Memorandum of Understanding

MOIMS and SOIS cooperation

Overview

This document outlines the boundaries between the two CCSDS working groups, MOIMS and SOIS.

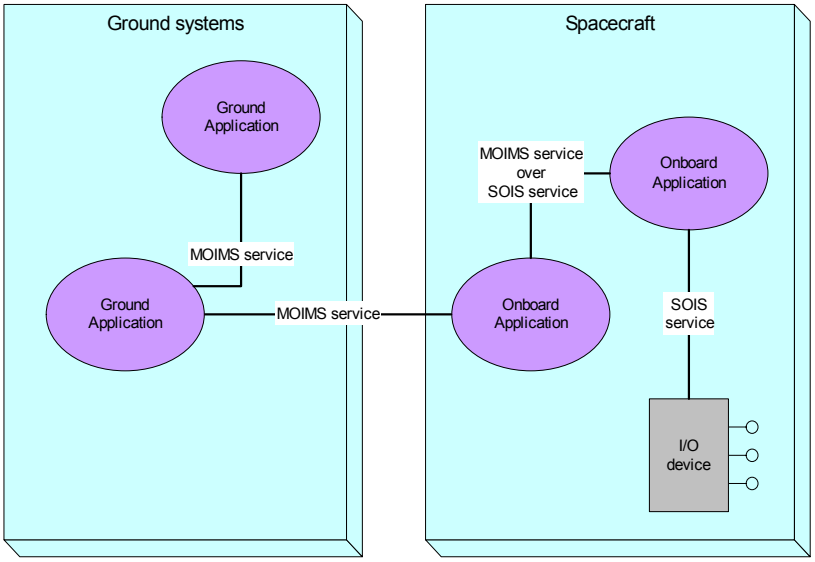
It details the areas that are considered to be in the remit of each working group in the context of a link from the high level ground applications to the remote onboard low level physical devices:

- The MOIMS working group is to define the reference operational concept that is used during the operation of a spacecraft.
- The MOIMS working group is to define the high level services between end to end applications that may be on the ground or onboard.
- The SOIS working group concerns itself with the definition of onboard services that are provided to the high level onboard applications that may implement the MOIMS services.

Neither working group will concern themselves with the actual implementation of the high level applications, only going as far as identifying candidate high level applications that would use the services defined by the MOIMS and SOIS working groups.

Operational services

The following diagram illustrates which service areas would be used in the communications between high level applications, both in the ground system and onboard:



The lines on the diagram show that the high level applications will provide and consume the MOIMS services and that the high level applications onboard will also consume low level SOIS services. Below is a list of proposed MOIMS services:

Service	Description
SM&C Core	Core Monitoring and Control service.
SM&C Common	Common Monitoring and Control service.
Automation	Activity automation management.
Scheduling	Activity scheduling.
Interaction	Operator notification and interaction.
Planning	Constraint and resource planning.
Flight Dynamics	Orbit determination, flight plan generation, and manoeuvre generation.
Time	Time correlation and modification.
Location	Tracking, ranging, and position services
Data Product Management	File management and transfer, both ground based and onboard.
Software Management	Software versioning, patching, and release.

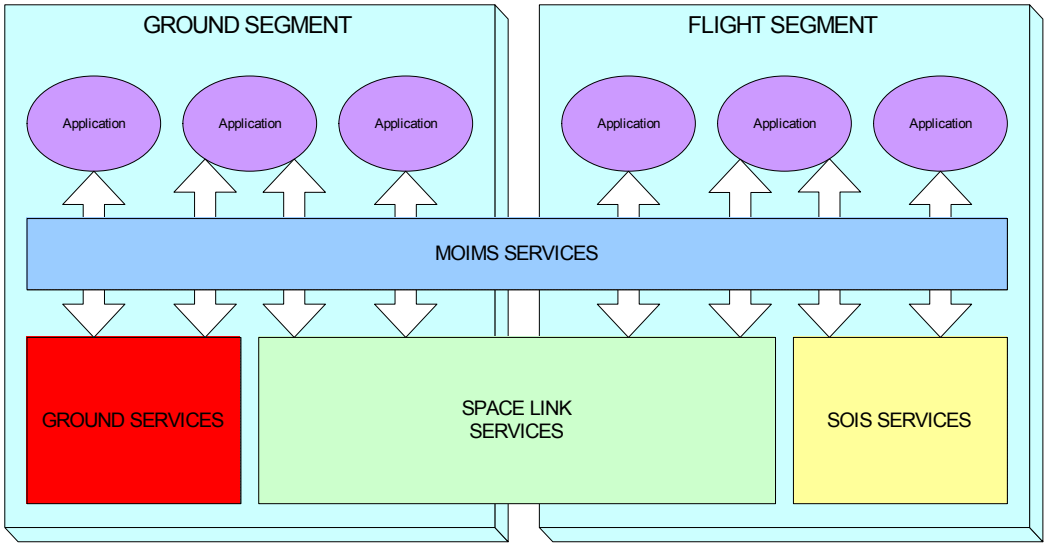
The onboard services are the remit of the SOIS group, below is a list of the SOIS services:

Service	Description
Command & Data Acquisition	Provides access to onboard sensors and actuators.
Time distribution	Distributes the spacecraft onboard time to users.
File Transfer	Transfers files between onboard users.
Messaging	Provides message transfer capability to onboard users.

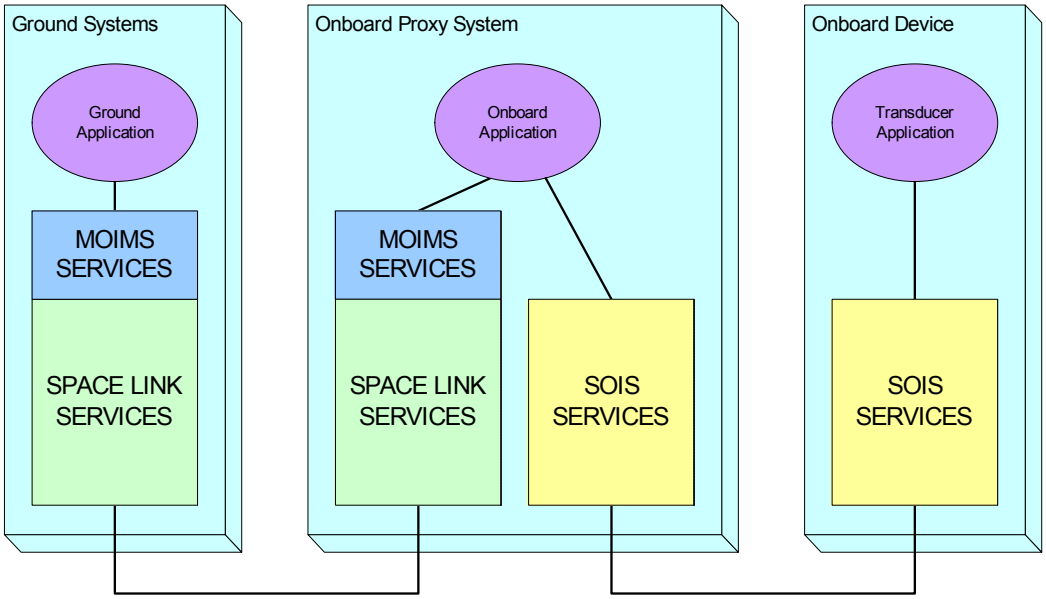
Below these there are a set of communication services that are still being worked out (and are yet to be named formally). These occupy layers 1 to 4 of the ISO 7-layer model and provide node to node communication capability onboard the spacecraft across multiple, possibly heterogeneous buses. The key points to note about these services are:

- They are intended to be provided over a variety of onboard buses and links (most of which are completely dissimilar to terrestrial buses and links)
- They are required to support distributed real time control of the spacecraft and therefore have timeliness and reliability requirements unlike traditional terrestrial systems. This also implies the need for priority based bandwidth allocation schemes.

The MOIMS area is responsible for the high level application to application services; the relevant low level services used to provide this is dependent on the context. For example, ground to ground links would be implemented over relevant ground services, ground to space would be implemented over relevant space link services, and onboard to onboard would be implemented over relevant onboard services:

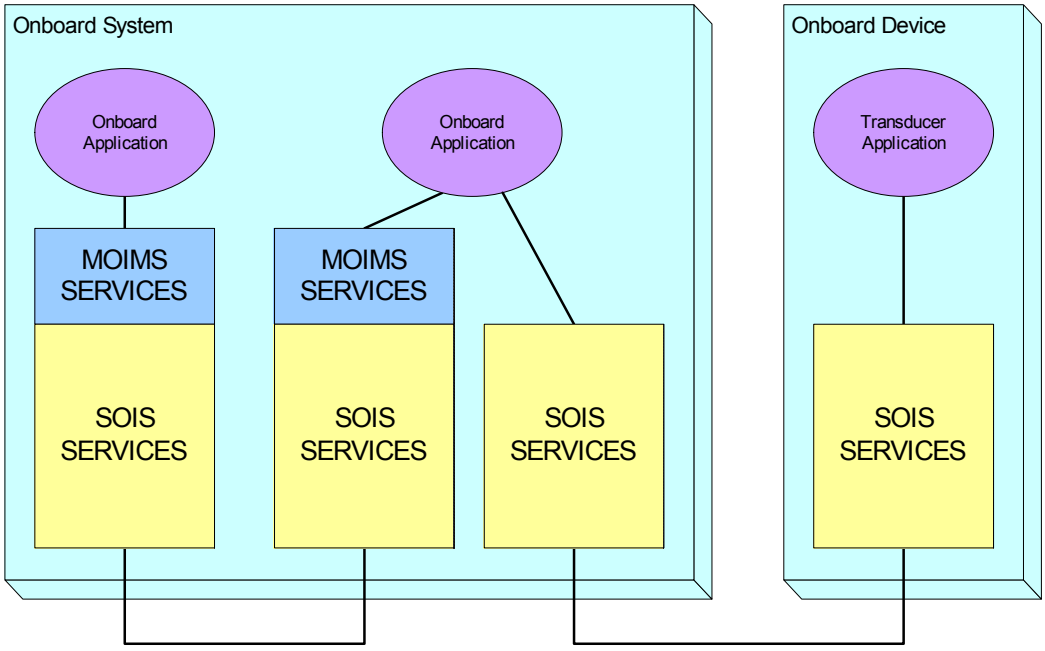


The following diagram shows one use of a service in detail, it can be considered a cross sectional view of the first diagram:



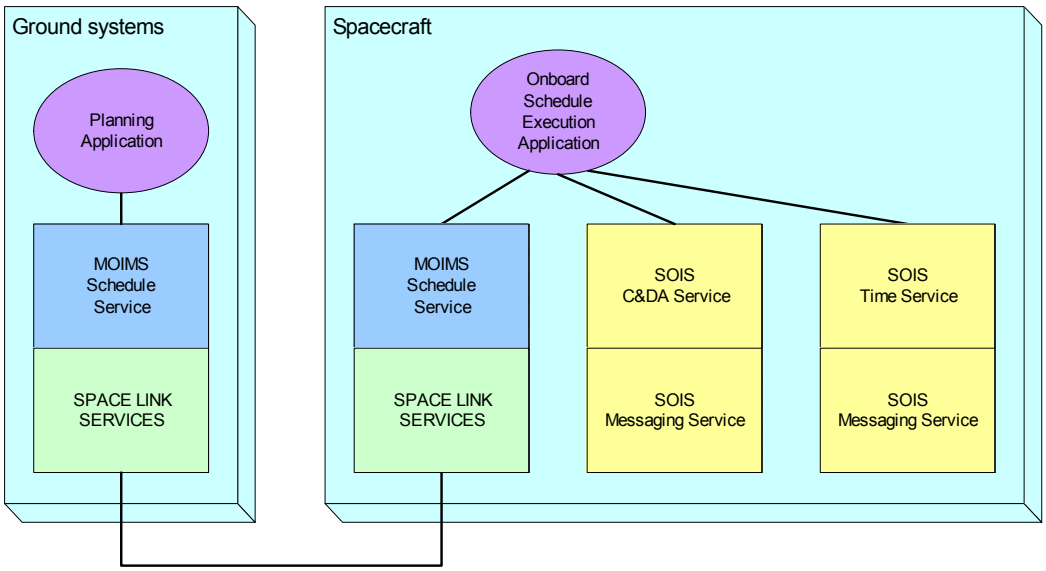
In the example it can be seen that the high level ground application is using the MIOMS service to communicate with the onboard application. In this example the MOIMS service is implemented over the relevant space link communication services. The onboard application would then most probably use onboard SOIS services from this point onwards.

The following diagram shows two onboard applications using MOIMS services onboard to communicate with each other. In this case the low level SOIS communication services are being used to transport the MOIMS service messages:



It should be noted that the implementation of both the ground and onboard high level applications are outside the areas of both working groups.

The diagram below illustrates the communication between a ground based application and an onboard application. In the example the ground based application is a planning system that generates a schedule of time tagged commands and the onboard application is the schedule execution application that is responsible for maintain the schedule and executing it:



From the diagram it can been seen that the ground based planning application is using the MOIMS high level schedule service to communicate with the onboard schedule execution application which is providing that service. The onboard application is then using relevant SOIS services, such as time and C&DA, to implement the schedule execution function.

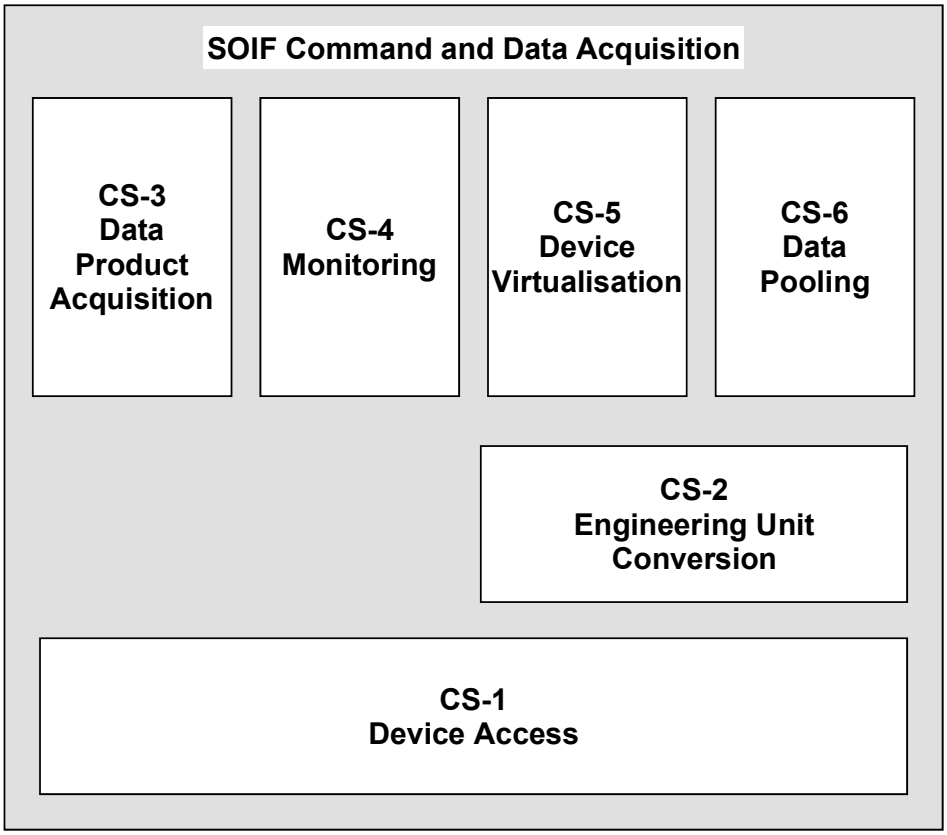
SOIS C&DA service issues

The SOIS Command and Data Acquisition service represents one area where service capabilities that are currently (May 2004) defined within the SOIS area are actually more appropriate to the MOIMS area.

Historically, the command and data acquisition service was conceived within the framework of the P1K SOIF activities as a service that provided basic read and write access to onboard devices such as sensors and actuators. The intention was to provide a uniform interface to onboard software applications to simplify the flight software development and to enhance the potential for software reuse across missions.

Two early prototypes of this service where developed independently by industry in the UK, and feedback from these activities together with comments from other reviewers indicated the usefulness of the service and suggested a number of ways that it could be extended. In order to retain SOIF focus on the most immediately useful

services while recognising the importance of the proposed extensions, it was decided that a number of capability sets within the C&DA service would be defined. The resulting capability set architecture is shown in FFFFF and described in the following paragraphs:



Capability Set 1 – Device Access

The basic command and data acquisition capability originally foreseen was simply a device access service. A software application makes a read or write request to a device using a logical identifier, the service then resolves this address to determine the physical address of the device and accesses it according to the interface type.

The benefit to the user is that he is no longer concerned with the details of the location of the sensor, or its physical interface. As a result, late configuration changes involving a change in the physical address of a device, or changes to its electrical interface, do not require changes to the application software using that device.

Capability Set 2 – Engineering Unit Conversion

A logical extension of the basic device access service is to add the engineering unit conversion capability for sensor reads. Using this capability, when the user performs a read on a given sensor, he receives a value that represents the parameter being read, e.g. a temperature value. In this case, the identifier is resolved to the physical address of the sensor device, and the engineering conversion rules associated with that device.

Capability Set 3 – Data Product Acquisition[1]

This provides the capability to acquire data from several devices in a single request. In this case, the logical ID is resolved to identify the data product and the service then acquires this data product using the available sensors. For example, the user may request a data product that comprises the accelerations and angular rates of the spacecraft. This would be acquired by reading the appropriate gyros and accelerometers.

Capability Set 4 – Monitoring

This capability allows parameters to be periodically sampled and checked against limit sets without requiring the user to repeatedly sample the device. The user is only notified if a parameter goes outside of the specified limits.

Capability Set 5 – Device Virtualisation

Device virtualisation involves the provision of virtual generic images of real physical devices. The user application communicates directly with the device image, and the service implementation translates these accesses to the virtual device into the appropriate accesses to the real device.

Capability Set 6 – Data Pooling

The concept of a data pool is a periodically maintained software image of the states of a number of devices on the spacecraft. Flight software can access the data in the data pool without explicitly requesting a read of the real device. The data pool implementation must sample the real devices at the appropriate frequency to ensure that the software image is accurate. Typically, the implementation of the service will provide data with a guarantee of the maximum age of each parameter in the pool.

Allocation of C&DA capabilities to SOIS and MOIMS

Following analysis of the capabilities that have been identified within the C&DA capability sets in terms of the scope over which the service must be provided and the relevance of that service to the different disciplines represented by the SOIS and MOIMS communities it has been agreed that the capabilities that should be addressed by MOIMS are those identified by the following C&DA capability sets:

- CS-2 Engineering unit conversion
- CS-4 Monitoring
- CS-3 data product acquisition (to be renamed Data aggregation)

Those capabilities that remain within the SOIS purview are:

- CS-1 Device access
- CS-5 Device virtualisation
- CS-6 Data pooling (to be renamed Onboard data pooling)

[1] A better name for this capability set would be Aggregated Data Acquisition since the term *data product* has many different connotations

It is also noted that the capabilities that have been identified and incorporated within the C&DA capability sets may not be the complete list.

Summary of understandings

1. MOIMS services are provided for the monitoring and control of a spacecraft.
2. MOIMS services are provided in all mission domains, i.e. on ground, onboard, and across the spacelink.
3. SOIS services are provided only onboard the spacecraft.
4. SOIS services are hierarchically below MOIMS services.
5. MOIMS services implemented onboard the spacecraft could, and should, use SOIS services.
6. Some of the SOIS C&DA capability sets properly belong to the MOIMS area, specifically:
   - CS-2 Engineering unit conversion
   - CS-4 Monitoring
   - CS-3 Data product acquisition
7. The following SOIS C&DA capability sets properly belong to the SOIS area:
   - CS-1 Device access
   - CS-5 Device virtualisation
   - CS-6 Data pooling