM effort

Developers participate in the commitment process

Use of CARMS enables management to gauge more accurately the demand for software development services

B.4.2. WEAKNESSES

Little historical data is available from completed projects to use in estimating new tasks

A checklist is lacking to cover all items that must be covered in the estimation process

Detailed milestone charts are not consistently used to represent project schedules

Few perceived consequences exist for late completion of projects

Current resource commitments not always considered when negotiating resources for a new project

B.4. SOFTWARE PROJECT TRACKING & OVERSIGHT (PS)

B.4.1. STRENGTHS

PMRs and weekly status reports are used to track progress against plan

Standard tools are used for planning and tracking

Actual resource expenditure is tracked to standard, pre-defined lifecycle phases

B.4.2. WEAKNESSES

Corrective actions not always appropriately taken when deviations from plan occur

Limited corporate view of resources available to augment projects that need additional help

Experience in use of AutoPLAN/AutoTEAM is limited

B.5. SOFTWARE QUALITY ASSURANCE (S)

B.5.1. STRENGTHS

A standard SQA plan has been developed

Good checklists and agendas are used for SQA's reviews of work products

SQA staffing level appears adequate

SQA has been effective at reporting and helping resolve noncompliance issues

B.5.2. WEAKNESSES

None Noted

B.6. SOFTWARE CONFIGURATION MANAGEMENT (PS)

B.6.1. STRENGTHS

Developmental CM has proven adequate for most project circumstances to date

Most work products, including plans and documentation are placed under configuration control

Procedures for analysis and review of proposed changes are in place

Steps are taken to verify that approved changes have been incorporated into the code and have been documented in a configuration file

B.6.2. WEAKNESSES

Changes to systems software periodically undermines the integrity of operational applications software

Development tools/scripts/utilities and COTS packages are not formally controlled, nor are test data or test scripts

In most cases, production code is not under CM control

A consensus has not been solidified on procedures for transitioning software from the developer to the user and to configuration control

Systematic recording of program trouble reports does not appear to be occurring routinely

B.7. ORGANIZATION PROCESS FOCUS (PS)

B.7.1. STRENGTHS

Responsibility for initiating and coordinating process improvement activities has been vested in an SEPG

Involvement in SPI activities is widespread

SPI efforts are planned and managed as thoroughly as the organization's development projects

B.7.2. WEAKNESSES

Software process training is incomplete

B.8. ORGANIZATION PROCESS DEFINITION (PS)

B.8.1. STRENGTHS

Procedures have been defined to cover the way that new policies, procedures, and guidebooks are developed

The process asset library has been established and populated with model work products, templates, checklists, and works in progress; process assets are available online

Proposed changes to the command media are handled expeditiously

B.8.2. WEAKNESSES

Some policies and procedures are still in development

Limited guidelines for tailoring standard processes

Project size and effort actuals are not recorded in the PAL to aid future estimation activities

Lessons learned from prior projects are not always captured and accessible to all that might benefit from them

B.9. SOFTWARE PRODUCT ENGINEERING (NS)

B.9.1. STRENGTHS

Some standardization of tools and implementation approach occurs in the database area

A library of code samples is in development to encourage learning and reuse

B.9.2. WEAKNESSES

Standard ways of performing analysis and design have not yet been identified

A large number of tools and languages are used for implementation

Standards do not yet exist for a number of software work products

B.10. TRAINING PROGRAM (NS)

B.10.1.   STRENGTHS

Some training needs are identified as part of civilian's annual performance appraisal

Position descriptions exist

B.10.2.   WEAKNESSES

Training needs are not systematically identified for SCD personnel

A training program has not yet been established

Priorities for training have not been clarified

Effectiveness of delivered training is not routinely assessed

B.11. PEER REVIEWS (PS)

B.11.1.   STRENGTHS

Standards exist for the content and conduct of major reviews, and for the follow-up activities afterward

B.11.2.   WEAKNESSES

Organizational manpower planning does not consistently account for staff time to support reviews

Code reviews are not required

A peer review handbook does not yet exist

Training in review technique has not been formally delivered

Appendix C. Summary of "A Guide to achieving SEI CMM Level 2 at NAIC"

This appendix contains the executive summary and suggestions from the report.

C.1. Executive Summary

The CMM's Level 2 KPA: Software Subcontract Management does not apply to SCD. There are some informal SCD roles to document in SCD's Policy and Practices Manual. Collection and use of historical data, documented correction actions, periodic project management reviews, and risk management practices will greatly help SCD toward satisfying the goals for project planning and tracking. There is still limited CM discipline in SCD. Policies and practices need to be defined and enforced.

C.2. Report Suggestions

C.2.1. Subcontractor Management

Rome Laboratory and NAIC/SCX are the process owners for the selection and management of software subcontractors, SCD personnel have roles in these efforts. SCD's Policy and Practices Manual (PnP) Chapter 12 must document these roles and concentrate on things SCD personnel need to know about subcontracting and / or who to contact about working with subcontractors. Roles identified to date include:
- Working with Intel customers to define needs and requirements
- Review Initial Estimates
- Review & Advise on PDL
- Review & Advise on Execution Plan
- Attend Monthly Reviews
- Test Delivered System

Above all else PnP Chapter 12 needs to clearly state and explains why SSM does not apply to NAIC. Assessors want to know and see it documented that an informed decision has been made.

C.2.2. Project Planning, Tracking and Oversight

PnP Chapter 5, Project Planning, Tracking and Oversight incorporate some project planning suggestions. Suggestions included:
- Clearly state policy

- Change "should or may" verbiage to say will (What is required)
- Or under what set of circumstances can this procedure be eliminated
- And who can approve the elimination.
- Change approval for all work to the SRB or resource holders (some small task could get approval for work and scheduled without the SRB or resource holder approval).
- Add a commitment procedure for all affected groups to agree to project commitments.

Concerns for Tracking and Oversight include:
- Tracking actual results and performance against the project plan.
- Corrective action for results and performance deviations from the project plan
- Standards (templates) for periodic program management reviews (PMRs)
- Risk management

Some of the concerns will work out as Chapter 5 is used by more of SCD and practitioners gain more knowledge and improve estimating procedures.

C.2.3. Configuration Management

The April 1994, Software Process Assessment (SPA) Findings Report said:

- Software Configuration Management is not widely implemented. This finding is evidenced by:

  - Resources and tools for CM are limited or unavailable.
  - Procedures are seldom formalized.
  - Existing procedures are usually not enforced.
  - Implementation is often left up to the individual.
  - Requirements, design and documentation are rarely baselined or controlled.

The following improvements have been made since the April 1994 SPA:

- User's requirements are loaded into ARS Carms.
- Domain managers monitor and manage requirements for their domains.
- The SRB informally performs some of the CCB tasks
- AutoPLAN can manage the schedule and changes to the schedules throughout a project's lifecycle. AutoPLAN allows multiple versions and baselines for a project.
- A draft PnP Chapter 11, Configuration Management has been written.
- A CM Working Group is working to recommend a commercial-off-the shelf (COTS) CM tool. Tool requirements were defined before tool evaluations.
- Policy statements for CM to take charge and move all project material to archival storage after each project.

While this may seem like a lot of improvements, there are many problems or risks to address. Without addressing and solving CM issues no quality improvement effort can succeed. Other risks noted include:

- CM procedures are limited and not enforced.
- Developers control and manage production systems.
- Configurable items are not always controlled by NAIC.
- Configurable items are not viewed as NAIC asset.
- Configurable items are stored in directories owned by the developers.
- Developers think and act like they "own" the source they develop.
- Developers install and manage production systems.
- Developers developing on production systems.

C.2.4. Change and Status Accounting

At this time with limited baselined systems, change and status accounting is limited to requirements in the ARS Carms system. Domain managers should periodically report on the status of requirements in their domain. Reports could contain the number of new requirements, old requirements (not yet scheduled), in-progress (requirements in the development process), and closeouts (requirements dropped). Closeouts could be broken down into new rejects, old requirements dropped, old requirements changed (drop the old requirement and add a new one), or requirements satisfied and system installed on production machine.

Work products, documentation, and deliverables need to be identified as Configurable Items (CIs). The processes need to state where CIs are created and when they are placed under CM control. The CM Plan will specify when and how software baseline audits will occur. Production systems will be created and their release controlled by CM personnel. Release procedures will need to be defined.

After version and baseline controls are instituted then NAIC/SCD will need a formal CCB process to manage and control changes to baselines. The SRB could add formal procedures and perform the CCB role. Additionally, CM will periodically report on any changes to the CM repository.

Appendix D. Acronyms, Offices, and Organizations

D.1. Acronyms
CM   Configuration Management
CMM   Capability Maturity Model
SEPG   Software Engineering Process Group
SPISG   Software Process Improvement Steering Group
KPA   Key Process Area
RM   Requirements Management
PnP   Policy and Practices
CMpit   Configuration Management Process Team
IPI   Internal Process Improvement
PSP   Personal Software Process

D.2. Offices and Organizations
Harris/HTSC
Harris/EPG
NAIC/SCX
NAIC/SCDD
NAIC/SCD
Rome Laboratory (now AFRL/IF)
AFIT   Air Force Institute of Technology
SEI   Software Engineering Institute

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