580 / SOFTWARE ENGINEERING DIVISION

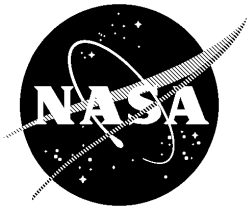
Criteria Action Table (CAT)

Software Requirements Specification

GSFC Mission Services Evolution Center (GMSEC)

Version 1.0

February 26, 2008



National Aeronautics and Space Administration

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Preface

The intent of this document is to provide component level requirements placed on the Criteria Action Table (CAT) software.

This document is under configuration management of the GMSEC Configuration Control Board (CCB). This document will be changed by Documentation Change Notice (DCN) or complete revision. Proposed changes to this document must be submitted to CCB along with supportive material justifying the proposed change.

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1. Introduction

1.1. Purpose

This document presents the component level requirements for the Criteria Action Table (CAT).

1.2. Scope

The requirements contained in this document are for the CAT software application. CAT is a GMSEC-compliant component that supports automation in a GMSEC architected system. This document meets the requirements documentation necessary for a Class B software system as defined by NPR 7150.2 – NASA Software Engineering Requirements.

1.3. Objectives

CAT supports automation in a GMSEC architected system by performing decision-making.

CAT reduces the level of hands-on operation required by users, such as a Flight Operations Team (FOT), by handling nominal conditions and recognizing exceptional conditions. CAT can derive the essential information from the surfeit of available information.

CAT simplifies both the upstream and downstream processing by separating out and performing the decision making function.

CAT applies operations knowledge captured in the configuration and allows insight into the decision making process at run-time.

1.4. References

1. GMSEC Architecture Document, Version 2.3, October 2006
2. GMSEC Interface Specification Document Version 2007 May
3. GMSEC API 2.2 User's Guide, March 2007

1.5. Overview

This document provides a top-down perspective of the system requirements, its relationships, constraints, and assumptions. First, it provides the background about this software system and the reason for its existence. This is followed by a section describing the interfaces required as well as

communication interfaces with external systems. Finally, it identifies external constraints placed upon the system as well as assumptions made by the requirements team, and mentions dependencies on systems external to CAT.

2. Overall Description

2.1. Product Description

CAT is a GMSEC-compliant software component that uses a rule-based approach to decision making.

The high-level objectives for CAT are to:

- Provide support for automation of spacecraft operations.
- Allow users to capture and apply knowledge of their systems.
- Separate decision-making function from information extraction and resulting action.

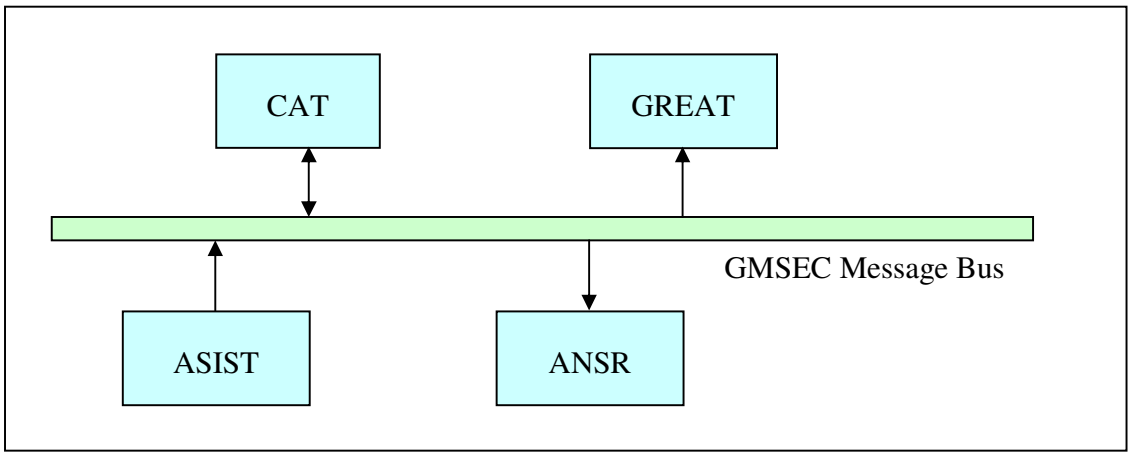

Figure 1 - High Level Architecture of GMSEC System with CAT

CAT is just one component of a GMSEC system. Figure 1 shows a GMSEC architected system where ASIST is publishing status messages on the bus; CAT is subscribing to at least some of that information, and based on its rules, publishing new messages; those messages in turn might be displayed in GREAT or used to page an operator using ANSR.

2.1.1. System Interfaces

CAT does not call any operating system functions or methods.

2.1.2. User Interfaces

CAT has three user interfaces.

1. The administrative interface is a graphical user interface (GUI). It allows the user to set up all aspects of CAT. It provides access to the user, network, message, and rule configuration.

2. The console interface is the textual interface for running the processing engine. It provides useful information during rule development.

3. The real-time interface is a second GUI. This interface allows the user to view the state of rule processing in real-time.

2.1.3. Hardware Interfaces

CAT runs on any computer platform suitable to run a Java program and GMSEC.

2.1.4. Software Interfaces

CAT is a GMSEC-compliant component. As such, CAT implements the latest GMSEC Application Programming Interface, currently version 2.2.1, and supports the GMSEC Interface Specification Document Version 2007 May. CAT interfaces with external software through messages.

CAT has the following external software dependencies shown in Table 1:

Table 1 - External software dependencies

Name	Message	Spec	Version	Source
GMSEC API	GMSEC	TBD	2.2.1	NASA/GSFC

2.1.5. Communications Interfaces

The only interface for CAT is through the GMSEC API, which accesses third party middleware services. All communications with GMSEC components and the other external software interfaces (e.g., ASIST, ANSR) are handled through this interface utilizing the GMSEC message definitions found in the GMSEC Interface Specification.

2.1.6. Memory

No memory management and resources requirements have been quantified at this time.

2.1.7. Operations

CAT monitors information broadcast by other GMSEC components on the bus. The interface is standardized and provides consistent functionality independent of the operating system used by the machine.

CAT configuration is performed using the administration mode. Before running CAT operationally, the administrator configures the CAT setup files. This involves the user, network, message and rule configuration. The user setup allows creating and modifying user accounts with either administrative or user credentials. The network setup describes the GMSEC connection parameters including the middle-ware type, server, and port. The message setup allows global filters to be applied to incoming messages and to define the fields and default values for outgoing messages. The rule setup is where the translation from incoming messages to outgoing messages occurs and allows for extracting fields, applying functions, or making use of built-in variables.

The FOT runs CAT using a script file (bat file for Windows) in one of several modes depending on whether CAT is to be run as a service, a console application, or to bring up a GUI. Details on starting and stopping CAT will be provided in the CAT User's Guide.

2.2. Product Functions

CAT has three primary features as listed below:

1. A graphical interface for configuration of the user, network, message and rule setup. This describes what GMSEC messages to subscribe to and how to process their content.
2. An engine for applying the criteria action table in real-time. This engine subscribes to messages on the GMSEC bus, carries out processing based on the rules, and publishes log messages and directives.
3. A graphical interface for monitoring the status of the criteria action table processing in real-time.

Criteria action table configuration is based on monitors. Monitors have filters, attributes, functions, rules, and actions. Filters control which input messages instantiate a monitor agent. Attributes are named variables which take their values from input messages. Functions modify attributes through statements. Functions and rules can have preconditions which are relationships between attributes and data values. When the preconditions of a function are satisfied, its statements are evaluated. When the preconditions of a rule are satisfied, its actions are taken. Taking an action sends an output message. Periodically, the functions and rules of active monitor agents are re-assessed to check for time-dependent changes.

2.3. User Characteristics

The primary user of CAT is the Flight Operations Team (FOT). The FOT develops the rule set for CAT to detect and perform processing on noteworthy conditions in their GMSEC architected system. During operations, CAT applies the rules it has been configured with, simplifying and reducing the level of monitoring required by the operator.

2.4. Constraints

2.4.1. Regulatory Policies

The software has not been approved for export.

2.4.2. Hardware Constraints/Limits/Requirements

Must execute on ground system operational grade hardware

2.4.3. Application Interfaces

2.4.3.1. GMSEC API

2.4.3.2. GMSEC Components – Interface uses GMSEC API Heartbeat messages

2.4.4. Parallel Operations

N/A

2.4.5. Audit Functions

N/A

2.4.6. Control Functions

N/A

2.4.7. Higher Order Language Requirements

Must run on a Java-enabled platform.

2.4.8. Signal Handshake Protocols

N/A

2.4.9. Reliability Requirements

N/A

2.4.10. Criticality of Application

Class B Software, as defined in NPR 7150.2.

2.4.11. Safety & Security Considerations

N/A

2.5. Assumptions and Dependencies

None.

3. General Requirements

The requirement classification scheme consists of the following field indexes separated using a dot notation.

Requirement type: A general classification of a requirement
Requirement area: A refinement of a the previous requirement type
High-level requirement: A broad summary requirement
N-level requirement: Supporting requirement of the high-level requirement

<Requirement Type> <Requirement Area> <High Level> …<Level N requirement>

N levels of requirements are supported, where each level further refines its parent. Details should not be presented in the high-level requirement but rather within the child requirements. Care should be taken to ensure that multiple requirements are not wrapped into a single requirement. If multiple requirements are identified, they should be decomposed into children of a high-level requirement. Each requirement should be testable.

If additional supporting prose accompanies the requirement, the requirement should be presented first, *followed by the ancillary prose in italics.*

1. Functional Requirements
   - 1.1. CAT shall be capable of monitoring all GMSEC messages in real-time
     - 1.1.1. CAT shall allow specifying the subjects to be subscribed
   - 1.2. CAT shall be capable of filtering incoming GMSEC messages and routing to criteria action processing
     - 1.2.1. CAT shall allow filtering based on any message field
   - 1.3. CAT shall be capable of building and sending all GMSEC compatible messages to the GMSEC bus including directives, log messages and heartbeat messages
   - 1.4. CAT shall be capable of evaluating GMSEC messages based on user defined rules and provide an actionable response when rules are satisfied
     - 1.4.1. A CAT rule shall be based on the attribute values extracted from message fields

1.4.2. Each CAT rule can be comprised of multiple attributes within a GMSEC message
1.4.3. Each CAT rule can be comprised of multiple attributes across multiple GMSEC messages
1.4.4. A CAT rule shall consist of attribute-data value relationships where each relationship is one of: equal to, not equal to, greater than, greater than or equal to, less than, or less than or equal to
1.4.5. CAT shall allow each attribute-data value relationship to be negated
1.4.6. A CAT rule shall be triggered when all of its attribute-data value relationships are satisfied
1.4.7. A CAT rule shall support up to four levels of parenthetical nesting or attributes and Boolean logic constructs
1.5. CAT shall have the capability to extract the attribute values from received messages
1.5.1. CAT shall support attributes of type integer, string, float and time
1.5.2. CAT shall support pattern matching for extracting attribute values
1.5.3. CAT shall perform automatic conversions between attribute types
1.5.4. CAT shall provide derived attributes with values set based on evaluation of rules and mathematical expressions
1.5.4.1. The addition, subtraction, multiplication, division, trigonometry, logarithm, exponentiation, minimum, and maximum functions shall be provided
1.6. CAT shall support time triggered actions
1.6.1. CAT shall be capable of taking an action at a specific time
1.6.2. CAT shall support periodic actions
1.6.3. CAT shall be capable of taking an action if a rule is not satisfied within the specified time period
1.7. CAT shall write a log file of actions taken
1.7.1. The action log shall be managed
1.8. CAT shall load its network, message, and rule configuration at run-time
1.9. CAT shall allow stopping and reinitializing processing
1.10. CAT shall allow stopping and reinitializing individual monitors
1.11. CAT shall provide a console (non-graphical) mode of operation
1.12. CAT shall be capable of operating as a system service (i.e., an application that is automatically started by the operating system at boot time)
1.13. CAT shall provide a graphical user interface for maintaining the user, network, message, and rule configuration
1.13.1. CAT configuration shall be stored in XML files
1.13.2. CAT shall provide user authentication and authorization capability with administration and operation credentials for criteria action table changes
1.13.3. CAT shall provide two types of user accounts: an administrative account that supports read/write permissions for adding and modifying rules, and an operational account that supports only read permissions for rules
1.13.4. CAT shall provide user management capability for creating, removing and modifying user accounts
1.13.5. CAT shall provide a change log for rule changes

1.13.5.1. There rule change log shall be managed

1.13.6. CAT shall provide the user with the capability to define the GMSEC network configuration including
- connection type
- server
- port

and arbitrary other parameters that may be specific to the middle-ware

1.13.7. CAT shall provide the user with the capability to define the fields and default values of GMSEC messages that will be published

1.13.8. CAT shall provide the user with the capability to set GMSEC message filtering and routing capability

1.13.8.1. The user shall have the capability to filter based on any field

1.13.9. CAT shall allow the user to create, modify, or remove the criteria action rules through the graphical user interface

1.13.9.1. The user shall have the capability to edit every aspect of the rules

1.13.9.2. The user shall have the capability to cut and paste information to the system clipboard

1.13.10. CAT shall provide the capability to validate the rules entered by the user

1.13.11. CAT shall allow mission specific inputs for the lookup of attribute values in the form of a configuration file <attributeName>_lookup.txt and will display these values in the graphical user interface

1.13.12. The user interface shall provide tooltips to assist in navigation

1.14. CAT shall provide a graphical user interface for monitoring the internal state of criteria action processing in real-time

1.14.1. The CAT real-time monitoring tool shall show the status of rule processing within CAT including
- monitor class
- monitor identity
- monitor start time

1.14.2. The CAT real-time monitoring tool shall allow viewing all attributes and their current values for a selected monitor

1.14.3. The CAT GUI shall support sorting on any column

1.14.4. The CAT GUI shall provide a display of historical (stopped) agents

2. External interface requirements
   2.1. External interfaces are specified in GMSEC Interface Specification Document Version 2007 May
3. Internal interface requirements - None
4. Internal data requirements
   4.1. Configuration files shall be XML based
5. Adaptation requirements - None
6. Safety requirements - None
7. Performance and timing requirements
8. Security and privacy requirements - None
9. Environment requirements - None
10. Computer resource requirements

- 10.1. Computer Hardware resource utilization requirements – Java enabled platform
- 10.2. Computer Software requirements
  - 10.2.1. Tool shall run on Microsoft Windows XP, Red Hat Linux Enterprise
  - 10.2.2. Tool shall use GMSEC API
- 10.3. Computer Communications requirements
  - 10.3.1. Tool shall communicate through GMSEC API.

11. Software quality characteristics - None
12. Design and implementation constraints - None
13. Personnel-related requirements - None
14. Training-related requirements
    - 14.1. Tool shall provide User's Guide and Installation Guide.
15. Logistics-related requirements - None
16. Packaging requirements
    - 16.1. Tool shall be delivered in an archive file
17. Precedence and criticality of requirements - None

Appendix A. Abbreviations and Acronyms

ANSR	**Alert Notification System Router**
API	**Application Programming Interface**
ASIST	**Advanced Spacecraft Integration and System Test**
CAT	**Criteria Action Table**
FOT	**Flight Operations Team**
GMSEC	**Goddard Mission Services Evolution Center**
GREAT	**GMSEC Reusable Events Analysis Toolkit**
GSFC	**Goddard Space Flight Center**
GUI	**Graphical User Interface**
MOC	**Mission Operations Center**
NASA	**National Aeronautical and Space Administration**
XML	**Extensible Markup Language**