Software Requirements Specification
for the
Core Flight System Test Framework Tool

Engineering Directorate
Software, Robotics and Simulation Division

Availability:
NASA & NASA contractor employees as required

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Baseline

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
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Verify this is the correct version before use

Change Record

Revision	*Date*	*Originator*	*Description*
N/A	Apr 2021	Tam Ngo	Initial draft
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1 INTRODUCTION

1.1 Purpose and Scope

This specification defines the functional, performance and interface requirements and implementation constraints for the Core Flight System (cFS) Test Framework (CTF) tool. The CTF tool is intended to be used to create and execute verification tests for a cFS software system, as well as to log, report and collect artifacts from the results of the test run.

1.2 Responsibility and Change Authority

This document is prepared in accordance with EA-WI-025, "GFE Flight Project Software and Firmware Development". The responsibility for the development of this document lies with the Engineering Directorate Software, Robotics, & Simulation Division (SR&SD), Spacecraft Software Engineering Branch/ER6. Change authority is the Software, Robotics and Simulation Division of the Johnson Space Center.

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this SRS to the extent specified herein.

Table 2-1: Applicable Documents

Document Number	***Document Title***	***Revision / Release Date***
NPR 7150.2	NASA Software Engineering Procedural Requirements	Rev C / Aug 2019
EA-WI-025	GFE Flight Project Software and Firmware Development	Rev D / Sep 2013
JSC-61949	Advanced Exploration Systems (AES) Core Flight Software (cFS) Software Development Plan	Rev C / Mar 2021

2.2 Reference Documents

The following documents are reference documents utilized in the development of this SRS. These documents do not form a part of this SRS and are not controlled by their reference herein.

Table 2-2: Reference Documents

Document Number	***Document Title***	***Revision/ Release Date***
N/A	CTF Test Plan and Procedures	Baseline / Mar 2022

2.3 Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence.

All specifications, standards, exhibits, drawings or other documents that are invoked as "applicable" in this specification are incorporated as cited. All documents referred to by an applicable document are considered to be for guidance and information only, with the exception of ICDs which will have their applicable documents considered to be incorporated as cited.

3 REQUIREMENTS SPECIFICATION

This section defines the requirements for the Core Flight System TBD Application. For a CFS product, these are as-built requirements and are not derived from higher-level requirements. Verification criteria and methods are documented in the TBD Test Procedures document.

The following terms shall be used throughout this section to differentiate between requirements and other statements.

Shall:	This is the only verb used for the binding requirements.
Should/May:	These verbs are used for stating non-mandatory goals.
Will:	This verb is used for stating facts or declaration of purpose.

3.1 Description

The cFS Test Framework (CTF) is developed specifically for the verification of requirements of the cFS software systems. It is intended to be part of the cFS ecosystem of tools and supporting software for the development life cycle of cFS. The CTF provides the users with the capability to develop and run automated test and verification scripts. The tool executes the JSON-based test scripts containing test instructions, while logging and reporting the results. The tool utilizes a plug-in software architecture to allow users to extend CTF with new test instructions, external interfaces and custom functionalities to meet their project's needs.

3.2 Functional and Performance Requirements

Requirement Number	***Shall/Will Statement***	***Design Element***
CTF-01	**CTF shall support the following primitive data types:** • **int8 and uint8** • **int16 and uint16** • **int32 and uint32** • **int64 and uint64** • **float and double** • **character string** • **bit-field** *Rationale: Support cFS-supported primitive data types.*	Data types

Requirement Number	*Shall/Will Statement*	*Design Element*
CTF-02	**CTF shall support the use of the following comparison operators on the CTF-supported primitive data types, except character string:** • **< and >** • **<= and >=** • **== and !=** *Rationale: Support comparisons between expected values and actual values as part of a verification success criteria.*	Comparison operations
CTF-03	**CTF shall support the use of the following comparison operators on the character string data types:** • **streq** • **strneq** • **regex** *Rationale: Support comparisons between character strings.*	Comparison operations
CTF-04	**CTF shall support configurable floating point tolerances.** *Rationale: Support user-defined floating point tolerances for comparison purposes*	Comparison operations
CTF-05	**CTF shall support floating point comparisons of plus tolerance values.** *Rationale: Support floating point comparisons of only plus tolerance*	Comparison operations
CTF-06	**CTF shall support floating point comparisons of minus tolerance values.** *Rationale: Support floating point comparisons of only minus tolerance*	Comparison operations
CTF-07	**CTF shall support floating point comparison of both plus and minus tolerance values.** *Rationale: Support floating point comparisons of both plus and minus tolerances*	Comparison operations
CTF-08	**CTF shall support a CTF-initiated cFS software build.** *Rationale: Support automated verification testing*	Automatic operations
CTF-09	**CTF shall support a CTF-initiated startup of a cFS instance.** *Rationale: Support automated verification testing*	Automatic operations
CTF-10	**CTF shall support a CTF-initiated execution of cFS unit tests.** *Rationale: Support automated unit testing as part of verification testing*	Automatic operations

Requirement Number	*Shall/Will Statement*	*Design Element*
CTF-11	**CTF shall execute multiple test scripts.** *Rationale: Verifications can be done with multiple test scripts. Each test script is contained in a single file.*	Test composition
CTF-12	**CTF shall support test scripts with one or more test cases.** *Rationale: A test script can contain multiple test cases.*	Test composition
CTF-13	**CTF shall support test cases with one or more test instructions.** *Rationale: A test case can contain multiple test instructions.*	Test composition
CTF-14	**CTF shall capture pass/fail result of verifications along with actual and expected values.** *Rationale: Support reporting of test results*	Test execution and verification
CTF-15	**CTF shall support the use of periodic telemetry in verification.** *Rationale: Telemetry sent by the target system can be periodic or non-periodic.*	Test execution and verification
CTF-16	**CTF shall support the use of non-periodic telemetry in verification.** *Rationale: Telemetry sent by the target system can be periodic or non-periodic.*	Test execution and verification
CTF-17	**CTF shall support continuous verification items.** *Rationale: Support continuous verification, i.e., verification items must always be true during the scope of the test.*	Test execution and verification
CTF-18	**CTF shall support non-continuous verification items.** *Rationale: Support one-time verification, i.e., verification items must be true only when verification is conducted at some point in the test*	Test execution and verification
CTF-19	**CTF shall support run-time updates of continuous verification items.** *Rationale: Support updates of verification items used in continuous verifications*	Test execution and verification
CTF-20	**CTF shall support run-time updates of non-continuous verification items.** *Rationale: Support updates of verification items used in non-continuous*	Test execution

Requirement Number	*Shall/Will Statement*	*Design Element*
	verifications.	and verification
CTF-21	**CTF shall support ending the test run upon execution failure of a test instruction.** *Rationale: Test run exit can be configured via user configuration in the .ini file or in a plug-in configuration.*	Test execution and verification
CTF-22	**CTF shall support the use of the "wait" attribute to allow a wait time prior to the execution of a test instruction.** *Rationale: Allow a wait time before a test instruction is executed*	Test execution and verification
CTF-23	**CTF shall support the use of the "disable" attribute to exclude the execution of a test instruction.** *Rationale: Allow exclusion of a test instruction from being executed instead of having to delete then add that test instruction from the test script when debugging a test issue*	Test execution and verification
CTF-24	**CTF shall allow user-input to decide whether to continue or stop the execution of a test case.** *Rationale: Allow a pause in the execution of a test case for user input to determine whether to continue or stop the execution.*	Test execution and verification
CTF-25	**CTF shall support execution of conditional looping test cases.** *Rationale: Provide the ability to execute steps in a conditional loop.*	Test execution and verification
CTF-26	**CTF shall support the use of local variables in conditional statements.** *Rationale: Provide the ability to use local variables in looping conditions or telemetry verifications.*	Test execution and verification
CTF-27	**CTF shall keep a test result summary in a readable-formatted file.** *Rationale: Provide test execution results in readable formats: JSON and text*	Logging and reporting
CTF-28	**CTF shall capture test execution data to a log file.** *Rationale: Provide test execution data in readable format*	Logging and reporting

Requirement Number	*Shall/Will Statement*	*Design Element*
CTF-29	**CTF shall log all telemetry received during a test execution.** *Rationale: Provide detailed test execution data in readable format.*	Logging and reporting

3.3 Software Interface Requirements

3.3.1 Internal Requirements

Requirement Number	*Shall/Will Statement*	*Category*
CTF-30	**CTF shall support the integration of custom plug-ins as extensions of CTF functionalities.** *Rationale: Support extending CTF functionalities to meet project-specific needs.*	User extension

3.3.2 External Requirements

Requirement Number	*Shall/Will Statement*	*Category*
CTF-31	**CTF shall support raw CCSDS message format.** *Rationale: Support the use of raw data packets*	Message formats
CTF-33	**CTF shall support CCSDS message payload in little-endian byte order.** *Rationale: The CCSDS message payload could be either little-endian or big-endian byte order. Note that the CCSDS message header is always in big-endian, or network byte order.*	Message formats
CTF-34	**CTF shall support CCSDS message payload in big-endian byte order.** *Rationale: The CCSDS message payload could be either little-endian or big-endian byte order. Note that the CCSDS message header is always in big-endian, or network byte order.*	Message formats
CTF-35	**CTF shall support CCSDS message definitions in JSON format.** *Rationale: The CCSDS message definitions will be defined in JSON syntax. This is by CTF design.*	Message formats
CTF-36	**CTF shall support sending a CCSDS message to one or more CTF-supported external interfaces.**	Message sending and

Requirement Number	*Shall/Will Statement*	*Category*
	Rationale: A CTF test scenario can involve sending a message to multiple external receivers.	receiving
CTF-37	**CTF shall support receiving a CCSDS message from one or more CTF-supported external interfaces.** *Rationale: A CTF test scenario can involve receiving a message from multiple external senders.*	Message sending and receiving
CTF-38	**CTF shall support sending an intended invalid CCSDS message to one or more CTF-supported external interfaces.** *Rationale: Support fault injection of an invalid message to verify the handling of an invalid message.*	Message sending and receiving
CTF-39	**CTF shall time-tag telemetry received from one or more CTF-supported external interfaces.** *Rationale: To avoid verification against stale telemetry*	Message sending and receiving
CTF-40	**CTF shall interface with one or more cFS systems running on the same computer.** *Rationale: A target system could consist of multiple cFS instances, e.g., a primary and a backup cFS instance.*	Interface types
CTF-41	**CTF shall interface with one or more cFS systems running on remote computers.** *Rationale: A target system could be running remotely instead of locally from CTF.*	Interface types
CTF-42	**CTF shall support user configuration of CTF core configuration items.** *Rationale: Support user setup of CTF core configuration items in the .ini file to work with their project workspace*	Config-urations
CTF-43	**CTF shall support additional project-specific configuration items.** *Rationale: Support additional project-specific configuration items as an extension of CTF core configurations*	Config-urations
CTF-44	**CTF shall support test scripts in JSON format.** *Rationale: This is by CTF design.*	Test format

Requirement Number	*Shall/Will Statement*	*Category*
CTF-45	**CTF shall support test script creation, modification and configuration via its graphical editor.** *Rationale: Provide a front-end editor to create and update test scripts without working directly in JSON format. Editor will generate the necessary JSON files.*	Graphical editor
CTF-46	**CTF shall support auto-suggestions of message data via its graphical editor.** *Rationale: Provide a user-friendly interface for developing and running test scripts*	Graphical editor
CTF-47	**CTF shall support the loading of configuration for the graphical editor.** *Rationale: Provide a user-friendly interface for developing and running test. This pertains to the editor configurations for workspace path and other display settings.*	Graphical editor
CTF-48	**CTF shall support the startup of test execution via its graphical editor.** *Rationale: Provide a user-friendly interface for controlling test script executions*	Graphical editor
CTF-49	**CTF shall support the stopping of test execution via its graphical editor.** Rationale: *Provide a user-friendly interface for controlling test script executions*	Graphical editor
CTF-50	**CTF shall display test status of each test case immediately after its execution.** Rationale: *Provide real-time status that include test number, requirements being verified, current test case being executed, test case status, execution time, test run, passed/failed results, CTF errors, etc.*	Graphical editor

3.4 Safety Requirements

The CTF is developed to meet the requirements for non-safety critical software. The software itself is considered a ground tool and is not currently identified as a cause or control to any hazards. Hence, there are no software requirements specific to safety.

3.5 Security and Privacy Requirements

As part of the static code analysis and code reviews, the CTF code was screened for issues that might be exploited by hostile actors. The goal was to ensure that the application did not create security or privacy issues for the projects using it. However, the tool itself does not have any operational security and privacy requirements. It is expected that users will need to identify any relevant operational security and privacy requirements in the user's requirements documents.

3.6 Implementation Constraints

The CTF implementation has the following constraints and software dependencies:

a. The cFS plugin and graphical editor requires the use of the JSON files for message definitions, message identifiers, type aliases and macros.
b. CTF currently runs on Linux platforms only.
c. CTF requires the 3rd-party software packages as listed in **Table 3-1**.

Table 3-1: 3rd-Party Software Dependencies

4 TRACEABILITY TO PARENT REQUIREMENTS

N/A

5 REQUIREMENTS PARTITIONING FOR PHASED DELIVERY

N/A

6 APPENDICES

6.1 Abbreviations and Acronyms

Term	*Definition*
CCSDS	Consultative Committee for Space Data Systems
cFE	Core Flight Executive
cFS	Core Flight System
COTS	Commercial Off-the-Shelf Software
CSCI	Computer Software Configuration Item
CTF	cFS Test Framework
GFE	Government Furnished Equipment
JSC	Johnson Space Center
JSON	Java Script Object Notation
NASA	National Aeronautics and Space Administration
PMP	Project Management Plan
PTRS	Project Technical Requirements Specification
SDD	Software Design Document
SDP	Software Development Plan
SRS	Software Requirements Specification

6.2 Definition of Terms

None.

7 NOTES

None.