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MISSION OPERATIONS DIRECTORATE

Lyndon B. Johnson Space Center

Houston, TX 77058

MISSION OPERATIONS DIRECTORATE MISSION CONTROL CENTER SYSTEM

USER APPLICATIONS SUBSYSTEM

SUBSYSTEM DESIGN SPECIFICATION

REVISION AND HISTORY PAGE

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NOTE: Updates to this document, as released by numbered changes (Change XX), are identified by a black bar on the margin.

MISSION CONTROL CENTER SYSTEM
USER APPLICATIONS SUBSYSTEM
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Signature Page

PREPARED BY:

_____ _____
Edgar Turcotte Date
Title: User Apps PM
NASA/JSC/DS15

SUBMITTED BY:

_____ _____
Edgar Turcotte Date
Title: User Apps PM
NASA/JSC/DS15

APPROVED BY:

_____ _____
Angela Bauer Date
Title: MCCS PM
NASA/JSC/DD52

_____ _____
Rex Frazier Date
Title: MCCS Chief Engineer
NASA/JSC/DD52

APPROVED BY:

_____ _____
Date
Title
Org
NASA/JSC/Org Code

_____ _____
Date
Title
Org
NASA/JSC/Org Code

Contents

1. Introduction

1.1. Identification

This document applies to the set of applications that comprise the MCCS User Applications subsystem.

1.2. Project Purpose

The MCCS User Applications subsystem is a collection of many separate software tools including global tools that are used by all MCCS user organizations and specialized "local" tools that are used by only one organization. These tools generally provide display, user interface, and local workstation computation capabilities for console operators.

This subsystem provides capabilities in support of both the International Space Station (ISS) Program and Constellation Program (CxP). Where possible and financially achievable, common software solutions that meet the needs of both programs are planned. However, there are cases in which separate solutions must be implemented based either on the technical differences in the vehicle interfaces or in the costs associated with migration of legacy ISS capabilities to Constellation tools.

The MCCS User Applications subsystem includes multiple software types, including executable files, shared libraries, COTS applications, data files, and script files. These items – and associated documentation – for each software deliverable are managed by an assigned owner organization. The assigned owner organization is typically the primary user of the software tool. The owner organization is responsible for the definition and update of individual application schedules, budgets, development, and test/acceptance documentation for each software component. Details regarding the management and coordination of these efforts are included in the MCCS User Applications Project Plan (JSC TBD).

Note that the MCCS User Applications subsystem does not include the following:

- Mission timeline generation tools – these are part of the separate MCCS Mission Planning subsystem
- Mission Automation Systems (MAS) tools – these are part of the separate MAS subsystem
- Robotics tools – these are included in the separate MCCS Robotics Operations Planning Subsystem
- Large scale vehicle performance modeling tools - these are part of the separate MCCS Spacecraft System Models (SSM) subsystem

1.3. Scope

The scope of this document encompasses all software elements that comprise the MCCS User Application subsystem. This includes generic applications, ISS specific applications, and Constellation specific applications

1.4. Assumptions

1.5. Constraints

2. Documents

2.1. Applicable Documents

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The documents listed in this paragraph are applicable to the extent specified herein.

Document Number	Document Title
JSC-63796	MCCS Level A Requirements
JSC-63998	MCCS User Applications Functional Requirements
JSC-63756	Mission Operations Directorate Software Management Plan

2.2. Reference Documents

The following documents contain supplemental information to guide the user in the application of this document.

Document Number	Document Title
CxP70022 Volume 4	Command, Control, Communications, and Information (C3I) Interoperability Standards, Volume 4
JSC TBD	MCCS User Applications Project Plan

3. Architecture Overview

3.1. Subsystem goals and objectives

MCCS User Application development efforts are targeted to meet the following goals:

- Reduce, where possible, the number and size of the user application toolset
- Reduce where possible the duplication of function across the user application toolset
- Provide toolsets that enable cost effective mission operations processes
- Reuse existing tools and data where possible and cost-effective
- Adherence to standards as defined by MOD and customer programs
- Reduction or elimination of manual steps in processing data associated with User Applications
- Application of new technologies where proven and found to be relevant and beneficial

The MCCS User Application will enable reuse of common tools across other elements of the Mission Systems architecture. Where existing tools area available, appropriate, and enable cost effective mission operations processes, they will be included in this subsystem. In some cases, this may require the development of MCCS User Application capabilities in such a way that other projects and facilities can use the same software components. In other cases, the MCCS User Application subsystem may receive software tools from other projects and organizations.

Assessment of MCCS User Application impacts on mission operations process costs is performed through development of Mission Operations System models and documented in the CxP 72203 Mission Operations Architecture Description Document.

3.2. Subsystem Interfaces

MCCS user application subsystem interfaces are defined in the separate MCCS User Applications Interface Agreement document (JSC TBD). Figure 3.3-1 below summarizes subsystem-to-subsystem interfaces. Internal interfaces are described in the tables listing individual user applications in this document.

Real-time telemetry is accessed through Information Sharing Protocol (ISP) interface provided by the Platform Services System (PSS). This is a reuse of currently deployed MCC interface capabilities.

The application program interface to the command system is expected to be new, yet compatible with current ISS command interface software.

Establishment of an overall standard MCCS messaging protocol is anticipated as part of future development. User Applications shall be compatible with that messaging protocol.

MCCS User Applications Context Diagram CEV-to-ISS

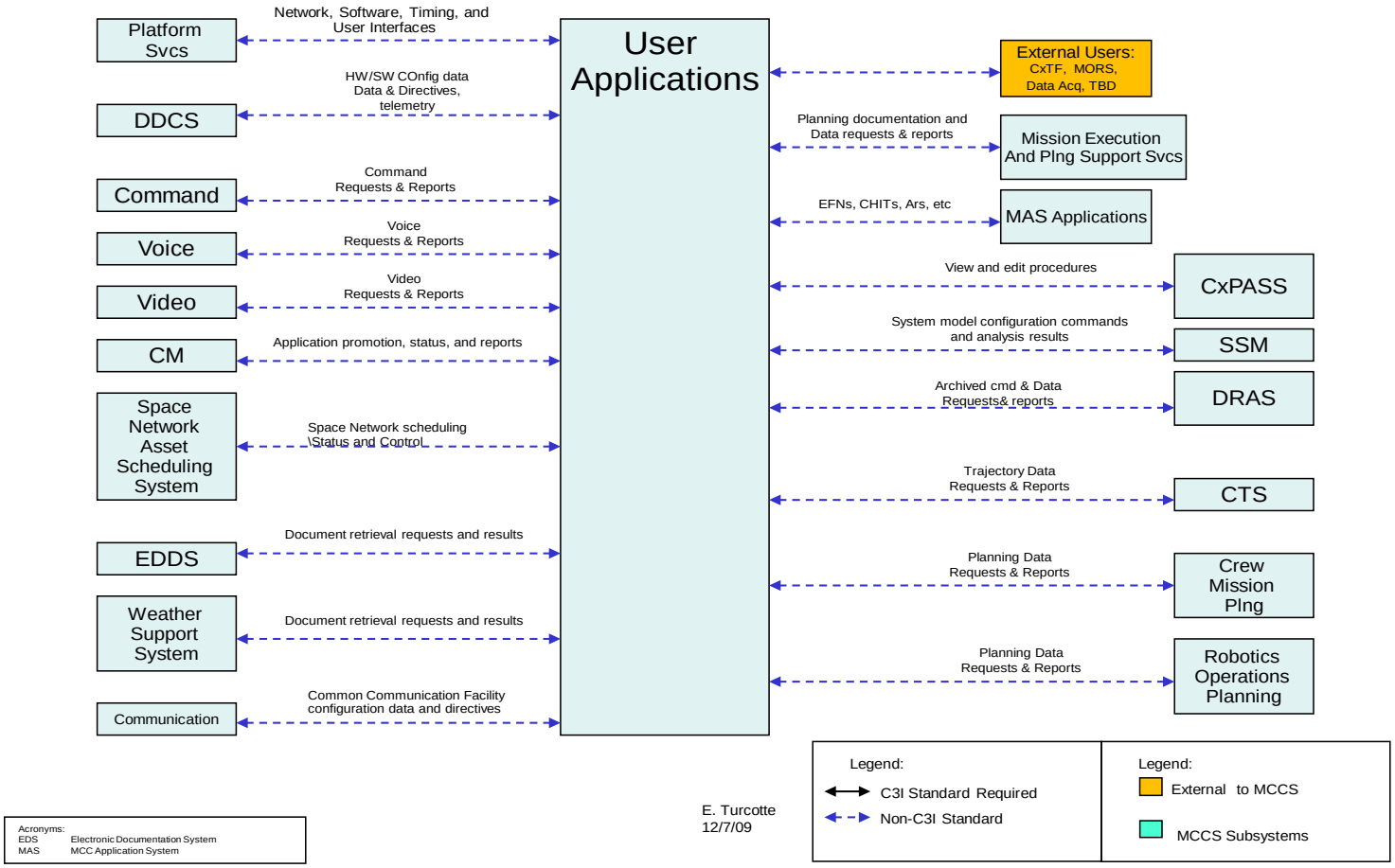


Figure 3.3-1 User Applications Interface Overview

3.3. Subsystem Hardware Architecture Overview

The majority of the MCCS User Applications subsystem executes within the MCCS workstation hardware environment and requires no unique hardware. However, a few of the global user tool functions do use separate server hardware to address performance needs. This hardware is provided as part of DDCS and is not described in any detail in this document.

3.4. Subsystem Software Architecture Overview

Key subsystem components are further defined later in this document. Detailed design information for each reused legacy software component may be found in the applicable software development notebook for that component.

3.5. Subsystem Data Architecture Overview

These subsystem components can interface with other MCCS subsystems, as well as one another, through generic platform services interfaces or negotiated interface agreements.

Real-time data is input and output using the MOD standard Information Sharing Protocol (ISP). Exchange on non-real-time data is accomplished using MOD facility standard messaging and information sharing architectures (TBD implementation, pending MOD decision).

Data exchange needs are detailed in the MCCS User Applications subsystem Interface Agreements document (JSC TBD).

4. Software Design

4.1. Subsystem Software Overview

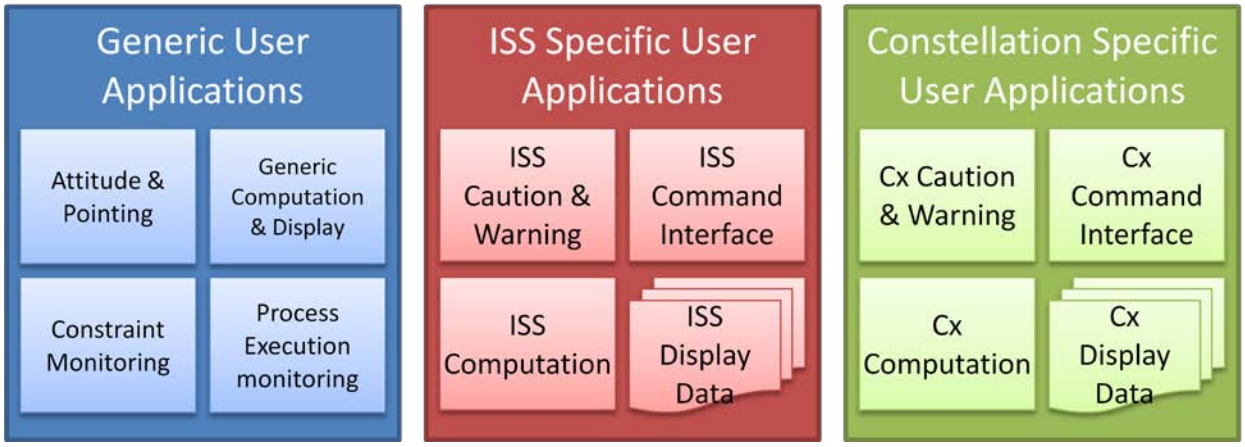
The User Applications Subsystem consists of several major software components, as outlined in the following section.

4.2. Major Subcomponents

The MCCS User Applications subsystem consists of several major functions and software groupings to provide those functions:

- **Generic User Applications** – Support common user interface and processing functions that are used by most or all MOD operators.
- **ISS Specific User Applications** – User tools that support needs that are specific to International Space Station operations. These include command interface capabilities, Caution & Warning tools, ISS crew displays, and program-specific display and computation capabilities. These tools are developed to meet interfaces and/or functional requirements that are unique to the ISS program and do not lend themselves to technical solutions that are common to multiple programs.
- **Cx Specific User Applications** – User tools that support needs that are specific to Constellation operations. These include tools that support C3I standards as well as program-unique command and telemetry interfaces.

Each of these groupings consists of multiple separate applications, each developed and maintained by a specified owner organization.



Sub elements of the MCCS User Applications Subsystem

4.2.1. Generic User Applications

Generic user applications provide overall capabilities that support all console operators such as data display user interfaces and institutional services.

The generic user applications toolset includes a combination of legacy application reuse and new application development to reduce life cycle cost.

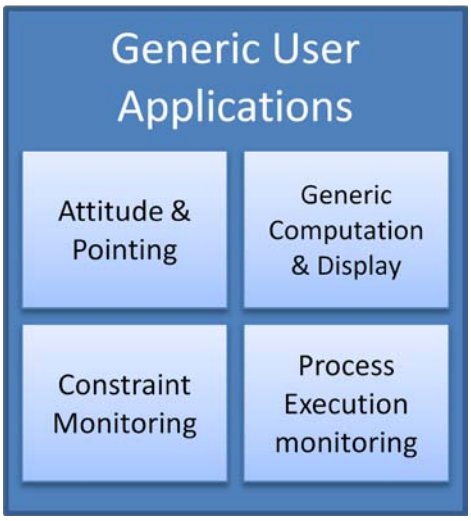


Figure 4.2.1-1 Generic User Application Element Components

Table 4.2.1-1 – Generic User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
Attitude & Pointing	Multi-Program Attitude and Pointing System (MAPS)	A collection of related attitude and pointing tools	DO4	Legacy Application reuse, with update to address Cx-driven requirements and to support Service Oriented Architecture. Reference DO section of J10 list for supporting applications	MOD Messaging bus (TBD implementation), Platform Services (ISP)	MOD Messaging bus (TBD implementation), Platform Services (ISP)
Generic Computation & Display	Mission Control Technologies (MCT)	A toolset for the development and use of command & control user interface tools	DS	New JAVA development based at Ames Research Center	Platform Services (ISP), Command System	Platform Services (ISP), Command System
	Ispatom	Ispatom (Advance tool of Math) is a command line driven application that uses ISP telemetry to publish computational values.	DI	Legacy application reuse **Candidate for replacement with MCT.**	Platform Services (ISP)	Platform Services (ISP)
	ISPresso	ISPresso is a Java implementation of Information Sharing Protocol (ISP) implementing the client-side interface to the ISP.	DI	Legacy application reuse	Platform Services (ISP)	
	Limb	Limb is a background limit server which publishes limit violations to ISP	DI	Legacy application reuse **Candidate for replacement with MCT.**	Platform Services (ISP)	Platform Services (ISP)

Table 4.2.1-1 – Generic User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
	Limbo	Limbo is a GUI X-Window client interface to the limb server which allows users to view or modify or add or delete limits to the limb server.	DI	Legacy application reuse **Candidate for replacement with MCT.**	Platform Services (ISP)	Platform Services (ISP)
	Climbo	Client limit manager test software.	DI	Legacy application reuse **Candidate for replacement with MCT.**	Platform Services (ISP)	Platform Services (ISP)
	Slim	slim is a GUI X-Window client interface to the limb server which allows users to modify a single limit on the limb server. Slim is intended for use with other applications to allow the user to modify the limit on a single telemetry item.	DI	Legacy application reuse **Candidate for replacement with MCT.**	Platform Services (ISP)	Platform Services (ISP)
	MATLAB (Under Review)	General Purpose Math engine	DS	COTS	Platform Services (ISP)	Platform Services ((ISP)
Constraint Monitoring	Constraint & Flight Rule Management (ConFRM)	A toolset for the capture and use of operational constraint information	DS	New JAVA development based at Ames Research Center	MOD Messaging bus (TBD implementation), Platform Services (ISP), MCCS EDDS	MOD Messaging bus (TBD implementation), Platform Services (ISP), MCCS EDDS

Table 4.2.1-1 – Generic User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
Process Execution Monitoring	Management Level Network Executive (MLNE)	Toolset to allow for monitoring, control, planning/replanning and orchestration of pre-mission flight production processes.	DA6	COTS deployment (SAVION)	MOD Messaging bus (TBD implementation)	MOD Messaging bus (TBD implementation)

4.2.1.1. Attitude & Pointing - Multi-program Attitude and Pointing System (MAPS)

MAPS is a suite of applications used to support pre-flight planning, real-time replanning, real time monitoring, and parametric analysis. This legacy software, which has roots in Apollo, has been gradually updated to support the Space Shuttle Program and ISS. MAPS utilizes standardized structure, language, and user interfaces. Spacecraft specific applications are limited, in number, to only where it is necessary. Future adaptations of the applications for Constellation will continue the process of updating the software to handle both spacecraft specific constraints and generic spacecraft.

4.2.1.2. Generic Computation and Display - Mission Control Technologies (MCT)

MCT is a toolset for the development and maintenance of user tools based on a common, structured, maintainable code base. MCT enables users to build, modify and use displays without programming. The resulting tools and data sets may be used on multiple platforms, in multiple facilities, for multiple MOD organizations. MCT addresses facility needs by standardizing the structure, language, and interfaces of user applications, reducing the variation in different tools that the platform must support, reducing the need for recurring test and certification.

Adoption of the MCT toolset is targeted to reduce the cost of development and maintenance of individual user displays, computation functions, and other discipline-specific tools. By enabling sharing of software components across facilities and organizations, the overall code size and associated code maintenance costs will be reduced.

MCT consists of a set of the following software items:

- Components - provide end-user functionality (telemetry display, computations, limit sensing, annunciations, command user interface, etc.)
- Framework – provides core services and manages components. The core services provided by the framework are:
    - Component and UI Services – The APIs that support Components and their lifecycle, providing services for instantiation, management, display, sharing, and persistence.
    - Object Sharing and Persistence – These provide for state synchronization among multiple workstations running the same MCT application, and for long-term persistence of changes to a relational database.

- ID/Role Management – This subsystem provides user identity management. The user's identity and roles can be examined by policies to restrict actions to authorized users.
- Policy Manager – The subsystem that tracks built-in and plug-in policies and coordinates their application.
- Plug-in Manager – The subsystem that coordinates the loading of MCT Plug-ins, and mediates their integration into the system.

- Cooperating Servers – two server systems supporting MCT capabilities:
  - Object Sharing Server – This server facilitates the sharing of changes to Java objects among client applications running on separate workstations. The MCT toolset uses the Terracotta object sharing server to propagate changes to Component state immediately to all MCT users.
  - Database Server – A database instance running on a shared server. (The MCT toolset uses a mySQL database server.
- Adapters –plug-ins – built as Java classes that implement an OSGi service - that provide interface to external data sources. Adapters will be provided to interface to the following data sources:
  - Information Sharing Protocol (ISP)
  - MCCS Command System

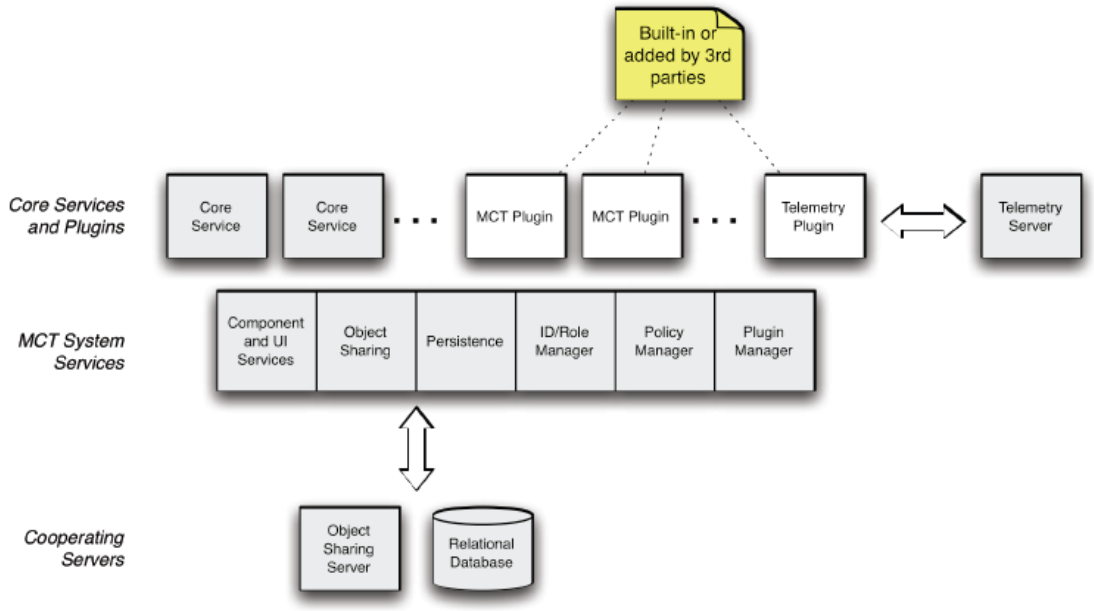


Figure 4.2.1.2-1 MCT Overview

The MCT system is normally deployed among a set of workstations with a consistent configuration. In this environment, user objects may be shared among different users so that all see a consistent view of the system.

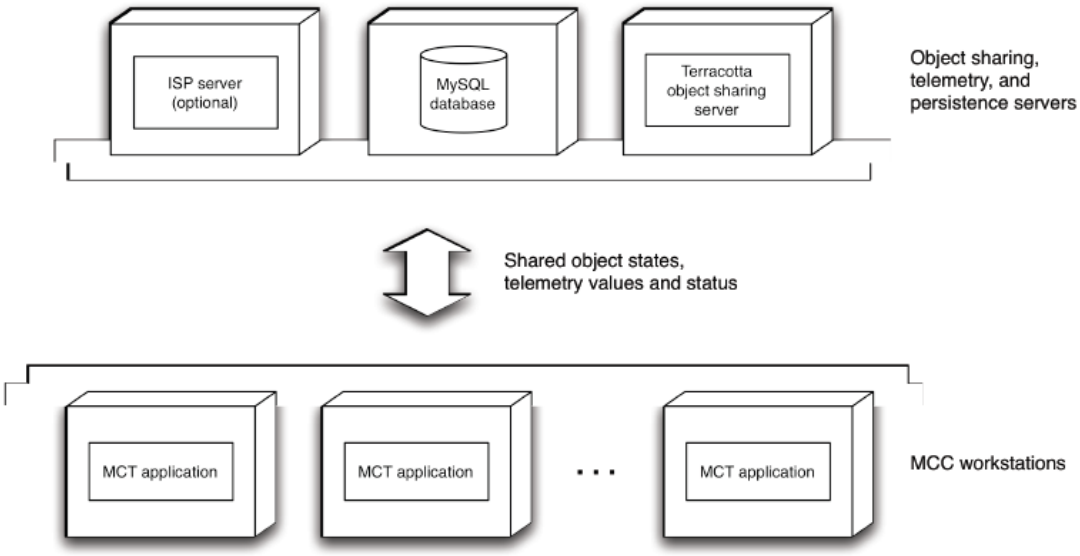


Figure 4.2.1.2-2 MCT Data Sharing Overview

In this configuration, the MCT system runs on each user's workstation. In addition, three other services must be present on server machines:

- A shared object server running the Terracotta object sharing service
- A instance of MySQL
- A telemetry server (such as an ISP server), if telemetry values need to be displayed

A more detailed description of the MCT architecture is available in the MCT Developer Document.

The functional design requirements for MCT can be found in the MCT Level C Requirements (JSC TBD)

4.2.1.3. Constraint Monitoring - Constraint and Flight Rule Management (ConFRM)

Constraints & Flight Rules Management (ConFRM) is a tool that captures ops-related constraints (planning ground rules & constraints, flight rules, workstation limits, etc.) in a standard format that supports pre-flight analysis and generation of products, while maintaining traceability and enabling efficient updates. The operation concept for ConFRM can be found in the ConFRM OPS Concept document (JSC TBD). The functional requirements for ConFRM can be found in the ConFRM Level C requirements (JSC TBD).

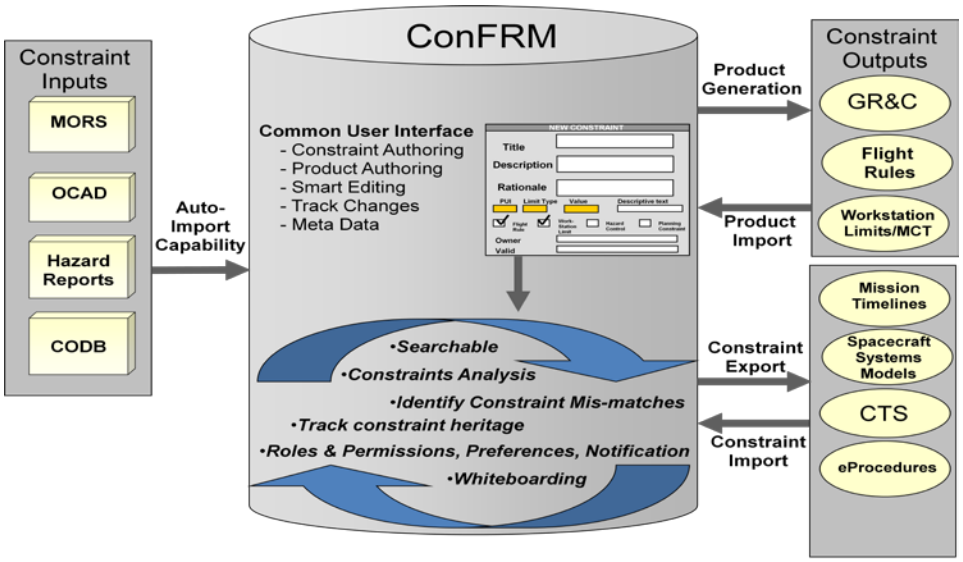


Figure 4.2.1.3-1 ConFRM Overview

4.2.1.4. Management Level Network Executive (MLNE[EJT1])

The purpose of the MLNE application is to provide the common Flight Production Process (FPP) services in support of the Constellation Program. MLNE facilitates Mission Operations status, tracking/monitoring, control, planning/replanning and orchestration of pre-mission flight production processes. This system is available to authorized users in the office, the control center, the training facilities, MORS, as well as other approved facilities.

The MLNE application will leverage existing, common MCCS architectures, policies, procedures and security capabilities to provide for integration of application development/test/deployment and pre-mission planning in a consistent manner.

Components of the MLNE subsystem architecture include the following:

- Run-time environment
  - The MLNE, process choreographer
  - Message handler
  - Service registry
- Simulation environment
- Process modeling production environment

In its role as process choreographer, the MLNE interfaces with other MCCS subsystems (e.g., CTS), other MS facilities (e.g., MORS and CxTF) and HCI systems for presentation of status, as well as monitoring and control of processes in execution.

The functional requirements for the MLNE applications can be found in the (TBD) document (JSC TBD).

4.2.2. ISS Specific User Applications

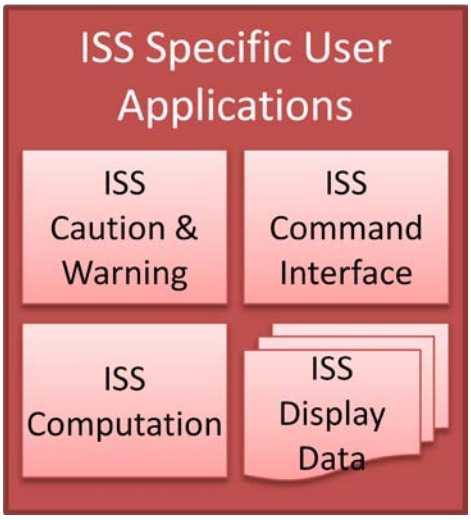


Figure 4.2.2-1 - ISS Specific User Application Element Components

ISS specific applications include those software capabilities that are customized to support ISS operations.

In general, ISS user applications have already been built, tested, certified, and deployed for use. To minimize cost, MCCS User Applications will reuse these applications for continued ISS operations support. In some cases, however, legacy applications will be replaced in order to achieve MOD standardization across supported programs and facilities. In particular, multiple display applications will be retired and replaced with the MCT capability included as part of the Generic User Application element.

The suite of current User Applications used to support ISS are contained in the J10 list (FDOC contract document) under the DO, DX and DI tabs. If a current application is a candidate for replacement by a tool developed for Cx it is noted on the spreadsheet in column Q. The link to the current version of this list is below.

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4.2.2.1. ISS Command Interface

ISS Command interface applications provide users with the ability to view, select, and request issuance of commands to the vehicle. These applications interface to the command system through a local workstation client that provides two-way data transaction services. Commands themselves are stored, processed, and uplinked by the command system.

The unique interfaces and data formats associated with ISS command capabilities require the continued use of custom software tools to exercise these capabilities. The MCCS User Applications subsystem will reuse already developed, tested and certified tools to fulfill these needs. Individual software components will be sustained as required by the owner organization.

Note that the command system provides limited command user interface capabilities. The additional capabilities provided through MCCS User Applications enhance these basic capabilities to make the commanding process more efficient for ISS operators.

4.2.2.2. ISS Caution & Warning (C&W)

The ISS Caution and Warning (C&W) toolset displays vehicle-initiated C&W messages to console operators and allows operators to manage the onboard C&W system configuration through acknowledging, enabling and inhibiting individual messages.

The unique interfaces and data formats associated with ISS C&W require the continued use of custom software tools to view and control this capability. The MCCS User Applications subsystem will reuse already developed, tested and certified tools to fulfill these needs. Individual software components will be sustained as required by the owner organization.

4.2.2.3. ISS Computation

ISS computation capabilities are provided through a combination of custom applications and generic, reconfigurable tools. Each application is developed and maintained by its owner organization.

In general, these functions will be transitioned to implementation in the generic MCT capability.

4.2.2.4. ISS Display Data

ISS Display data sets, currently implemented using legacy tools, will be converted to be compatible with the MCT toolset provided as part of the Generic User Application set.

4.3. Constellation Specific User Applications

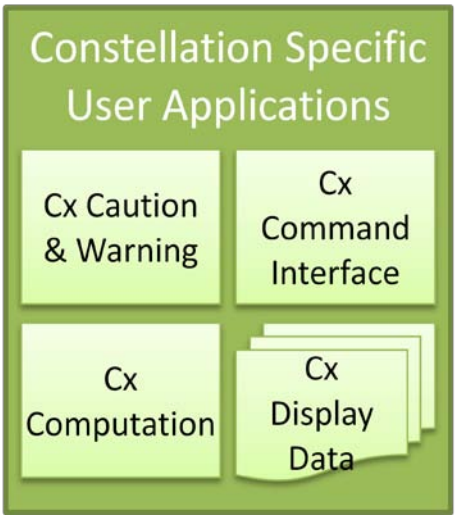

Figure 4.3-1 - Constellation Specific User Application Element Components

Constellation specific applications include those software capabilities that are customized to support Constellation operations.

In general, the determination of what functions will be required from the Cx Specific Applications toolset was based on reviewing the current state of the Cx vehicle and software design along with the set of applications used to support the Space Shuttle and ISS Programs. Once the need for a function was determined, an assessment as to how to provide that function was made. Options included: using an existing application without modification, using a modified version of a current application (modifying exiting code), or the development of a totally new application. Given the preliminary stage of Cx vehicle and flight software design, along with uncertainties in the final operations concept it is likely this set of applications and the best method to provide the needed functions will be quite fluid.

The suite of current User Applications used to support SSP are contained in the FDOC Contract document J10 list (link below) under the DO, DS and DX tabs. If a current application, as is or modified, is needed in some form for Cx it is noted in columns O, P and Q. If a current SSP application is no longer needed and can be retired it is noted in columns O and P.

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Applications that have been identified as being needed for Cx support but that are not currently a part of the ISS or SSP suite of applications are listed below in Table 4.3.1

Table 4.3-1 – Constellation Specific User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
Cx Caution & Warning	C&W Management Tool	View active C&W events, C&W history, C&W event management, C&W logs, etc.	DS	New custom development, COTS (TEAMS)	Platform Services (ISP)	User Applications (MCT)
Cx Command Interface	CFDP Client	Initiate file transfers, file management functions. Requires MCCS CFDP Server.	DS	TBD	TBD	Command System
	File Management Tool	Used to manage files stored on Orion's Mass Memory Card and initiate file transfers via CFDP or FTP client.	DS	New custom development	TBD	Command System
	Data Recorder Management Tool	Used to manage which Data Recording List files are in use.	DS	TBD	TBD	TBD
	Automation Script Builder	Used to create SCL Automation Scripts from scratch data file.	DS	COTS procurement (SCL) based on Orion onboard implementation.	CxPASS	Platform Services (ISP), MOD Messaging Bus (Implementation TBD)
	Memory Dump Management Tool	Used to command Ares or Orion to dump a region of memory or a list of parameters to a file or to telemetry.	DS	New custom development	TBD	Command System
	Cx Memory Dump Viewer	Used to view memory dump files and/or memory dump	DS	New custom development	Platform Services (ISP)	Platform Services (ISP)

Table 4.3-1 – Constellation Specific User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
	Tool	telemetry				
Constellation Display Data	MCT Display Data Records	Display layouts are composed, stored, and used within the MCT toolset using certified software reconfiguration data sets supplied by MORS to the MCCS	All Organizations		Platform Services (ISP)	Platform Services (ISP)
	Hardware Locator (Under Review)	This application graphically displays hardware locations for the purpose of assessing collateral damage	DS	New Development or COTS	Platform Services (ISP)	Platform Services (ISP)
	I-Load Builder	Used to create Orion I-loads for all others systems than Trajectory.	DS	New Development	Platform Services (ISP)	Platform Services (ISP, Command, EDDS
	Log File Viewer	Used to view the contents of Orion log files.	DS	New Development	Platform Services (ISP)	Platform Services (ISP)
	Telemetry Packing Map Tool	Used to create telemetry packing map (TPM) files for use by Orion and the MCC FEPs.	DS	New Development[EJT2]	Platform Services (ISP)	Platform Services (ISP)
	Telemetry Management Tool	Used to manage usage of the telemetry downlink including loading new TPMs, changing downlink priorities, etc.	DS	New Development	Platform Services (ISP)	Platform Services (ISP), Command

Table 4.3-1 – Constellation Specific User Applications

Function	Application	Description	Owner Org	Development / Deployment Approach	Application Interfaces	
					Input	Output
	Video Viewer	Used to view downlink video and video files.	DS	New Development	Platform Services (ISP)	Platform Services (ISP)
	Audio Tool	Used to listen to down linked recorded audio files.	DS	New Development	Platform Services (ISP)	Platform Services (ISP)
	Telemetry Formant Tool	Used to Define TLM	DS	New Development	Platform Services (ISP)	Platform Services (ISP)

4.3.1.1. Constellation Caution & Warning (C&W)

The Constellation Caution and Warning (C&W) toolset displays vehicle-initiated C&W messages to console operators and allows operators to manage the onboard C&W system configuration through acknowledging, enabling and inhibiting individual messages. This toolset may also provide enhanced ground only features such as advanced failure root cause analysis and impact assessment (capabilities currently under evaluation).

The unique interfaces and data formats associated with Constellation C&W require the continued use of custom software tools to view and control this capability. The MCCS User Applications subsystem will develop new applications to process, display and manage C&W related data.

Some portions of this Cx C&W software may be implemented as an MCT software component. The more advanced capabilities (advanced failure root cause analysis and impact assessment) may be accommodated through the use of the COTS application TEAMS – a reuse of the same COTS tool and associated data sets implemented by Constellation vehicle projects.

4.3.1.2. Constellation Command User Interface

Constellation command user interfaces will be implemented as data sets in the MCT toolset. Command user interfaces are built, tested, certified and executed using capabilities provided by MCT software components. The definition of these command user interfaces, command IDs, labels, and associated command data are stored in the MCT database.

Selected command capabilities may be implemented as standalone tools to either take advantage of available Commercial off the Shelf (COTS) tools or pre-existing tools developed in support of Constellation projects. The COTS tool SCL will be used to support Orion command scripting capabilities, since the implementation of this in Orion onboard avionics drives proprietary data interfaces.

4.3.1.3. Constellation Computation

Constellation computations will be implemented primarily as data sets in the MCT toolset. Computations are built, tested, certified and executed using capabilities provided by MCT software components. The definition of these computations – equations, algorithms, constants, etc. – are stored in the MCT database.

Where computational requirements exceed the ability of the toolset, computation functions may be transferred to other MCCS subsystems or rely on MCT accessing a COTS math engine such as MATLAB (actual choice of math engine is TBD).

4.3.1.4. Constellation Display Data

Constellation display data sets will be implemented as data sets in the MCT toolset. Display compositions are built, tested, certified and executed using capabilities provided by MCT software components. The definition of these displays (command and parameter IDs, labels, groups, and x,y location data) are stored in the MCT database.

4.3.2. Design Considerations (Section in work - currently limited to topic collection)

- Continued use of ISP for telemetry sharing
- New Command System Interface
- New MCCS messaging design
- TBD

4.3.2.1. General Constraints (Section in work - currently limited to topic collection)

- TBD Workstation performance and applicable SMP limits

4.3.2.2. Development Method (Section in work)

- TBD

4.3.2.3. Recon products for MORS (Section in work)

- TBD

4.3.3. Subsystem Software Preliminary Design

4.3.3.1. Software Configuration Items (Section in work- currently limited to topic collection)

- TBD Functional breakdown with description. Identify software CIs (COTS, custom, etc).

4.3.3.2. Standards, methods, constraints and tools used (Section in work - currently limited to topic collection)

- OSGI, XML, ISP, TBD

4.3.4. Software Policies and Tactics

4.3.4.1. Programs supported (Shuttle, ISS, CxP)

The MCCS User Applications subsystem supports the ISS and Constellation programs. It is assumed that the Space Shuttle Program will be decommissioned by the time that this User Applications subsystem design is implemented.

4.3.4.2. Shuttle Decommission plan

This design specification assumes the retirement of Space Shuttle Program unique applications with the completed decommissioning of that program.

User Application capability deployment will be phased over time. Selected legacy applications still in use for ISS operations will be retained due to the unique interface requirements for that vehicle.

The suite of current User Applications used to support ISS and SSP are contained in the FDOC Contract document J10 list (link below). If a current application, as is or modified, is needed in some form for Cx it is noted in columns O, P and Q. If a current SSP application is no longer needed and can be retired it is noted in columns O and P.

https://myfdoc.jsc.nasa.gov/contract/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fcontract%2fShared%20Documents%2fConformed%20Contract&FolderCTID=&View=%7bCE4AEB40%2d19E4%2d4F15%2dAD9D%2d3EABED01AE4D%7d

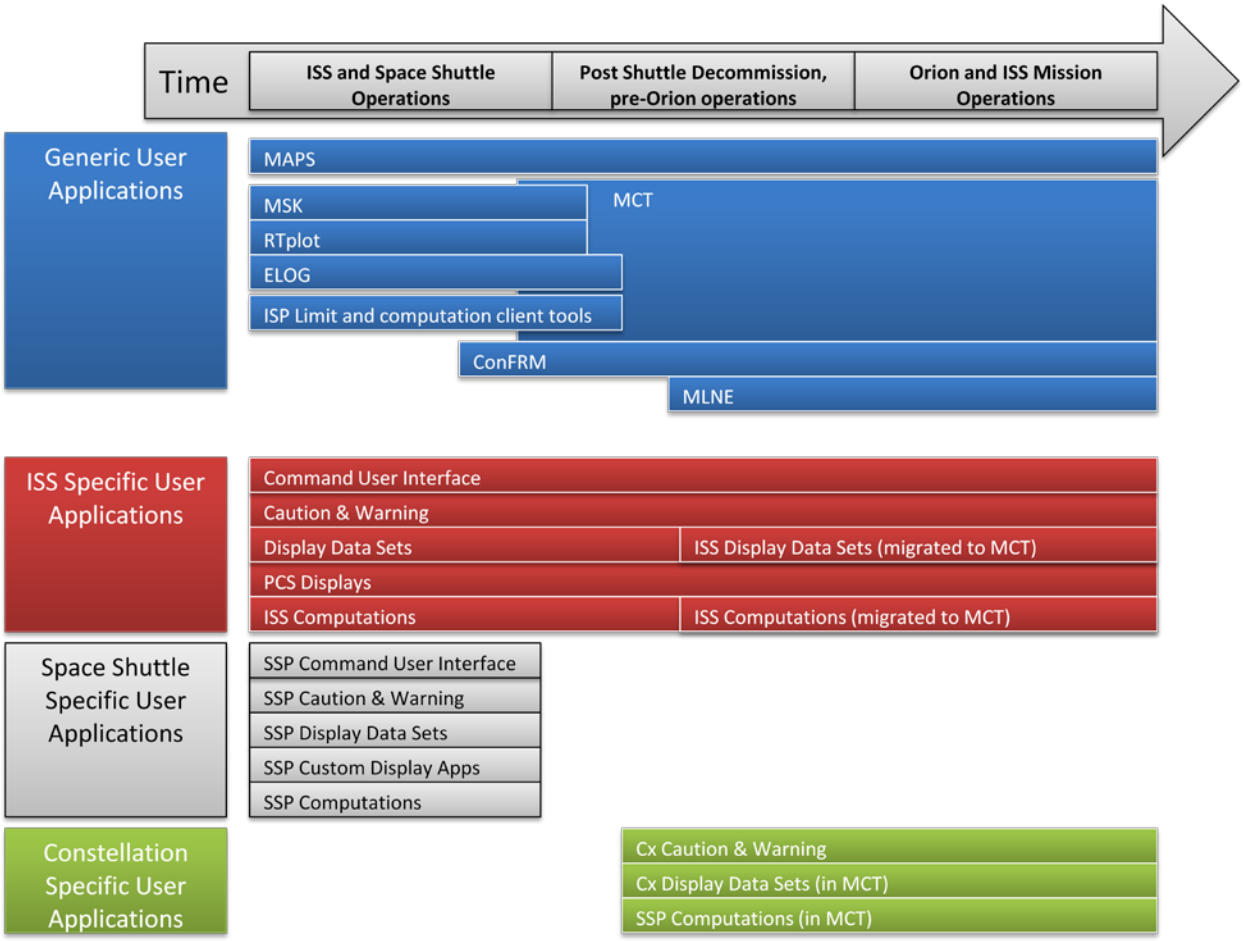

Figure 4.3.4.2-1 SSP Decommission Plan

4.3.5. Maintenance Plan

Software components of the User Applications subsystem are managed by their respective owner organizations and maintained by FDOC.

5. Specialty Engineering

5.1. Subsystem Performance (Section In Work - currently limited to topic collection)

(Describe any subsystem unique performance requirements and characteristics (e.g. latency, loading). Include both hardware and software where applicable.)

5.2. Subsystem Reliability, Maintainability, and Availability (Section In Work currently limited to topic collection)

(Describe any subsystem unique RMA capabilities for hardware and software. E.g. checkpoint, restart, failover methods)

5.3. Safety

Preliminary Hazard reports for MCCS have been created. The database containing the hazard reports can be accessed from the website: https://cxhazard.nasa.gov

The six Hazard Reports that impact the User Applications Subsystem are briefly described below.

Cx Hazard Record: 321

HR #: MO-MORS-CMD-01

Title: MORS Miscalculated Command and telemetry Configuration Data Due to Mission Operations Reconfiguration system (MORS)

Hazardous Condition Description: Failure in the MORS ability to accurately receive, process or supply integrated flight software or reconfiguration product builds to MCCS can result in MCCS sending a command with incorrect information to the Orion/Ares vehicle which could result in a hazardous operation.

Cx Hazard Record: 322

HR #: MO- CxPASS-CMD-02

Title: CxPASS Wrong/Inadvertent/Miscalculated Commands

Hazardous Condition Description: Processing of electronic procedures containing automated commands can be executed from the MCCS via the CxPASS Procedure Ground Viewer/Executor (PVE) to the spacecraft/crew to mitigate a number of hazardous conditions. The ability of the CxPASS to execute these electronic procedures with wrong/inadvertent/miscalculated commands scripts could result in LOM or LOC.

Cx Hazard Record: 323

HR #: MO-CxPASS-CMD-001

Title: CxPASS Inability to Command

Hazardous Condition Description: Processing of electronic procedures containing automated commands can be executed from the MCCS via the CxPASS Procedure Ground Viewer/Executor (PVE) to the spacecraft/crew to mitigate a number of hazardous conditions. The inability of the CxPASS to execute these electronic procedures could result in LOM.

Inability to execute automated command.

Cx Hazard Record: 324

HR #: MO-MCCS-RSTLM-01

Title: MCCS Unable to Send TML to Range Safety

Hazardous Condition Description: The Orion/Ares Mission Operations Link (MOL) which contains critical Range Safety data will flow through a Tracking and Data Relay Satellite System (TDRSS) link established for launch preparation and ascent. The MCCS Communications Subsystem provides processing of the MOL and forwards Range Safety data to the Eastern Range. Failure of the MCCS Communications Subsystem will result in the loss of Range Safety insight into vehicle status and performance. This loss of critical data such as metric GPS tracking, Flight Termination System (FTS) status, and inertial state of the vehicle could force a Range Safety termination of flight.

Cx Hazard Record: 326

HR #: MO-MCCS-CMD-03

Title: MCCS Inadvertent or Wrong Command

Hazardous Condition Description: Inadvertent sending of command (must not work function) with hazardous consequences on ARES/ORION (LOM or LOC). This concern is defeating the independence of the existing Hazard Controls provided by ARES/ORION design. Selection and execution of improper commands can have the same consequences.

Must not work function is defined by a function must not work when the features are in place. Inadvertent command refers to a command being sent when not expected.

Wrong command refers to a (correctly formatted) wrong command being sent.

Cx Hazard Record: 327

HR #: MO-MCCS-CMD-02

Title: MCCS Miscalculated Command

Hazardous Condition Description: Failure in the MCCS subsystems can result in MCCS sending a command with incorrect information to the Orion vehicle which could result in a hazardous operation. Examples of the hazardous operation could be an incorrect state vector from Core Trajectory Subsystem (CTS) used for guidance/navigation/control to ensure avoidance of orbital debris, a procedure with missing or incorrect steps from CxPASS resulting in unsafe crew operations.

Miscalculated command refers to a command being generated with internal parameters of the command corrupted.

MCCS subsystems and components that could cause a miscalculated command include the Communication Subsystem (Gateway, Downlink Front End Processor), Command Subsystem (Command Server and software), Core Trajectory Subsystem Production (software) and Operations (servers and software), Constellation Procedures Application Software Suite (Cx PASS), MCCS user applications (command clients), platform services (LAN, software services), Configuration Management (CM servers), Data Display and Computation Subsystem (DDCS) workstations, and the Spacecraft System Models (SSM) subsystem.

Causes 1 through 3 are ingesting of data from external entities that are used for commands.

Causes 4 through 9 are processing of data used to create commands, including the telemetry path for determining commands to be sent. Causes 10 through 16 are hardware and software components used in the command path from initiation to exit from MCCS.

APPENDIX A
ACRONYMS AND ABBREVIATIONS

C&W	Caution and Warning
C3I	Command, Control, Communications, and Information
CM	Configuration Management
ConFRM	Constraint and Flight Rule Management
COTS	Commercial Off The Shelf
CTS	Core Trajectory System
CxP	Constellation Program
CxTF	Constellation Training Facility
DDCS	Data Display and Computation System
DRAS	Data Recording and Archive System
EDDS	External Data Distribution System
FTS	Flight Termination System
ISP	Information Sharing Protocol
ISSP	International Space Station Program
LOC	Loss of Crew
LOM	Loss of Mission
MAPS	Multiprogram Attitude and Pointing System
MAS	Mission Automation System
MCCS	Mission Control Center System
MCT	Mission Control Technologies
MLNE	Management Level Network Executive
MOD	Mission Operations Directorate
MOL	Mission Operations Link
MORS	Mission Operations Reconfiguration System
PSS	Platform Services System
PVE	Procedure, Ground Viewer/Executer
RMA	Reliability, Maintainability and Availability
SMP	Software Management Plan
SSM	Spacecraft Systems Models
SSP	Space Shuttle Program

Appendix B

User Application Subsystem Requirements Allocation to Software Elements

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0001	The User Applications Subsystem shall accept inputs from the following MCCS subsystems		X		X		X				X		
UA.0002	The User Applications Subsystem shall provide outputs to the following MCCS subsystems		X		X		X				X		
UA.0003	User Application Subsystems shall support[EJT3] the following data types:		X					X	X			X	X
UA.0004	The User Application Subsystems shall support the data types specified in CxP 70022 Command, Control, Communications, and Information (C3I) Interoperability Standards.		X					X	X			X	X
UA.0005	The User Application Subsystems shall support the following operational data products:	X	X		X		X		X		X		X
UA.0006	User Application Subsystems shall modify data per role-based permissions and MCC policies.		X		X		X		X		X		X
UA.0007	User Application Subsystems shall be able to access, view, and utilize data regardless of where it is stored within the MCCS.	X	X	X		X	X	X	X	X	X	X	X
UA.0008	User Application Subsystems shall be able to access, view, and utilize data stored external to the MCCS per authorized access.	X	X	X		X	X	X	X	X	X	X	X
UA.0009	User Application Subsystems shall be able to share data.	X	X		X			X	X			X	X
UA.0010	User Application Subsystems shall be able to search for and retrieve data from MCCS systems and subsystems (MAS, IPS, DDCS, Data Storage, etc) based on user defined criteria.	X	X	X					X				X
UA.0011	User Application Subsystems shall allow users and groups to manage display preferences such as color, font, size, and layout per the MOD SMP Appendix H standards.		X						X				X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0012	User Application Subsystems shall allow users to create, modify, or combine displays during operational use within the limits of the user's permissions.		X						X				X
UA.0013	User Application Subsystems shall provide access to shared applications and displays based on the user's access permissions.	X	X						X				X
UA.0014	User Application Subsystems shall define the access permission when sharing applications and displays.		X						X				X
UA.0015	User Applications shall provide the capability to present data in the following representations:		X						X				X
UA.0016	User Application Subsystems shall allow the user to change how the data is represented at any time.		X						X				X
UA.0017	User Application Subsystems shall provide the capability to view combinations of like data regardless of data source.		X						X				X
UA.0018	User Application Subsystems shall issue user notifications to users based on predefined criteria.		X	X	X	X			X	X			X
UA.0019	User Application Subsystems shall allow users to create, modify, save, restore, and delete user notifications at any time.		X	X	X	X			X	X			X
UA.0020	User Application Subsystems shall allow users to define how user notifications are presented during run time.		X	X	X	X			X	X			X
UA.0021	The User Application Subsystems shall provide an integrated user interface for sending commands and viewing telemetry.	X	X				X		X		X		X
UA.0022	The User Application Subsystems shall provide the capability to build, view, edit, and delete the appropriate *command types* as specified in the Command Subsystem requirements.		X				X				X		
UA.0023	The User Application Subsystems shall provide the capability to *uplink*[EJT4] the appropriate command types as described in the Command Subsystem requirements.		X				X				X		

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0024	The User Application Subsystems shall support the *safeguards* for commanding operations as described in the Command Subsystem requirements.		X				X				X		
UA.0025	The User Application Subsystems shall interface[EJT5] with the MCCS Command Subsystem to support *time authentication* as described in the Command Subsystem requirements.		X				X				X		
UA.0026	The User Application Subsystems shall support the management functions for event-triggered commands, as described in the Command Subsystem requirements. (*JSC 63796* MCCS Level A Requirements , Section 3.2).		X				X				X		
UA.0027	The User Application Subsystems shall support the management functions for time-triggered commands, as described in the Command Subsystem requirements. (*JSC 63796* MCCS Level A Requirements , Section 3.2).		X				X				X		
UA.0028	The User Application Subsystems shall support the management (start execution, pause, resume, and abort) of command scripts. (*JSC 63796* MCCS Level A Requirements , Section 3.2).		X				X				X		
UA.0029	User Application Subsystems shall limit the user's access and permissions based on their identity and roles.		X						X				X
UA.0030	User Application Subsystems shall authenticate users using the system provided authentication services to determine the system access, roles, and permissions		X				X		X		X		X
UA.0031	User Application Subsystems shall utilize the configuration managed data products for configuration and data settings.		X						X				X
UA.0032	The User Application Subsystem shall plot line of sight for available communications stations and satellites positions, superimposed on an AZ/EL depiction of the vehicle with CEV blockage and docked vehicle blockage areas highlighted	X	X										X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0033	The User Application Subsystem shall plot predicted line of sight for available communications stations and satellites positions, superimposed on an AZ/EL depiction of the vehicle with CEV/CLV blockage and docked vehicle blockage areas highlighted.	X	X										X
UA.0034	The User Application Subsystem shall provide a scheduling tool which integrates network support schedules, geometric line of sight availability, predicted loss of signal, and planned usage of vehicle C&T equipment	X			X								
UA.0035	The User Application Subsystem shall provide tools that assist the user in creating commands for subsequent uplink		X				X				X		
UA.0036	The User Application Subsystem shall provide tools that assist the user in uplinking commands and verifying their proper execution onboard.		X				X				X		
UA.0037	The User Application Subsystem shall provide a tool that tracks, versus time, the downlinking, onboard recording, and ground receipt status of all data sources on the CEV that are available to the MCC data center, highlighting loss of data and filling gaps with data dumps.		X								X		
UA.0038	The User Application Subsystem shall provide status of the onboard data acquisition subsystem.		X						X				X
UA.0039	The User Application Subsystem shall provide a tool to monitor IMU to IMU attitude and velocity comparison data											X	X
UA.0040	The User Application Subsystem shall provide a tool to monitor IMU to GPS velocity comparison data.											X	X
UA.0041	The User Application Subsystem shall provide a tool to monitor IMU to Star Tracker attitude comparison data.											X	X
UA.0042	The User Application Subsystem shall provide a tool to monitor IMU attitude drift over a period of time.											X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0043	The User Application Subsystem shall provide a tool to calculate OME TVC trim positions required for current vehicle cg.											X	X
UA.0044	The User Application Subsystem shall retrieve IMU matrices from telemetry, manipulate the matrices as required, and produce results for uplink to vehicle											X	X
UA.0045	The User Application Subsystem shall provide a tool to display attitude and velocity comparison data from different vehicles (Ares to Orion, Orion to LSAM).	X	X	X					X			X	X
UA.0046	The User Application Subsystem shall provide a tool to monitor IMU velocity to Ground RADAR comparison data											X	X
UA.0047	The User Application Subsystem shall provide a tool to calculate linear accelerations, angular accelerations, total forces, and total torques applied to the vehicle when any combination of jets fire, or external force is applied to the vehicle.		X	X								X	X
UA.0048	The User Application Subsystem shall perform angular computations using matrices, quaternions, and Euler angles, and convert among the three	X	X									X	X
UA.0049	The User Application Subsystem shall display the current star field of view by the Star Trackers and any backup system (COAS) based on current attitude, predict any future star field of view based on the attitude being held and any future scheduled maneuvers, and supply angular differences between given stars.	X											
UA.0050	The User Application Subsystem shall provide tools to monitor flight control performance and compare the sensed response to the expected response		X	X								X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0051	The User Application Subsystem shall provide tools for SM main engine performance analysis and Aux thruster[EJT6] translation analysis for burns and abort dumps. These tools should use hardware specific parameters and flight design estimations or rocket equation predictions or other acceptable methods											X	X
UA.0052	The User Application Subsystem shall perform computations for propellant quantity, leak detection, and leak analysis based on consumables-related information including pressure, temperature, and valve position data.		X	X								X	X
UA.0053	The User Application Subsystem shall provide an interface to the real-time computations of propulsion systems consumables as well as provide for monitoring of important propulsion pressure, temperature, quantity, and leak status information.		X	X								X	X
UA.0054	The User Application Subsystem shall provide a tool to allow the user to compute corrected constants to be used in the onboard calculations of propellant tank quantities.		X									X	X
UA.0055	The User Application Subsystem shall provide a tool to calculate actual propellant usage over a period of time by the summation of individual firing times for the SM Aux thrusters and for the CM thrusters.		X	X								X	X
UA.0056	Deleted												
UA.0057	Deleted												
UA.0058	The User Application Subsystem shall provide a tool to calculate predicted quantities in percent and pounds for each propellant tank		X	X								X	X
UA.0059	The User Application Subsystem shall provide a tool to analyze the SM main engine and Aux thruster deorbit capabilities using hardware specific parameters and propellant quantities predicted at deorbit TIG											X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0060	The User Application Subsystem shall provide a tool to calculate the performance data necessary to determine whether sufficient capability remains for entry in the event of a propellant tank failure											X	X
UA.0061	The User Application Subsystem shall provide a tool to track propellant quantities in each SM tank.											X	X
UA.0062	The User Application Subsystem shall provide a tool to track propellant quantities in each CM tank											X	X
UA.0063	The User Application Subsystem shall generate summaries of propellant margins, performance capability, and extension day capabilities.		X	X								X	X
UA.0064	The User Application Subsystem shall provide an interface to propulsion program data, such as standard constants, engine specific data, and propellant usage files		X	X	X							X	X
UA.0065	The User Application Subsystem shall provide a user interface to allow for the creation and modification of propellant usage plans (i.e., timelines) based on planned flight activities		X	X								X	X
UA.0066	The User Application Subsystem shall perform propellant usage calculations and redline generation capability necessary to accompany the propellant usage plan		X	X								X	X
UA.0067	The User Application Subsystem shall provide tools to monitor changes in data, detect potential problems based on established limits, and provide indication of potential problems to console operators.		X	X						X		X	X
UA.0068	The User Application Subsystem shall provide tools to detect and enunciate channelization (RIU, channel, card) failures based on input from telemetry data		X	X								X	X
UA.0069	The User Application Subsystem shall graphically display current valve configuration and evaluate power and avionics failure impact(s) to valve functionality and engine/thruster statuses.		X	X								X	X
UA.0070	The User Application Subsystem shall provide tools to integrate real-time data with system failure logic to provide up-to-date system status		X	X								X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
	information												
UA.0071	The User Application Subsystem shall log all pertinent events and activities with an MET and GMT time tag.	X	X	X					X				X
UA.0072	The User Application Subsystem shall comply with the design and human factors standards in Appendices F and H of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0073	The User Application Subsystem shall comply with the maintainability standards in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0074	The User Application Subsystem shall use reconfiguration products for all configurable parameters, commands, and health and status parameters				X								
UA.0075	The User Application Subsystem shall only use non- proprietary[EJT7] interfaces to the OS		X										
UA.0076	The User Application Subsystem shall comply with the performance standards in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0077	The User Application Subsystem shall conform to the composite MCC availability of at least 0.9998 in support of the following functions for a single CxP real-time activity.		X										
UA.0078	The User Application Subsystem shall comply with the fault tolerance and architecture standards[EJT8] in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan.		X										
UA.0079	The User Application Subsystem shall comply with the security standards in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0080	The User Application Subsystem shall receive recorded telemetry (health & status) data from the MCCS Archive System.		X	X	X				X				X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0081	The User Application Subsystem shall request recorded telemetry (health & status) data from the MCCS Archive System.		X	X					X				X
UA.0082	The User Application Subsystem shall request recorded command data from the MCCS Archive System.		X	X					X				X
UA.0083	The User Application Subsystem shall provide data files to the MCCS Archive System for long term storage.		X		X								
UA.0084	The User Application Subsystem shall request data files from the MCCS Archive System.		X										
UA.0085	The User Application Subsystem shall be decoupled from the MCC platform services, but not require another application in order to access those services.		X		X								
UA.0086	The User Application Subsystem shall only use operating and windowing system independent interfaces, libraries, and toolkits.		X										
UA.0087	The User Application Subsystem shall receive planning system data from the MCCS Planning System.	X	X					X				X	
UA.0088	The User Application Subsystem shall request planning system data from the MCCS Planning System.	X	X					X				X	
UA.0089	All user application software shall comply with the human interface/usability requirements in Appendix H of the MOD SMP.		X										
UA.0090	All user application software which provide a Graphical User Interface, shall comply with the Graphical User Interface (GUI) requirements in Appendix G of the MOD SMP.		X										
UA.0091	Not Assigned												
UA.0092	Not Assigned												
UA.0093	Not Assigned												
UA.0094	Not Assigned												

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0095	Not Assigned												
UA.0096	Not Assigned												
UA.0097	Not Assigned												
UA.0098	Not Assigned												
UA.0099	Not Assigned												
UA.0100	The User Application Subsystem shall receive recorded command data from the MCCS Archive System.		X				X		X		X		X
UA.0101	The User Application Subsystem shall provide the following data to the MCCS Trajectory System	X	X									X	X
UA.0102	The User Application Subsystem shall receive trajectory system data from the MCCS Trajectory System.	X	X									X	X
UA.0103	The User Application Subsystem shall receive MCCS hardware/software configuration data from the MCCS Platform Services System.		X										
UA.0104	The User Application Subsystem shall receive telemetry data from the MCCS Platform Services System.		X					X					X
UA.0105	The User Application Subsystem shall receive space network scheduling data from the Space Network Asset Scheduling System.	X	X										
UA.0106	The User Application Subsystem shall receive space network scheduling system health & status data from the Space Network Asset Scheduling System.	X	X										
UA.0107	The User Application Subsystem shall output scheduling request data to the Space Network Asset Scheduling System.	X	X										
UA.0108	The User Application Subsystem shall output control directives to the Space Network Asset Scheduling System.		X				X				X		
UA.0109	The User Application Subsystem shall receive spacecraft performance analysis results data from the SSM		X					X	X			X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0110	The User Application Subsystem shall receive configuration data from the SSM.	X	X	X					X				X
UA.0111	The User Application Subsystem shall output[EJT9] configuration data to the SSM.	X	X	X				X	X			X	X
UA.0112	The User Application Subsystem shall request data from the SSM. (CxP) (Orion-to-ISS and subsequent)	X	X	X				X	X			X	X
UA.0113	The User Application Subsystem shall provide user interfaces for monitoring of booster flight systems and components for the Ares I and Ares V vehicles including: Solid Rocket Boosters, J-2X engine, and RS-68 engine									X		X	X
UA.0114	The User Application Subsystem shall provide user interfaces for control of booster flight systems and components including: Solid Rocket Boosters, J-2X engine, and RS-68 engine											X	X
UA.0115	The User Application Subsystem shall provide user interfaces for monitoring of Communication, Command, and Telemetry flight systems and components.	X	X	X				X	X	X		X	X
UA.0116	The User Application Subsystem shall provide user interfaces for control of Communication flight systems and components.	X	X	X							X	X	X
UA.0117	The User Application Subsystem shall provide user interfaces for monitoring of data processing flight systems and components		X	X				X	X	X		X	X
UA.0118	The User Application Subsystem shall provide user interfaces for control of data processing flight systems and components.		X	X							X	X	X
UA.0119	The User Application Subsystem shall provide user interfaces for monitoring of life support flight systems and components		X	X				X	X	X		X	X
UA.0120	The User Application Subsystem shall provide user interfaces for control of life support flight systems and components.		X	X							X	X	X
UA.0121	The User Application Subsystem shall provide for the adjustment of total pressure and ppO2 by the crew and Constellation Systems, within the ranges described in the CxP70024, Human System Integration Requirements.		X								X		X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0122	The User Application Subsystem shall provide user interfaces for monitoring of electrical flight systems and components		X	X				X	X	X		X	X
UA.0123	The User Application Subsystem shall provide user interfaces for control of electrical flight systems and components		X	X							X	X	X
UA.0124	The User Application Subsystem shall provide user interfaces for monitoring of guidance, navigation and control flight systems and components		X	X				X	X	X		X	X
UA.0125	The User Application Subsystem shall provide user interfaces for control of guidance, navigation and control flight systems and components		X	X							X	X	X
UA.0126	The User Application Subsystem shall provide user interfaces for monitoring of propulsion flight systems and components		X	X				X	X	X		X	X
UA.0127	The User Application Subsystem shall provide user interfaces for control of propulsion flight systems and components		X	X							X	X	X
UA.0128	The User Application Subsystem shall provide user interfaces for monitoring of EVA flight systems and components.		X	X				X	X	X		X	X
UA.0129	The User Application Subsystem shall provide user interfaces for control of EVA flight systems and components		X	X							X	X	X
UA.0130	The User Application Subsystem shall provide user interfaces for monitoring of robotics flight systems and components.		X	X				X	X	X		X	X
UA.0131	The User Application Subsystem shall provide user interfaces for control of robotics flight systems and components		X	X							X	X	X
UA.0132	The User Application Subsystem shall provide user interfaces to monitor and control the following MCCS functions	X	X		X				X		X		X
UA.0133	The User Application Subsystem shall perform and provide the Surgeon/BME Flight Control Team (FCT) the ability to monitor biomed Electrocardiogram (ECG) telemetry from EVA and/or IVA crewmembers.									X		X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0134	The User Application Subsystem shall perform (TBD) computations of crew health care systems hardware telemetry related to the Crew Health and Environmental System		X					X	X	X		X	X
UA.0135	The User Application Subsystem shall provide capability to determine the spacecraft's orientation on-orbit and to provide pointing data for desired targets within system and mission constraints	X	X	X				X	X			X	X
UA.0136	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy instrument pointing constraints	X	X	X				X	X			X	X
UA.0137	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy target acquisition constraints	X	X	X				X	X			X	X
UA.0138	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy communications constraints	X	X	X				X	X			X	X
UA.0139	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy thermal constraints	X	X	X				X	X	X		X	X
UA.0140	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy line-of-sight constraints.	X	X	X				X	X			X	X
UA.0141	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy lighting constraints	X	X	X				X	X			X	X
UA.0142	The User Application Subsystem shall provide the capability to determine the spacecraft orientation on-orbit to satisfy physical blockage constraints	X	X	X				X	X			X	X
UA.0143	The User Application Subsystem shall provide the capability to generate attitude control system I-Loads.	X	X	X				X	X			X	X
UA.0144	The User Application Subsystem shall provide the capability to generate attitude data for onboard displays	X	X					X	X			X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0145	The User Application Subsystem shall provide the capability to generate (the equivalent of) thermal protection plots, Reference to Stable Member Matrices (RefSMMAT's), Relative Matrices (RelMAT's), and quaternions	X	X									X	X
UA.0146	The User Application Subsystem shall provide the capability to generate attitude timelines including	X	X	X				X	X			X	X
UA.0147	The User Application Subsystem shall support the MCCS maximum downtime for a single CxP real-time activity of 0.016 hours or less over a continuous 79-hour time period for at least 90% of disruptions that occur over the specified continuous 79-hour time period		X		X								
UA.0148	The User Application Subsystem shall receive recorded voice data from the MCCS Archive System.		X						X				X
UA.0149	The User Application Subsystem shall receive recorded video data from the MCCS Archive System.		X						X				X
UA.0150	The User Application Subsystem shall receive recorded files from the MCCS Archive System.		X						X				X
UA.0151	The User Application Subsystem shall send computed data to the MCCS Archive System for archival.		X					X	X			X	X
UA.0152	The User Application Subsystem shall receive command data from the Command System.		X				X		X		X		X
UA.0153	The User Application Subsystem shall receive file transfer and file management status from the File Transfer Subsystem.		X		X								
UA.0154	The User Application Subsystem shall send command directives to the Command System.		X				X		X		X		X
UA.0155	The User Application Subsystem shall send file transfer requests to the File Transfer Subsystem.		X		X								
UA.0156	The User Application Subsystem shall send file management requests to the File Transfer Subsystem.		X		X								

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0157	The User Application Subsystem shall receive telemetry, computation, and MCCS systems data from the Communication System.		X					X	X			X	X
UA.0158	The User Application Subsystem shall receive voice packet data from the Communication System.		X						X				X
UA.0159	The User Application Subsystem shall receive video packet data from the Communication System.		X						X				X
UA.0160	The User Application Subsystem shall request telemetry, computation, and MCCS systems data from the Communication System.		X					X	X			X	X
UA.0161	The User Application Subsystem shall provide computation and status data to the Communication System.		X					X	X			X	X
UA.0162	The User Application Subsystem shall receive data products from the Configuration Management System.		X		X								
UA.0163	The User Application Subsystem shall send data products to the Configuration Management System.		X		X								
UA.0164	The User Application Subsystem shall request MCCS hardware/software configuration data from the MCCS Platform Services System.		X		X								
UA.0165	The User Application Subsystem shall receive timing data from the MCCS Timing System.		X					X	X			X	X
UA.0166	The User Application Subsystem shall request timing data from the MCCS Timing System.		X					X	X			X	X
UA.0167	The User Application Subsystem shall receive video streams from the MCCS Video System.		X						X				X
UA.0168	The User Application Subsystem shall send reconstructed vehicle video files to the MCCS Video System.		X						X				X
UA.0169	User Application Subsystems shall provide the capability to view the relationship between data parameters based on the information model or ontology		X					X	X			X	X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0170	User Application Subsystems shall provide the status associated with each data parameter with the data value.		X						X				X
UA.0171	User Applications shall provide the capability to view, listen to, and save voice and video streams and files.		X						X				X
UA.0172	User Application Subsystems shall issue user notifications to users based on the limit criteria defined in the telemetry definition products.		X	X					X				X
UA.0173	The User Application Subsystems shall provide the capability to view the attributes of any command, as described in the Command Subsystem requirements. (*JSC 63796* MCCS Level A Requirements , Section 3.2).		X								X		X
UA.0174	The User Application Subsystems shall provide the capability to view the attributes of uplinked commands.(*JSC 63796* MCCS Level A Requirements[EJT10] , Section 3.2).		X								X		X
UA.0175	The User Application Subsystems shall protect against the inadvertent initiation of mission and safety critical commands by providing a two-step process (two independent ground personnel actions[EJT11]).		X								X		X
UA.0176	User Application Subsystems shall provide the capability to save the current configuration and data settings to the configuration managed storage area if the user is authorized				X								
UA.0177	The User Application Subsystem shall provide the capability to build new telemetry format definition files for use by CxP vehicles.		X								X		X
UA.0178	The User Application Subsystem shall provide the capability to select the desired onboard[EJT12] telemetry format configuration.		X								X		X
UA.0179	Deleted												
UA.0180	The User Application Subsystems shall provide the capability to perform file transfers as described in the Command Subsystem File Transfer requirements.		X								X		X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0181	The User Application Subsystems shall provide the capability to perform the file management functions as described in the Command Subsystem File Transfer requirements.		X								X		X
UA.0182	The User Application Subsystem shall provide the capability to manage communications sessions scheduling.		X									X	X
UA.0183	Deleted												
UA.0184	The User Application Subsystem shall provide a tool to track and distribute the status of C&W events for all CxP vehicles.		X							X		X	X
UA.0185	User Application Subsystems shall allow users to switch between authorized roles within the same logon session				X								
UA.0186	The User Application Subsystem shall provide user interfaces for monitoring of mechanical flight systems and components		X						X	X		X	X
UA.0187	The User Application Subsystem shall provide user interfaces for control of mechanical flight systems and components.		X	X							X	X	X
UA.0188	The User Application Subsystem shall perform (TBD) computations related to the vehicle Electrical Systems (i.e. Solar Arrays and batteries).		X	X				X	X			X	X
UA.0189	The User Application Subsystem shall perform (TBD) computations related to the vehicle Mechanical Systems (i.e. LIDS)		X	X				X	X			X	X
UA.0190	The User Application Subsystem shall perform (TBD) computations related to the vehicle Booster Systems. (CxP) (Orion-to-ISS and subsequent)		X	X				X	X			X	X
UA.0191	The User Application Subsystem shall perform (TBD) computations related to the vehicle Environmental Systems.		X	X				X	X			X	X
UA.0192	The User Application Subsystem shall perform (TBD) computations related to the vehicle Guidance, Navigation and Control Systems		X	X				X	X			X	X
UA.0193	The User Application Subsystem shall perform (TBD) computations related to the vehicle Propulsion Systems		X	X				X	X			X	X
UA.0194	The User Application Subsystem shall receive configuration, health and status data from the MCCS systems Communication Subsystem Element		X		X								

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
	Manager.												
UA.0195	The User Application Subsystem shall request configuration, health and status data from the MCCS systems Communication Subsystem Element Manager.		X		X								
UA.0196	The User Application Subsystem shall send control directives to the MCCS systems Communication Subsystem element manager.		X		X								
UA.0197	The User Application Subsystem shall receive configuration, health, status and user performance data from the Space Network Asset Scheduling System (SNASS).		X		X								
UA.0198	The User Application Subsystem shall send control directives, date or data files to the Space Network Asset Scheduling System (SNASS) for scheduling and real time Ground Configuration Message Requests.		X		X								
UA.0198	The User Application Subsystem shall send control directives, date or data files to the Space Network Asset Scheduling System (SNASS) for scheduling and real time Ground Configuration Message Requests.		X		X								
UA.0199	User Application Subsystems shall process data per role-based permissions and MCC policies.		X		X								

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0200	User Application Subsystems shall have the capability to save data per role-based permissions and MCC policies.		X		X				X				X
UA.0201	User Application Subsystems shall have the capability to delete data per role-based permissions and MCC policies.		X		X				X				X
UA.0202	The User Application Subsystem shall comply with the data management standards[EJT13] in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan.		X										
UA.0203	The User Application Subsystem shall comply with the error handling standards[EJT14] in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan.		X										
UA.0204	The User Application Subsystem shall comply with the web standards[EJT15] in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0205	The User Application Subsystem shall provide the capability to capture and maintain traceability of the various ops-related constraints such as planning ground rules & constraints, flight rules, workstation limits, etc		X	X									
UA.0206	The User Application Subsystem shall request recorded voice files from the MCCS Archive System.		X						X				X
UA.0207	The User Application Subsystem shall request recorded video files from the MCCS Archive System.		X						X				X
UA.0208	The User Application Subsystem shall request voice packet data from the Communication System.		X						X				X
UA.0209	The User Application Subsystem shall request video packet data from the Communication System.		X						X				X
UA.0210	The User Applications subsystem shall provide the Space Radiation and Analysis Group (SRAG) the capability to monitor space weather events		X						X				X

	Requirement	Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0211	The User Application subsystem shall provide the SRAG the capability to receive space weather prediction information.		X	X				X	X			X	X
UA.0212	The User Application Subsystem shall provide a tool to monitor GPS velocity to Ground RADAR comparison data		X									X	X
UA.0213	The User Application Subsystem shall perform (TBD) computations related to the vehicle Propulsion Systems		X									X	X
UA.0214	The User Application Subsystem shall perform (TBD) computations related to the vehicle Propulsion Systems		X									X	X
UA.0215	The User Applications Subsystem shall receive telemetry data from the Data Acquisition System.		X					X	X			X	X
UA.0216	The User Applications Subsystem shall accept inputs from the Command Subsystem		X				X		X		X		X
UA.0217	The User Applications Subsystem shall accept inputs (as Required (TBD)) from the Command Subsystem		X				X		X		X		X
UA.0218	The User Application Subsystem shall provide a tool that allows a user to view the vehicle hardware component locations and layouts in 3-D space		X										X
UA.0219	The User Applications Subsystem shall provide users the ability to access a mathematical computation environment (i.e. MATLAB)		X					X				X	
UA.0220	The User Application Subsystem shall provide tools that allow users to manage the Flight Production Process (FPP). The purpose of these tools is to provide a method to streamline the FPP along with the ability to assist MOD personnel in mission re-planning activities.		X		X								
UA.0221	The User Application Subsystem shall monitor and receive statuses required for the FPP from other MCCS subsystems		X		X								
UA.0222	The User Application Subsystem shall output statuses required from the FPP to the other MCCS subsystems		X		X								
UA.0223	The User Application Subsystem shall provide the capability to generate training and flight support products for attitude and pointing	X	X		X								

		Generic User Applications				ISS User Applications				Cx User Applications			
MCCS User Applications Requirement		Attitude & Pointing	Generic Computation & Display	Constraint Monitoring	Process Execution Monitoring	ISS Caution & Warning	ISS Command User Interface	ISS Computation	ISS Display Data	Cx Caution & Warning	Cx Command User Interface	Cx Computation	Cx Display Data
UA.0224	The User Application Subsystem shall provide the capability to design, plan, and analyze and perform parametric line-of-sight parametric analysis.	X		X								X	X
UA.0225	The User Application Subsystem shall provide user interfaces for viewing and editing ops-related constraints captured by the tool (TBD) described by requirement.	X		X				X	X			X	X
UA.0226	The User Application Subsystem shall comply with the performance standards[EJT16] in Appendix F of the JSC-63756 Mission Operations Directorate Software Management Plan		X										
UA.0227	The User Application Subsystem shall receive Vehicle ID –VID, Format ID – PID data, Metadata, PID from the Reconfiguration subsystem.		X								X		X
UA.0228	The User Application Subsystem shall receive Orion vehicle communications system real time and time tag commands from the command subsystem and telemetry		X								X		X
UA.0229	The User Application Subsystem shall send control directives to the communications subsystem to configure or reconfigure the telemetry processor.		X								X		X
UA.0230	The User Application Subsystem shall send control directives to the TDRS real time manager (TRM) to configure or reconfigure and send ground configuration message requests.		X								X		X
UA.0231	Orion Telemetry Control (OTC) User Application shall detect planned and real time changes to the Orion Mission Operations Link (MOL) link rates, data rates, Telemetry format PID and initiate control directives to reconfigure the communications subsystem processor and/or space network link configuration such that the space communication configuration and communications subsystem processor configuration are synchronized with the Orion vehicle configuration.		X								X		X
UA.0232	Orion Telemetry Control (OTC) User Application shall detect, flag and report disconnects between the ground and vehicle return link and telemetry configurations.		x								x		X