# CCSDS Reference Architecture: MOIMS Area Inputs

The CCSDS System Architecture Working Group (SAWG) is currently developing a reference architecture that addresses all aspects of CCSDS standardisation. This builds upon the previous CCSDS Communications System Architecture, which showed how the communication layers of the SLS, SIS and CSS area standards related to each other, but did not address the application layer standardisation activities of the MOIMS and SOIS areas.

The CCSDS Reference Architecture will be a model that comprises 5 views:

* Functional: identifying standard functions of a space mission system, and the interactions between them in terms of service interfaces and/or information exchanged at application level.
* Service: characterisation of potential application level services in terms of the operations performed and information exchanged.
* Data: information model of the top level data objects exchanged between functions and the relationships between them.
* Protocol: communications protocol stack view, showing how application level services can be overlaid on CCSDS communication layers.
* Deployment: example deployment architectures identifying where key interfaces between functions are exposed to interoperability boundaries.

The work is scheduled in two phases: first to produce a set of diagrams and tables giving a “cartoon” overview of the model using [extended] CCSDS RASDS notation; second to produce a green or magenta book that presents the agreed model.

This document contains the draft Service viewpoints covering the MOIMS area of standardisation.

# Service Viewpoint

The Service viewpoint is presented as a table that lists potential services together with the operations they provide, and the data objects exchanged or referenced by the service. Services may be grouped together within a single standard. The Functions column references functions identified in the functional viewpoint, either as a provider of the service [**in bold**] or as a consumer. The Data column references information objects identified in the data viewpoint. The Standards column identifies the CCSDS standards that identify or specify the service or associated key data formats. Other columns are colour coded:

* Column A: correlates to the functional areas identified within the Functional view:

◼ Common Services

◼ Mission Control

◼ Planning & Scheduling

◼ Navigation & Timing

◼ Data Storage & Archiving

◼ Operations Preparation

◼ Mission Data Products

* Column S and D: show the current status of CCSDS specification with respect to standard CCSDS book colours for both the Service (S) and Data format (D). White indicates no specification has yet been produced; pastel green indicates a green book in production.

## COM and Common Services

| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MO COM** | ***Archiving*** | ***Providers:***Ops. Archive***Consumers:***<any function> | StoreUpdateQuery | <any COM obj> | Generic archive service for MO services defined in terms of the Common Object Model [COM]. | MO Common Object Model[CCSDS 521.1-B-1] |  |  |
|  |  | ***Activity Tracking*** | ***Providers:***<any function>***Consumers:***<any function> | Publish/Subscribe | <any Activity> | Activities are COM objects that have a limited duration. The service provides a mechanism to report progress/status and uses the COM Event service. |  |  |  |
|  |  | ***Event*** | ***Providers:***<any function>***Consumers:***<any function> | Publish/Subscribe | <any Event> | Events are COM objects that represent an occurrence at a point in time. Each service can define the Events it supports. |  |  |  |
|  | **MO Common** | **Directory** | ***Providers:***Service Directory***Consumers:***<any function> | Publish ProviderWithdraw ProviderLookup ProviderGet Service XML | Service Descriptor | Allows Providers to publish information about the services they provide; and Consumers to query the Service Directory and retrieve Service XML descriptors. | MO Common Services[CCSDS 522.0-R-n] |  |  |
|  |  | **Login** | ***Providers:***Login and Authentication***Consumers:***<any function> | LoginLogoutReport Available RolesHandover to other User | Authentication Credentials | Common login service for submission of authentication details to a deployment specific security system. Integrated with Access Control aspect of MO MAL. |  |  |  |
|  |  | **Configuration** | ***Providers:***Configuration Management & Distribution***Consumers:***<any function> | ActivateListGet Current Get XMLAddRemoveStore CurrentStore XML | ConfigurationsXML Configurations<any Config Data> | Configurations can be hard-coded, use bespoke configuration data, or a standard COM service configuration.Service consumers can activate predefined configurations of a service provder; and list, get, add, remove and store current configurations.It also defines a standardised XML representation for configurations. |  |  |  |

## M&C Services

| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MO M&C** | **Action** | ***Providers:***Monitoring & Control***Consumers:***AutomationOn-board Configuration ManagementNavigation InterfacePlanningPlan ExecutionOperations PreparationOperations ArchiveUser SupportMission Data ProcessingSpacecraft Development & Maintenance | Submit ActionpreCheck ActionManage Action Definitions | Action | Allows control directives (e.g. a spacecraft telecommand) to be invoked and their evolving status to be monitored.Uses COM Services for Action Tracking and Archiving. | MO Monitoring & Control Services[CCSDS 522.1-R-n] |  |  |
|  |  | **Parameter** | Monitor ValueGet ValueSet ValueEnable GenerationManage Parameter Definitions | Parameter | Provides the capability to monitor and set parameter values.Uses COM Archiving service for Parameter Archiving. |  |  |  |
|  |  | **Alert** | Enable GenerationManage Alert Definitions | Alert | Provides a mechanism for asynchronous notification of operationally significant events or anomalies.Uses COM Event and Archiving services to publish/subscribe to Alerts and to archive them.  |  |  |  |
|  |  | **Check** |  | Get Current Transition ListGet Summary ReportEnable ServiceGet Service StatusEnable CheckTrigger CheckManage Check Definitions | ParameterCheckCheck LinkCheck Transition Event | Provides on-line checking of Parameter values against defined checks [Limit, Constant, Delta] and notification of check violations.Uses COM Event service to publish/subscribe to check status transition events. |  |  |  |
|  |  | **Statistics** |  | Get StatisticsReset EvaluationMonitor StatisticsEnable ServiceGet Service StatusEnable GenerationAdd Parameter EvaluationUpdate Parameter EvaluationRemove Parameter Evaluation | ParameterStatistic LinkStatistic Value | Provides on-line statistical evaluation of Parameter values.Uses COM Archive service. |  |  |  |
|  |  | **Aggregation** |  | Monitor ValueGet ValueEnable GenerationEnable FilterManage Aggregate Definitions | Aggregation of Parameters | Provides aggregation of separate Parameter values into coherent sets.Uses COM Archive service. |  |  |  |
|  |  | **Conversion** |  | none | ParameterConversion | Provides conversion of raw Parameter values into engineering units.Uses COM Archive service |  |  |  |
|  |  | **Group** |  | none | Group of <any COM object>s | Provides the ability to define groupings of objects to simplify the operations of other services.Uses COM Archive service |  |  |  |
|  | **MO AUT** | **Automation** | ***Providers:***Automation***Consumers:***Monitoring and ControlNavigation InterfacePlan ExecutionOperations Archive | Start ProcedureStop ProcedureSuspend/Resume ProcedureManual ControlManage Procedure Definitions [TBD] | Procedure | Provides support for automation of mission operations. The service allows automated procedures or autonomous functions to be invoked, controlled, and their evolving status to be monitored.Uses COM Services for Procedure Tracking and Archiving. | MO Services Concept[CCSDS 520.0-G-3]*Automation Service* |  |  |
|  | **MO OSM** | **Software Management** | ***Providers:***On-board Configuration Management***Consumers:***AutomationPlan Execution | Load Software ImageDump Software ImageCheck Software Image | On-board Software Image | Supports the management of software loaded into the remote system [spacecraft]. | MO Services Concept[CCSDS 520.0-G-3]*Software Management Service* |  |  |
|  |  | **Procedure Management** | ***Providers:***On-board Configuration Management***Consumers:***AutomationPlan Execution | Load Procedure DefinitionDump Procedure DefinitionCheck Procedure DefinitionManage Procedure Definitions [TBD] | On-board Procedure Definition | Supports the management of automated procedure definitions loaded into the remote system [spacecraft]. | *Proposed extension to scope of MO OSM service.* |  |  |

## Other MO Services

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
|  | **MO MDP** | **Data Product Distribution** | ***Providers:***Operations ArchiveOn-board File Store***Consumers:***Mission Data ProcessingUser SupportSpacecraft Development & Maintenance | Subscribe OnlineSubscribe BatchRetrieve[TBD] | Mission Data Product | Mission Data Product Distribution Service is used for the distribution of historical archived data and on-line 'live' dataIt provides two delivery modes, batch mode and stream mode. | MO Services Concept[CCSDS 520.0-G-3]*Data Product Management Service* |  |  |
|  | **MO FTM** | **File Transfer & Management** | ***Providers:***On-board File Store***Consumers:***Mission ControlPlanning & SchedulingNavigation and Timing | List, Rename, Move, Copy and Delete Files and DirectoriesAdd DirectoryGet Drive InformationUpload FileDownload File | DirectoryFileDrive | Supports the management of a remote [on-board] file store and the initiation of transfers of files between local and remote file stores. | MO Services Concept[CCSDS 520.0-G-3]*Remote Buffer Management Service* |  |  |

## Mission Planning and Scheduling Services

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
|  | **MO MPS** | **Planning Request [PRS]** | ***Providers:***PlanningPlan Execution***Consumers:***User SupportOperations PreparationNavigation & TimingPlanning [Distributed] | Submit RequestUpdate or cancel RequestsProvide Request Status feedbackManage Request Definitions | Planning RequestPlanPlanning ActivityPlanning EventPlanning ResourcePlanning Constraint | Asynchronous submission of planning requests, associated responses and their subsequent management and status feedback.A planning request may reference a Plan (output from an earlier planning process), in which case the provided feedback includes the status of the plan in terms of its contained activities and other items. | MO Services Concept[CCSDS 520.0-G-3]*Planning Request*Mission Planning and Scheduling Concept[Draft Green Book] |  |  |
|  |  | **Plan Distribution & Retrieval [PLS]** | ***Providers:***PlanningPlan Execution***Consumers:***User SupportNavigation & TimingMission Data ProcessingPlanning [Distributed] | Retrieve Plan or Plan StatusSubscribe to Plan or Plan Status | PlanPlanning ActivityPlanning EventPlanning ResourcePlanning Constraint | Provides distribution and access to plans generated by the planning function. | MO Services Concept[CCSDS 520.0-G-3]*Scheduling [Part]* Mission Planning and Scheduling Concept[Draft Green Book] |  |  |
|  |  | **Planning Process Management [PMS]** | ***Providers:***Planning***Consumers:***Plan ExecutionMission ControlNavigation & TimingUser SupportMission Data ProcessingPlanning [Distributed] | Initiate, Monitor and Control Planning ProcessesUpdate Plan StatusManage Planning Definitions | PlanPlanning ActivityPlanning EventPlanning ResourcePlanning Constraint | Management of the planning process itself - initiation, status feedback and control.Also supports provision of plan status updates by a third party. | MO Services Concept[CCSDS 520.0-G-3]*Scheduling [Part]* Mission Planning and Scheduling Concept[Draft Green Book] |  |  |
|  |  | **Plan Execution Management [PES]** | ***Providers:***Plan Execution***Consumers:***PlanningMission Control | Initiate, Monitor and Control Plan executionEdit Plan contentUpdate Planning Events and Resources.Manage Planning Definitions | PlanPlanning ActivityPlanning EventPlanning ResourcePlanning Constraint | Control and management of the execution of a plan, including actions to Start/Stop and Pause/Resume execution.Update [editing] of the executing plan at activity level. Update planning events/resources. | MO Services Concept[CCSDS 520.0-G-3]*Scheduling [Part]*Mission Planning and Scheduling Concept[Draft Green Book] |  |  |

## Navigation and Timing Services

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
|  | **TIM** | **Time** | ***Providers:***Time/Position Determination***Consumers:***Time Correlation | Report TimeSet TimeConfigure rate of Time Report generation. | Time Report | Provides accurate reporting of on-board time. For an unsynchronised on-board clock this may require correlation with the system reference time | MO Services Concept[CCSDS 520.0-G-3]*Time* |  |  |
|  |  | **Time Correlation** | ***Providers:***Time Correlation***Consumers:***Mission ControlMission Data Processing | Correlate Time | Time Correlation | Supports Time correlation between on-board clocks and the system reference time. | MO Services Concept[CCSDS 520.0-G-3]*Time* |  |  |
|  |  | **Time Reception** | ***Providers:***TT&C***Consumers:***Time Correlation | Report Reception Time | Reception Time | Provides accurate ground reception time reporting that can be associated with a Time Report.This is currently supported by the CSS Space Link Extension Transfer Services, where Earth Receive Time is provided as an annotation parameter to the transfer data. An alternative service may be required where SLE is not used. | Space Link Extension – Return All Frames Service Specification[CCSDS 911.1-B-4]*And related CSS SLE Transfer Services* |  |  |
|  | **NAV** | **Navigation Services** | ***Providers:***Navigation Functions***Consumers:***Mission ControlMission Planning & SchedulingMission Data ProcessingData Storage & Archiving User SupportTT&CSatellite Dev. & Maintenance | Request Navigation MessageRetrieve Navigation MessageSubscribe to Navigation Message | Orbit VectorAttitudeTracking DataPredicted Orbital EventsSpacecraft ManoeuvreConjunctionPointing Request | Supports the provision of spacecraft positioning information such as:* Position reports (e.g., from on-board GPS)
* Spacecraft ranging and range-rate measurements
* Antenna tracking azimuth and elevation
* Orbit vectors
* Attitude vectors
* Trajectory requests
* Predicted orbital events (including ground station visibilities)

The services will use the following data message formats defined by the CCSDS Navigation working group, but wrap these as service specifications based on the MO framework. | MO Services Concept[CCSDS 520.0-G-3]*Navigation* |  |  |
|  |  | **Orbit Data Message [ODM]** | ***Providers:***Orbit Determination and Propagation***Consumers:***Manoeuvre PlanningAttitude DeterminationConjunction AssessmentMission ControlMission Planning & SchedulingMission Data ProcessingTT&CUser Support | - | Orbit Vector | The ODM contains information that defines the orbit state of a spacecraft at one or more times. | Orbit Data Messages[CCSDS 502.0-B-2] |  |  |
|  |  | **Attitude Data Message [ADM]** | ***Providers:***Attitude Determination***Consumers:***Orbit Determination and PropagationManoeuvre PlanningMission ControlMission Data ProcessingUser Support | - | Attitude | The ADM contains information that defines the attitude state of a spacecraft at one or more times. | Attitude Data Messages[CCSDS 504.0-B-1] |  |  |
|  |  | **Tracking Data Message [TDM]** | ***Providers:***Time/Position DeterminationTT&CMission Data Processing***Consumers:***Orbit Determination and Propagation | - | Tracking Data | The TDM contains information that can be used to determine the orbit state of a spacecraft. | Tracking Data Messages[CCSDS 503.0-B-1] |  |  |
|  |  | **Event Message [EVM]** | ***Providers:***Orbit Determination and Propagation***Consumers:***Attitude DeterminationManoeuvre PlanningMission Planning & SchedulingMission Control | - | Predicted Orbital Events | The EVM contains the predicted timings of orbital events, such as ground station visibilities, sensor blindings, eclipses, etc. | *Proposed new Navigation message.* |  |  |
|  |  | **Spacecraft Manoeuvre Message [SMM]** | ***Providers:***Manoeuvre Planning***Consumers:***Orbit Determination and PropagationAttitude DeterminationConjunction AssessmentMission Planning & SchedulingMission ControlMission Data Processing | - | Spacecraft Manoeuvre | The SMM contains information on the transformation from one state (attitude or orbit) to another. | Navigation Data Messages Overview[CCSDS 500.2-G-1]*SMM* |  |  |
|  |  | **Conjunction Data Message [CDM]** | ***Providers:***Conjunction Assessment***Consumers:***Manoeuvre PlanningMission Planning & Scheduling | - | Conjunction | The CDM contains information that defines the relationship between the orbit states of different space objects at different times. | Conjunction Data Messages[CCSDS 508.0-B-1] |  |  |
|  |  | **Navigation Hardware Message [NHM]** | ***Providers:***Mission Control***Consumers:***Manoeuvre PlanningOrbit Determination and PropagationAttitude Determination | - | Navigation Hardware Data | The NHM contains information that can be used to determine both the spacecraft attitude and orbit state. It also contains information that can be used for spacecraft manoeuvre reconstruction. | Navigation Data Messages Overview[CCSDS 500.2-G-1]*NHM* |  |  |
|  |  | **Pointing Request Message [PRM]** | ***Providers:***User SupportMission Data Processing***Consumers:***Attitude DeterminationManoeuvre PlanningMission Control | - | Pointing Request | The PRM contains information on the pointing of a spacecraft or instrument desired by a mission user at one or more times. | Pointing Request Message[CCSDS 509.0-R-1] |  |  |

## Operations Preparation Services

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
|  | **OPD** | **Satellite DB [SDB]** | ***Providers:***Satellite DB DefinitionSpacecraft Development & Maintenance***Consumers:***Mission ControlSpacecraft Development & Maintenance | - | Satellite DB | Contains definition of Telemetry Data, Telecommands and Events present in the TM/TC interface with the spacecraft and represented within the Mission Control System.XTCE provides an exchange format for TM/TC data between systems. | XML Telemetric and Command Exchange (XTCE)[CCSDS 660.0-B-1] |  |  |
|  |  | **Automated Procedure Definition [APD]** | ***Providers:***Automated Procedure DefinitionSpacecraft Development & Maintenance***Consumers:***Mission ControlSpacecraft Development & Maintenance | - | Automated Procedure | Definition of an operational procedure that can be automatically executed within a space system (either on-board a spacecraft, or within the mission control system). | No CCSDS standard.ECSS PLUTO [ECSS E-70-32] defines a standard model for a procedure, but not a normative representation. |  |  |
|  |  | **Planning Data Definitions [PDB]** | ***Providers:***Planning DB Definition***Consumers:***Mission Planning & Scheduling | - | Planning Data Definitions | Definitions of Planning Data (Activities, Events, Resources and Constraints) and potentially of Planning Rules. | No CCSDS standardMission Planning and Scheduling Concept[Draft Green Book] introduces Planning Data Model. |  |  |
|  |  | **On-board Software [OSW]** | ***Providers:***On-board Software DefinitionSpacecraft Development & Maintenance***Consumers:***Mission ControlSpacecraft Development & Maintenance | - | On-board Software | On-board Software Image | No CCSDS standard |  |  |

## Data Archiving Services

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | Group | Service | Functions | Operations | Data | Description | Standards | S | D |
|  | **DAI** | **Producer Archive Interface [PAIS]** | ***Providers:***Data Archive Ingestion***Consumers:***Mission Data Processing | TBD | Submission Information Package (SIP)SIP Sequencing ConstraintTransfer ObjectCollection Descriptor | The current PAIS standard provides the abstract syntax and an XML implementation of descriptions of data to be sent to an archive. It addresses how these data will be aggregated into packages for transmission and one concrete implementation for the packages based on the XML Formatted Data Unit (XFDU) standard.A service specification is proposed but has not yet been developed. | Reference Model for an Open Archival Information System (OAIS)[CCSDS 650.0-M-2]Producer-Archive Interface Specification (PAIS)[CCSDS 651.1-B-1]XML Formatted Data Unit (XFDU) Structure and Construction Rules[CCSDS 661.0-B-1] |  |  |
|  |  | **Consumer Archive Interface [CAIS]** | ***Providers:***Data Archive Access***Consumers:***User Support | TBD | Dissemination Information Package (DIP) | Delivery of digital sources from the Archive. | Reference Model for an Open Archival Information System (OAIS)[CCSDS 650.0-M-2] |  |  |
|  |  | **Archive Storage and Retrieval** | ***Providers:***Data Archive Storage***Consumers:***Data Archive IngestionData Archive Access | TBD | Archival Information Package (AIP) | Storage and Retrieval of standard Archival Information Packages (AIP). Abstract specification of an AIP may be expressed using PVL, EAST or DEDSL languages.  | Reference Model for an Open Archival Information System (OAIS)[CCSDS 650.0-M-2]Parameter Value Language (PVL) Specification[CCSDS 641.0-B-2]The Data Description Language EAST Specification[CCSDS 644.0-B-3]Data Entity Dictionary Specification Language (DEDSL) [CCSDS 647.1-B-1] Abstract[CCSDS 647.2-B-1] PVL[CCSDS 647.3-B-1] XML/DTD |  |  |