# APPLICATION AND SUPPORT LAYER ARCHITECTURE – Green Book Outline

RST Contribute (General)

RST Contribute (MOIMS Perspective)

RST Provide (Based on material already prepared/under development)

# INTRODUCTION

## Purpose

*<< Describe the application and support layer services from MOIMS and SOIS and how they use underlying communications services and data exchange standards >>*

## Scope

*<< Application level services, support services, and data formats (syntax & semantics), on ground and in flight>>*

*<< Scope is explicitly just MOIMS & SOIS, this is a companion to the SCCS-ADDand must be read in that context >>*

*<< MOIMS services and data exchange standards and SOIS services and data exchange standards >>*

## Rationale

*<< To provide an understanding of how all of the CCSDS services and data exchange standards work together >>*

## Document Structure

## Definitions

*<< Reference these from MOIMS & SOIS docs and also from SCCS-ADD and RASDS, as needed. Identify the source. >>*

## References

*<< Lists references from MOIMS & SOIS docs and also from SCCS-ADD and RASDS. >>*

# Application and Support Layer Architecture Concepts

## Background

*<< Motivated by existing SCCS-ADD and desire of CMC to have a more complete “CCSDS Reference Architecture”. >>*

## Role of This Architecture Description Document

*<< Provide an understanding of the application and support layer services and other supporting standards from MOIMS and SOIS and how they use underlying communications services and data exchange standards >>*

## General Description of Content

*<< A gentle intro to the content: Application and support layer functions in flight and on ground. The information they exchange- that semantics and information content are important, not purely data formats; and that data items exposed at application level interfaces may reference other data items at the same level. How they are assembled to define services –which includes specification of the interaction between communicating entities . What the communications protocol stacks look like: may be a data format for file exchange, or an interactive service based on message exchange Underlying communications protocol stack may either be as already defined in the SCCS-ADD for space links, or make use of alternative terrestrial technologies depending on the deployment context.*

*This document seeks to model the mission operations aspects of a space system as a set of reference function; identify where the interactions between those functions may be at an interoperable boundary between agencies, organisations or systems; map these to existing or planned CCSDS standards; and identify any key gaps in coverage.>>*

## Application Support Layer Domains

*<< Introduce the scope of the document in terms of the primary domains : Mission Operations (MOIMS and SOIS The flight and ground domains are connected and secured using underlying data transport and other services provided by the other CCSDS areas: SLS, SIS, CSS, and SEA. >>)>>*

### Mission Operations and Information Management

*<< MOIMS defines MO services, common services, and an abstract message framework that may be deployed in a variety of ways. It also defines navigation data exchanges and data archive processes (and some services). These are primarily intended for terrestrial use, but some of them may appear in flight. List the top level functional areas includes>>*

*New text to be produced – will draw on existing MO material (note MO GB update pending). Should cover other MOIMS areas, including NAV, DAI and MPS.*

### Spacecraft Onboard Interfaces

*<<SOIS defines a dictionary of terms, the means for describing components and service interfaces using Electronic Data Sheets, spacecraft on-board services, subnetwork services, and on-board wireless.>>*

## Relationship Between ASL and other CCSDS Architecture Documents

*<< ASL uses underlying communications services and data exchange standard. This data transport architecture and security services are documented in the SCCS-ADD & ARD, and in the 80 other standards that they describe.>>*

## ASL Architecture: Assumptions, Goals, and Challenges

*<< Biggest assumption is that these ASL services live on top of underlying CCSDS standard data transfer services (and terrestrial ones as needed). Other assumption, and challenge, is that the MOIMS service framework may be deployed in space as well as on the ground. >>*

*In this context explain how an MO compliant service may be implemented in different ways, ranging from an implementation that follows the MO layering concept – implementing a service framework – to compliance at a concrete interface level only.*

*<<NIH, reinvention, tailoring; DoT could be widely applied and extended for other uses; acknowledging existing SW frameworks and the need to work with them>>*

# Application and Support Layer Reference Architecture

## Introduction

*<< Overview of the how the Reference Architecture is presented in the document, including use of an extended version of the RASDS representation – introduce structure of the remainder of the document>>*

*New text to be written.*

## Six Views of System Architecture

*<< Functions, Information, Services, Communications (protocols), Physical (nodes & types), and End-to-End (deployment)>>*

*New text to be written – explain scope of each view and what it shows.*

*Functional: functions and the interfaces between them in terms of information exchanged and services. Introduce alternative presentations: function centric and data/service centric.*

*Information: principal information objects exchanged across interfaces between functions and relationships between them – inheritance, composition, aggregation and other associations.*

*Service: interactions between functions, either as simple off-line transfer of data (information objects) or more complex on-line interactions between service provider and consumer. Identifies functions interfaced (functional model), information exchanged (information model) and the high-level capabilities [operations] of any associated service.*

*Protocol: shows how the application level services are supported by underlying communications protocol stacks depending on the deployment context. Introduce principal deployment contexts [ABA/SSI and Space, Space-Ground, Ground]. Relates to SCCS ADD. Note that multiple protocol deployments may be possible for the same service interaction.*

*Physical: identifies potential deployment nodes and the types of communication interface supported between them. Ties up with deployment contexts for Protocol viewpoint, and example deployment use cases for Deployment viewpoint. Extends set of deployment nodes identified in SCCS ADD to cater for representative ground segment scenarios [note health warning on this – actual deployments may be different].*

*Deployment: illustrates some example deployment scenarios that demonstrate that the Services identified may be exposed to interoperability boundaries. Shows functions deployed to nodes, with resultant exposed interactions [data/service].*

## Graphical Conventions

*<<Reference RASDS, provide a short summary of the graphical notation used in this document>>*

*<<Include RASDS extensions>>*

*Re-use / update existing graphic summarising RASDS notation used and the specific extensions. Explain the extensions and their meaning. Introduce colour codings used.*

*Also include existing material from MOIMS Information Viewpoint that introduces the UML notation used and the specific representation of relationships between entities (extending standard Inheritance, Aggregation, Composition and Association with special representation of “Source” and “Related” – although this is specific to MOIMS and so perhaps should be introduced there.)*

## Deployment Use Cases

*<< Summarize the SCCS nodes and deployment cases (ABA and SSI) and explain how these relate to application layer MOIMS and SOIS interactions. Identify additional fundamental deployment patterns (in addition to ABA and SSI) to represent distributed networks on ground and on board>>*

*<< Consider alternative deployment use cases for MO services in the context of: ground only, space to ground, and within space. Also identifying which of these are current, and which future.>>*

*New text to be written – use introductory diagrams from MOIMS Protocol viewpoint set. This includes some diagrams taken from SCCS ADD [slides 4-6] and new diagrams that explain the potential deployment contexts for MOIMS functions (Space, Space-Ground, Ground-Ground) [slides 7-10].*

*<< Consider how we are to handle constellations & formation flying, docking, and related subjects>>*

## Service Agreements and Access Arrangements

*<< Discussion of the kinds of agreements and access management arrangements might be needed in multi-mission and multi-agency cross support and interoperability environments. >>*

## Transitional Strategies

*<< Discussion of issues and strategies that might be employed in the transition from ABA to SSI style deployments and from MOS services only on the ground to MOS services in flight >>*

*New text to be written. Introduce use of proxy or gateway functions that translate to MO services on the ground, encapsulating the space link and bespoke or legacy protocols used.*

# Functional View

## Overview

*<< Functional view covers the groups of functions and brief descriptions of their behaviors. >>*

## MO functions (M&C, Nav, MP, DA, OpsPrep, Common)

*Uses existing material from MOIMS Functional Viewpoint – at two levels*

*Top level breakdown into 5 functional areas + common. Use only the new extended RASDS format diagrams (not source material). Introduce colour coding of functions.*

*Add description of 5 functional areas, explaining their scope and function.*

*Note boundaries: does not include mission data processing. Note that while these functions are typically present in most existing mission operations systems there is no intention or expectation that architectures should follow this breakdown – that is an implementation choice.*

*Note that the diagrams are showing Application level interactions between functions, and that consequently interfaces that relate only to communications level routing do not appear, or at least are not shown in the context of Application level interactions in which the associated function is not an end-point of that interaction.*

*Note that there is no intention to express the deployed location of the functions.*

*6 following subsections giving the next level breakdown for each of the 5 areas + common, using existing diagrams and adding descriptions of the lower level functions.*

*Data is introduced (as it is shown on the diagrams) – but only as necessary to express the interaction between functions that is shown.*

*Explain the usage of provider/consumer [or maybe this should be in 3.3] and in particular highlight that it does not express data flow, or the origin of the data [which can be an input to or an output from the service provider]. Potential use of household services analogy: we all understand that electricity, gas and water are provided by the associated service provider as the provider supplies that commodity; in the case of sewage, the service provider takes the material from the user – the main flow is in the opposite direction. With data services, interactions are often bidirectional, and data products may be generated by both provider and consumer of the service.*

## SOIS functions (Time, File & Packet, Device Discovery & Enum, Data Acq)

## Integrated Flight/Ground Functions (future territory, ???)

## Security Concepts for Functional View

*<< Specific security functions, access control, encryption, authentication, key management. Anything still in the process of “becoming” gets marked [Future]. >>*

# Information View (Information Objects)

## Overview

*<< Information view covers the structure and contents (syntax & semantics) of the various information objects that are defined. Anything still in the process of “becoming” gets marked [Future]. >>*

## MO Information Views (Current Mo Materials, NAV, DAI (Incomplete))

*Use existing materials from MOIMS Information View. Note that data is only introduced at high level (sufficient to identify the information exchanged and relationships which may relate to items across multiple interfaces), and direct the reader to relevant standards for detailed specification of the data. Note also that data is associated with functional areas: the data concerns information exchanged across interfaces between functions.*

*Introduce the fact that some data items refer to complex, self-contained file schema, while others are exposed across service-based interfaces.*

*Structure as sub-sections, with one for the MO Common Object Model, followed by one for each principal functional area. Diagrams exist for MO COM, M&C, MPS and NAV. Those for DA and OPD are in progress, plus some enhancement of the NAV diagram. May also require a diagram for “Common” services data.*

## SOIS Information Views (EDS, “containers”, DoT, naming & resolution, MIB)

## Security Concepts for Information View

*<< Specific information / data security including for privacy purposes. Anything still in the process of “becoming” gets marked [Future]. >>*

# Service View

## Overview

*<< Service view covers the nature, interfaces, and behaviors of the various Service objects that are defined. Anything still in the process of “becoming” gets marked [Future]. >>*

## MO Services (current MO tables)

*“Services“ correspond to off-line exchange of information [files] or on-line interactions between functions.*

*Use existing tables from MOIMS Service Viewpoint. These show the functions interfaced, the information objects exchanged, operations/capabilities of the service/data exchange and references the CCSDS standards that relate to this. Tables already exist for each of the 5 main functional areas and Common. Propose to structure according to this in subsections.*

*Explain colour coding – debate to be had on inclusion in the document of current status information.*

*Add some general descriptive text for each area, explaining how the services identified relate to CCSDS standardisation areas and book series.*

## SOIS Services (current SOIS tables)

## Integrated Flight/Ground Services (discussion)

## Dependence of ASL Services on SCCS Architecture

## Security Concepts for Service View

*<< Secure service interfaces. Anything still in the process of “becoming” gets marked [Future]. >>*

# Communications View (Protocol stacks)

## Overview

*<< Communications view covers the protocol stacks that are defined. These will mostly, but not only, be associated with service interface bindings and should be thought of as “building blocks” for deploying services on nodes. Anything still in the process of “becoming” gets marked [Future]. >>*

## ISO Protocol Stack and Layer Definitions

*<< Borrow from SCCS-ADD. >>*

## Specific Protocols for MO Service Interface Binding (MAL, lower level bindings (terrestrial & space), layered over SCCS & other links)

*Use existing diagrams from MOIMS Protocol viewpoint.*

*Assuming general introduction of deployment contexts is already included in §3, this does not need to be repeated here.*

*Include general introduction to MOIMS application level protocol layering for both MAL and File exchange cases [Slide 11].*

*This is then followed by separate subsections for each deployment context and the concept of context bridging. Uses existing slides for Space Link, Ground and Context Bridging with explanatory text added.*

*Note there are currently no diagrams for the Space context – requires SOIS input to agree presentation of deployment of MO over SOIS.*

*Note add additional terrestrial case of deployment of MO over http.*

### Space Link Context

### Ground Context

### On-board Context

### Context Bridging

*<< Will have to have two phases, MO only terrestrially and MO in space. Anything still in the process of “becoming” gets marked [Future]. >>*

## Specific Protocols for SOIS Service Interface Binding (sub-net, message bus, addressing & address mapping, WiFi (802.x or other))

*<< Will need to address single S/C and also multi-S/C and Hab/EVA types of deployments. Anything still in the process of “becoming” gets marked [Future]. >>*

### SOIS End-to-End Protocol Operation (set of subsections)

*<< Will need to have two phases, ABA and SSI. Anything still in the process of “becoming” gets marked [Future]. >>*

## Remaining Challenges to Protocol Deployment

*<<Multi-mission protocol interoperability for widely distributed heterogeneous systems>>*

## Security Concepts for Protocol View

*<< Secure protocols, link and network layer encryption are handled in SCCS-ADD, application service layer encryption, & authentication. Key management protocols. Anything still in the process of “becoming” gets marked [Future]. >>*

# Physical (Connectivity) View (Representative component node / building blocks & connections among them)

## Overview

*<< Physical view covers the types of nodes that must be defined in addition to those SCCS nodes (ESLT & other). Much of this is likely to just be specialization of the User Nodes types (Space User Node & Earth User Node) from the SCCS ADD. Anything still in the process of “becoming” gets marked [Future].*

*Make it very plain that the deployment cases are just examples selected to illustrate cases where interfaces may be exposed to an interoperability boundary>>*

## MO Physical Elements (MOC, P/SOC, archive, User, current lexicon?)

*<<Identify functions that may be distributed to PI, POC/SOC, MOC and Archive nodes – including Mission Planning, access to M&C data/services, Navigation data, etc.>>*

*TBD  
Identify a set of ground deployment nodes.*

## SOIS Physical Elements (SOIS components, S/C of various kinds, orbital, relay, station, surface, formation, EVA participants, etc,)

## Security Concepts for Physical View

*<< Secure service sites (physical and logical). Anything still in the process of “becoming” gets marked [Future]. >>*

# End-To-End Deployment View (Representative end-to-end with multiple connected components & protocols)

## Overview

*<< End-to-end deployment views will just include a limited, but useful, set of examples. They cannot be exhaustive because there are un-countable numbers of possible deployments. The views will be end-to-end, possibly for interoperability and cross support, with a suitable set of nodes, protocol stacks, and application layer deployments. Anything still in the process of “becoming” gets marked [Future]. >>*

## MO End-to-End Deployment Views

*TBD*

*Set of example deployment cases to be identified, but anticipated to include:*

* *Traditional case – all MO functions within MOC, distributed User nodes; show interaction with Station network*
* *As above but with separate POC and Data Archive*
* *With Functions distributed to spacecraft*
* *With Functions distributed to Mission Data Processing*
* *Use of external services for NAV*
* *Use of external services for Operations Preparation (typically manufacturer)*
* *Collaborative Mission Planning*

## SOIS End-to-End Deployment Views

## Security Concepts For End-to-End Protocol View

1. ACRONYMS
2. BACKGROUND