

DOMINO



Design and interface requirement for communication booking D16

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Abstract

This document describes the detailed design of the Coverage use case identified in the D2.2 Use Case Definition document.

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Applicable documents

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Acronyms & Definitions	
<i>AB</i>	<i>Advisory Board</i>
<i>EC</i>	European Commission
<i>EU</i>	European Union
<i>REA</i>	Research Executive Agency
<i>UAB</i>	User Advisory Board
<i>WP</i>	Work Package

1 INTRODUCTION

1.1 Scope

This document is the design the of use cases for Communication Booking (WP4000). It specifies the requirements that apply to the Satellite Communication and Resource Management Service in order to implement the use cases defined in the Use Case Definition document.

1.2 Structure of the document

The document is organised as follows:

- this chapter gives an overview of the document and explains the requirement formalism;
- chapter 3 explains the vocabulary used;
- chapter 4 introduces briefly the component;
- chapter 5 describes its use cases;
- chapter 6 lists the functional requirements of the component;
- the following chapters gives the non-functional requirements of the component:
 - deployment requirements in chapter 7;
 - operational requirements in chapter 8;
 - performance requirements in chapter 9;
 - security requirements in chapter 10;
 - external interfaces requirements in chapter 11;
 - design and development requirements in chapter 12;
 - testability requirements in chapter 13;
 - export control requirement in chapter 14.

1.3 Reading keys

Requirements within this document are described using the same format, consisting in several lines:

- a requirement identifier line;
- the requirement text;
- a set of attributes (one per line);
- an optional note;
- a tag [ReqEnd] to delimit the requirement.

The requirement text follows the requirement identifier line. If tables are considered as part of a requirement, they are referenced clearly in the text and inserted after and separated from the requirement and are managed as free text attached to the identifier requirement.

All the attributes are prefixed by “DECOVER_”.

Among the possible attributes, “DEBOOK_Verification Method” is mandatory. The **Verification Method** codes are as follows (as per ECSS):

- R for Review of Design;
- A for Analysis;
- I for Inspection;
- T for Test;
- Any combination of the previous codes, comma separated, when a requirement needs to be verified using several methods (for example: T, I).

All document elements not presented in the format explained above are not requirements and will not be verified or tracked.

The following gives an example of the format of a requirement:

[\[DE-BOOK-REQ-00100\] Requirement Title](#)

Requirement text.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: Requirement complementary information.

[ReqEnd]

2. DEFINITION AND ACRONYMS

Definition and acronyms can be found in the Domino-X Glossary included in the [RD01].

2.1 Acronyms

The following table lists some additional acronyms used in this document:

Acronym	Meaning
CRUD	Create, Read, Update, Delete
REST	Representational State Transfer
ACS	Archive/Catalogue Service
ADGS	Auxiliary Data Gathering Service
APS	Advanced Processing Service
CS	TM/TC Cipherring Service
DDS	Data Distribution Service
DITS	Data Integrity and Traceability Service
EPS	Enhanced Processing Service
FDS	Flight Dynamic Service
FOS	Flight Operation Service
FS	Federation Service
INTS	Interoperability Service
IQS	Image Quality Service
KBDS	Knowledge Builder and Decision Service
MAPQS	Machine-learning Application Production & Quality Service

MPS	Mission Programming Service
OMS	Operational Monitoring Service
PPS	Primary Processing Service
SCMS	System Configuration Management Service
SCRMS	Satellite Communication and Resources Management Service
SLA	Service Level Agreement
SMS	Security Monitoring Service
SSS	Satellite Simulator Service
TM/TC	TeleMeasures / TeleCommands (TM Data download/ plan upload)
UAS	User Access Service

Table 1: Acronyms

2.2 Terms

The following table lists some additional terminology used in this document, and its context:

Term	Meaning	Context
Owned Station	This is a station belonging to the customer on which all the contacts can be freely used.	
GSaaS	This is an external station for which the system shall book each needed contact. The cost of the contacts may depend on the contact duration (pay per use policy).	
Ground Station Site	This is a location where one or several Ground Stations are deployed. It can be a Site provided by a GSaaS provider or a Site of an Owned Station.	
Routine Needs	Needs of the system for each cycle (orbit or day for instance) in term of ITM and TM/TC contacts based on an average estimated workload.	
Workload-driven Need	Workload-driven needs compared to the routine needs identified by configuration. This represents the current workload of the system.	
Applicable (Contact) Plan	This is the plan of contacts derived from the Routine Needs taking into account additional contact needs or updates according to the actual workload of the system.	
Routine Pivot Point or RPP	A Routine Pivot Point is a virtual point used to bound Elementary Mission Plans. It is considered as a slot regarding margins to take into account	

	around. On this slot, programming is forbidden.	
Slot	Period of time allocated in the schedule	
Contact (Slot)	Slot in the schedule allocated for the satellite communication (TM/TC or ITM)	
Orbital Slot	Slot in the schedule allocated for an orbital event (RPP, Unavailability, Manoeuvre)	
Global (Slot) Schedule	This is the schedule handled by the SCRMS that includes all the contact slots and the orbital slots scheduled	

Table 2: Terminology

Those terms are generally used throughout this document with the following convention: each compound word has the first letter capitalised (as in the first column of this table).



3. GROUND SEGMENT OVERALL DESCRIPTION

The Domino-E ground segment is based on the Domino-X Architecture described in the Domino-X Architecture Document. Domino-X ground segment offers the following main services:

- Multi-Mission User Services
- Missions Services
- Satellite Command & Control Services (SCC)
- Resources Mgmt Services
- Processing Services
- Data Management Services
- Reactivity Services
- Monitoring Services

Each main service can be implemented by one or more dominoes.

A domino provides a valuable service useful to any earth observation ground Segment.
It:

- Autonomously produces outputs from a set of inputs
- May serve several missions
- Can be deployed on a cloud
- Is independent from other dominoes infrastructure
- Is accountable for its performances
- Is interchangeable by another implementation respecting the same interfaces

Note : A domino is not a toolbox or a framework and not a building block (not a library).

A domino can be :

- Dedicated to one mission (homogeneous constellation of satellites) or to several missions (multi-missions)
- Deployed on customer premises (on a dedicated hardware) or on a public or private cloud
- Deployed as a service (aas) provided by an industrial or as a delivered component
- Deployed in a unique way (central), by design or many concurrent implementation can be deployed
- Integrates mandatory or optional features

Inter-domino data and service exchanges are realized through communication standards such as OGS API or Open API 3.0 and standard formats such as JSON.

The Domino-X ground segment is interfaced to:

- External service providers through dedicated interoperability services
- External data providers/consumers
- Owned ground stations or can call ground station cloud services (GSaaS)

Domino-X ground segment can be operated with very few operators and provides products to numerous End-Users.

Domino-X Ground Segment

Targeted deployment

- One "VHR" 2 sat constellation
- One "HR" 8 sat constellation

Domino's perimeter

- = dedicated to an homogenous constellation
- = multi-mission
- = external system

Domino's instances

- = one unique instance of this domino
- = could be many instances deployed Without "redundancy" dimension

Domino's mode

- = "as a service" mode in targeted deployment (operated by an industrial)

Domino's optionality

- = The dominoes' functionalities are not mandatory, depending on the needs

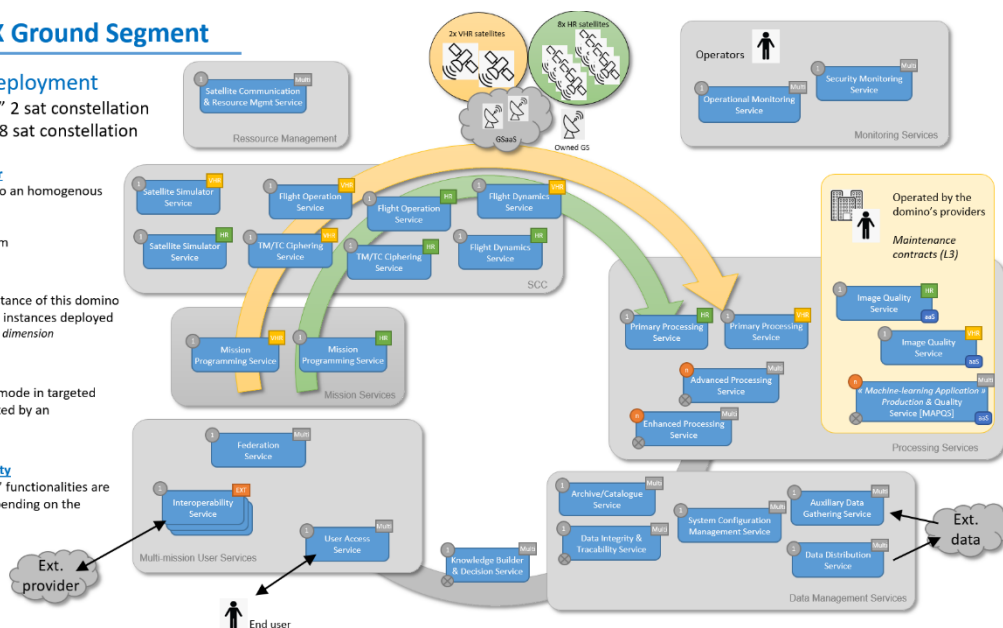


Figure 1 : Domino-X Ground Segment overview



4. COMPONENT OVERVIEW

4.1 Component Main Role

The main functions of the SCRMS:

- Allocate in an optimized manner the communication slots matching the system needs (TM-TC and ITM)
- Solve the conflicts on every orbital slots (resources) as well as on multi-mission stations (owned)
- Schedule and set-up communications contacts with each owned Ground Stations
- Book and set-up communications contacts by interaction with the GSaaS providers
- Maintain the system slot schedule, as needed for satellite manoeuvre, techno operations, or forbidden
- Provide up-to-date ephemeris data for contact exploitation (with mission and ground stations)
- Allow the level-2 operator to configure the SCRMS: ground stations network, routine plan and additional contact profile

4.2 Stakeholders Identification

The SCRMS has the following stakeholders:

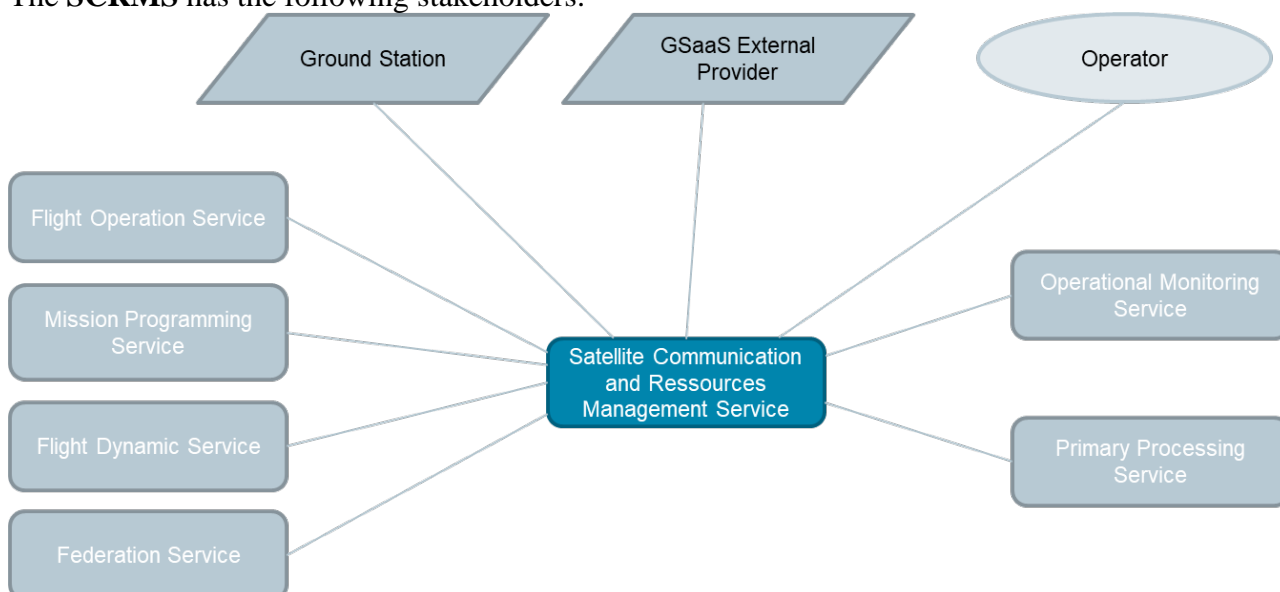


Figure 2 : SCRMS Stakeholders

4.2.1 Flight Operation Service

The Flight Operation Service (FOS) domino monitors the satellites status by receiving and analysing telemetry and controls the satellite behaviour by sending telecommands.

4.2.2 *Mission Programming Service*

The Mission Programming Service (MPS) domino is in charge of elaborating the satellite(s) mission plan of one sovereign system. It gathers as well functions for the calculation of the satellite(s) mission plan, as functions for the management of mission plan follow-up (uploading, execution...). The MPS is also in charge of managing the Programming Requests of one sovereign system. It gathers as well basic functions for the Programming Requests storage and status management, as advanced ones for the feasibility study or for the mission plan calculation.

4.2.3 *Flight Dynamic Service*

The Flight Dynamics Service (FDS) domino is in charge of controlling the satellite's orbit during its whole lifetime.

4.2.4 *Federation Service*

The Federation Service (FS) domino is in charge of offering unified services to the UAS while optimizing the use of federated systems and performing orchestration of dominoes activities. It gathers functions for User Requests management, and sequencing of related processing activities. [FS] Domino owns the User Requests, as so it is in charge of store them and every updates related to them (updates, follow-up, cancellation).

4.2.5 *Operational Monitoring Service*

The Operational Monitoring Service (OMS) domino :

- Regroups the services needed to ensure the proper functioning of the system (ground segment, space segment, external providers...)
- Provides access to all other dominoes' performance KPI (bandwidth, budget...) and displays and logs (on a regular basis or on demand) the metrics defined by the domino's owners.
- Offers the means to investigate a contingency using AI (cognitive assistance). It provides, to operator and AI, access to all other dominoes for investigation.

4.2.6 *Primary Processing Service*

The Primary Processing Service domino (PPS) is responsible for the Pivot level (L2 for optical sensors) product generation.

4.3 **System Data Model**

The **SCRMS** is in charge of maintaining a consistent communication and orbital slot schedule.

The following picture sums up these exchanges, it shows the data or information exchanged between the **SCRMS** and the other dominoes

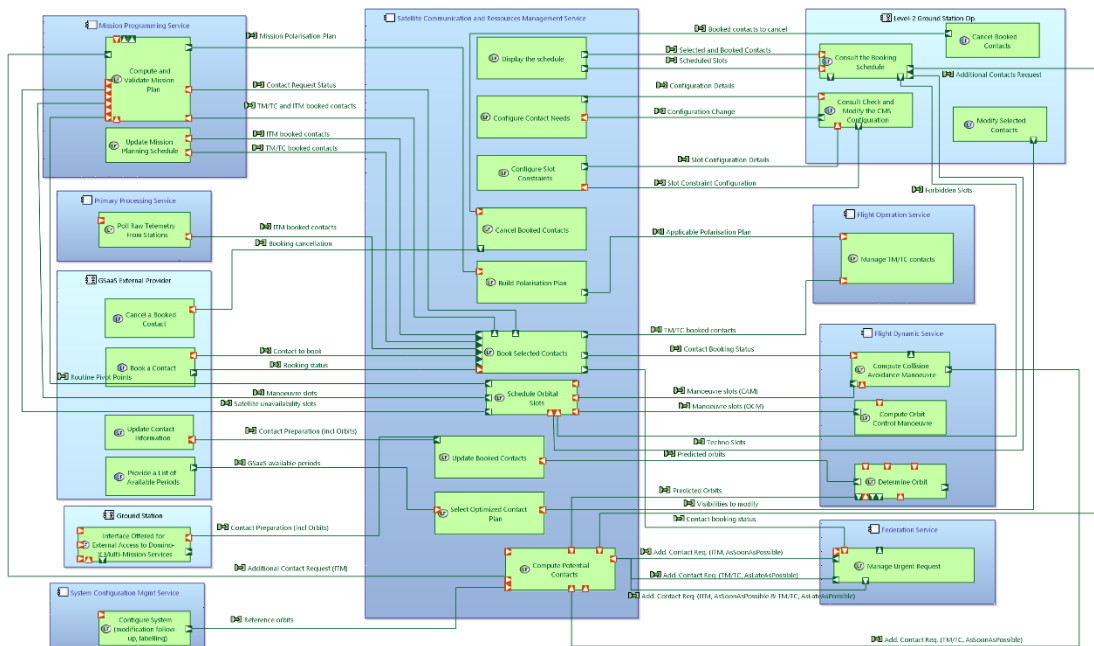


Figure 3: Context diagram of the SCRMS Domino.

4.4 Use Cases Identification

4.4.1 Overview

The use cases derive from the main functions of the SCRMS, which are:

- Extending the plan, on a set frequency (for instance every day at midnight)
- Updating the plan, when the workload evolves

This behaviour is described in the following diagram.

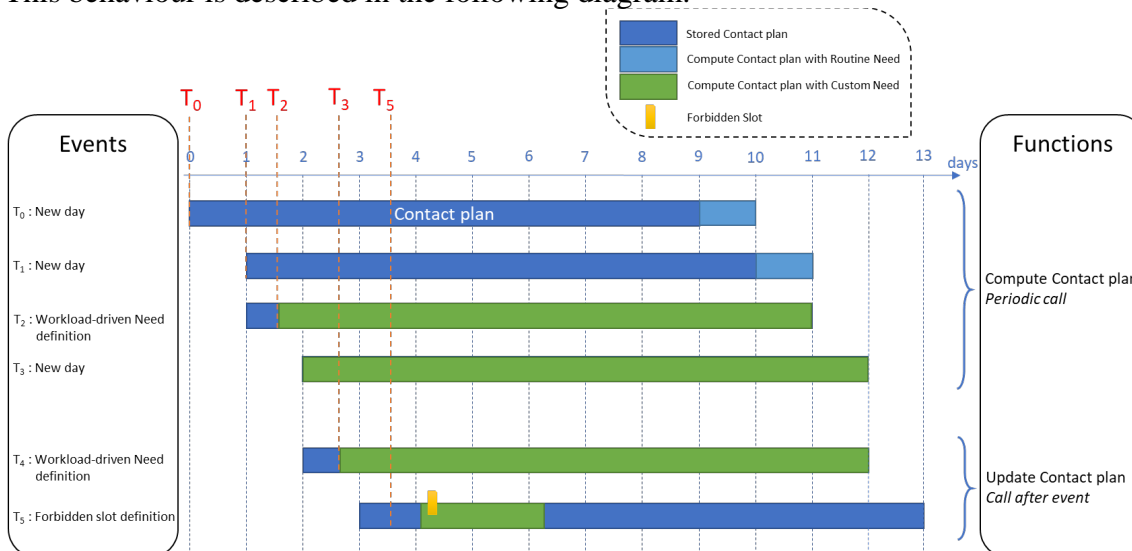


Figure 4 : SCRMS global behaviour



4.4.2 Use cases

The use cases considered in this document are described in the D2.2 Use Case Document.

The use cases introduce complexity in a step-by-step manner. The view of the main components is given in the following diagram. This view will be completed in the use case descriptions with the specifics of each use case.

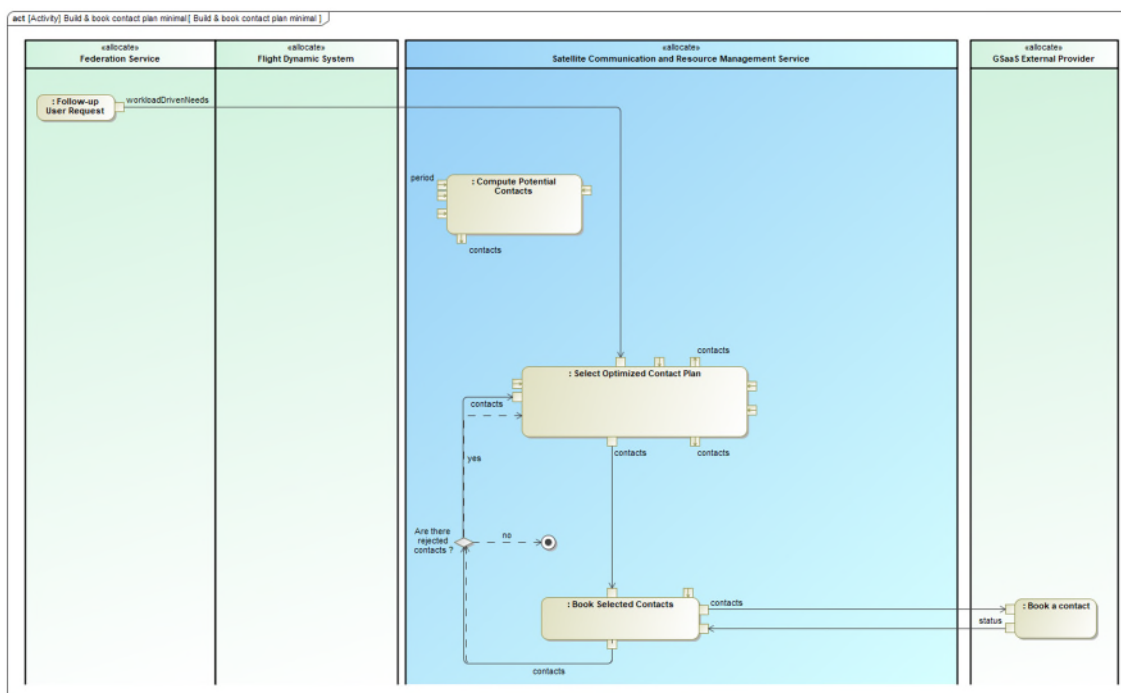


Figure 5 : Simplified view of the SCRMS with the main components

In the first use case, the SCRMS computes a contact schedule for routine needs. It will also take into account the conflicts between contacts.

In the second use case, the SCRMS computes a contact schedule for workload-driven needs.

In the third use case, the SCRMS takes into account the jammings that can occur between two communications.

4.4.3 Compute Routine Contact Plan according to configuration

This use case corresponds to the computation and scheduling of the Applicable Contact Plan according to the *Routine Needs* configuration and first optimisations.

The **SCRMS** automatically (base on its internal scheduling) computes this plan, selecting and booking the needed TM/TC and ITM contacts to match regular routine operations over several cycles (can be days, orbits, etc.).

This use case requires that the **SCRMS** is configured with the Routine Needs and available Ground Station Sites in accordance with contractual agreement. At the end of

this use case, the **SCRMS** has booked the TM/TC and ITM contacts matching the Routine Needs. The internal schedule is updated accordingly.

Additionally, this use case handles conflicts with forbidden slots and between TM/TC and ITM contacts. This requires that the **SCRMS** is configured with the conflict resolution rules.

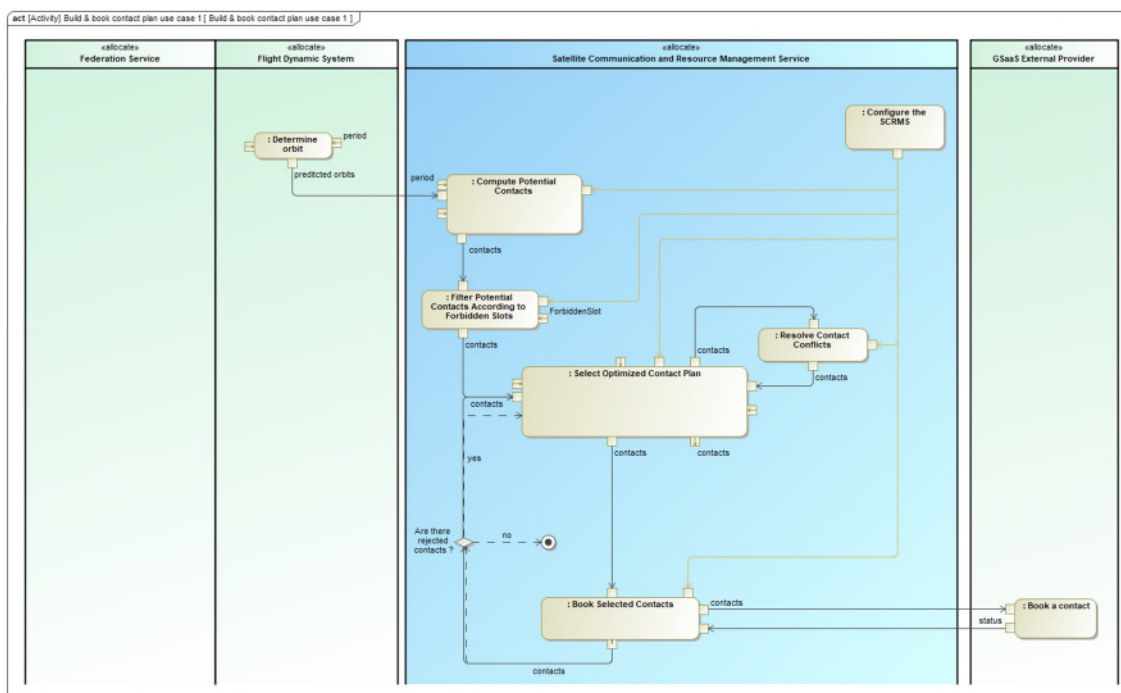


Figure 6 : SCRMS activity diagram for the Routine Plan use case

NOTE: For Owned Stations the SCRMS does not need to apply an actual booking toward the station, the SCRMS simply registers the slot allocation in its schedule (this is needed to avoid conflict when owned station are used in a multi-mission manner).. On GSaaS, the booking is performed by the **SCRMS** through the provider API that informs in return if the booking has been correctly performed.

4.4.4 Applicable Plan optimization with workload

This use case corresponds to the improvement of the Applicable Contact Plan using the actual workload.

The actual workload customizes the needs.

This use case requires that the **SCRMS** is configured with the Workload-driven Needs. At the end of this use case, the **SCRMS** has booked the TM/TC and ITM contacts matching the actual workload of the system. The internal schedule is updated accordingly.

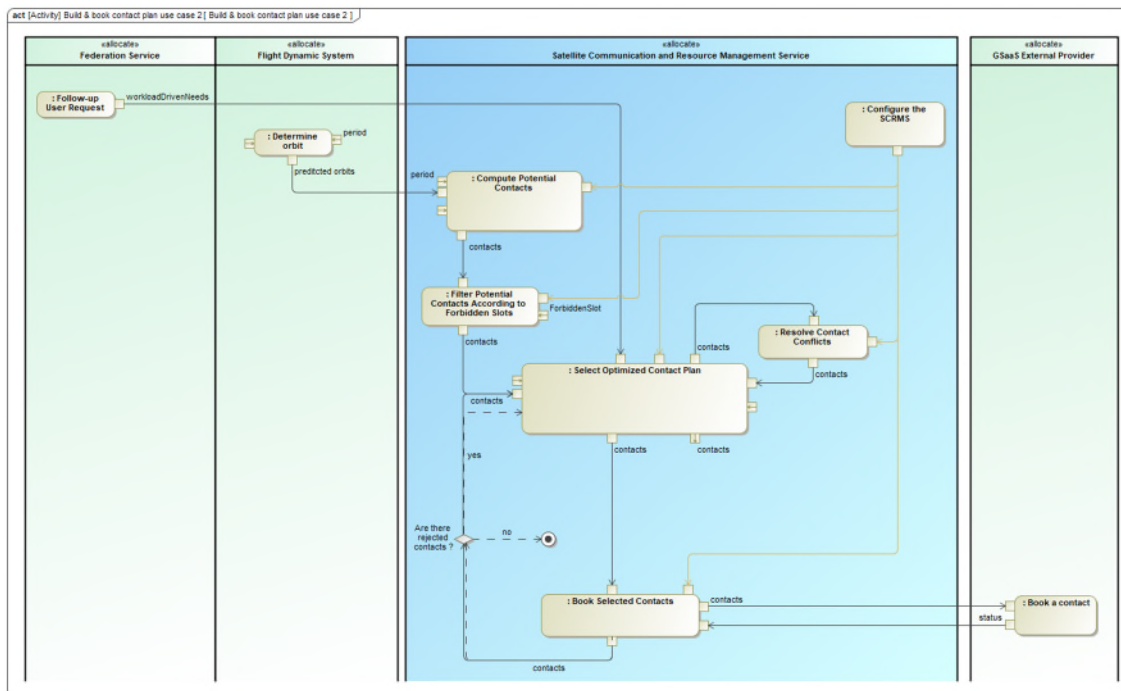


Figure 7 : SCRMS activity diagram for the workload-driven Plan use case

4.4.5 Jamming reduction

This use case corresponds to the optimisation of the jamming reduction that the **SCRMS** could perform automatically to improve the quality of the contacts and reduce the operator manual intervention.

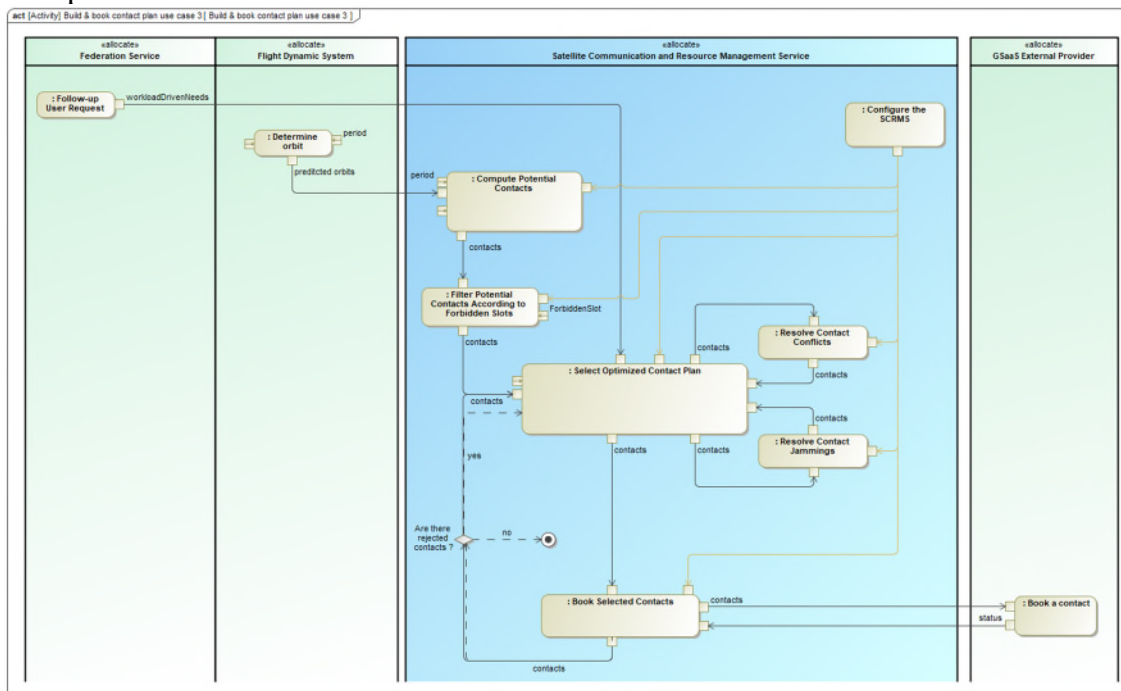


Figure 8 : SCRMS activity diagram for the jamming use case



5. FUNCTIONAL REQUIREMENTS

The following diagram presents the functions of the **SCRMS** Domino with the identification of what will be prototyped and which algorithms need to be developed.

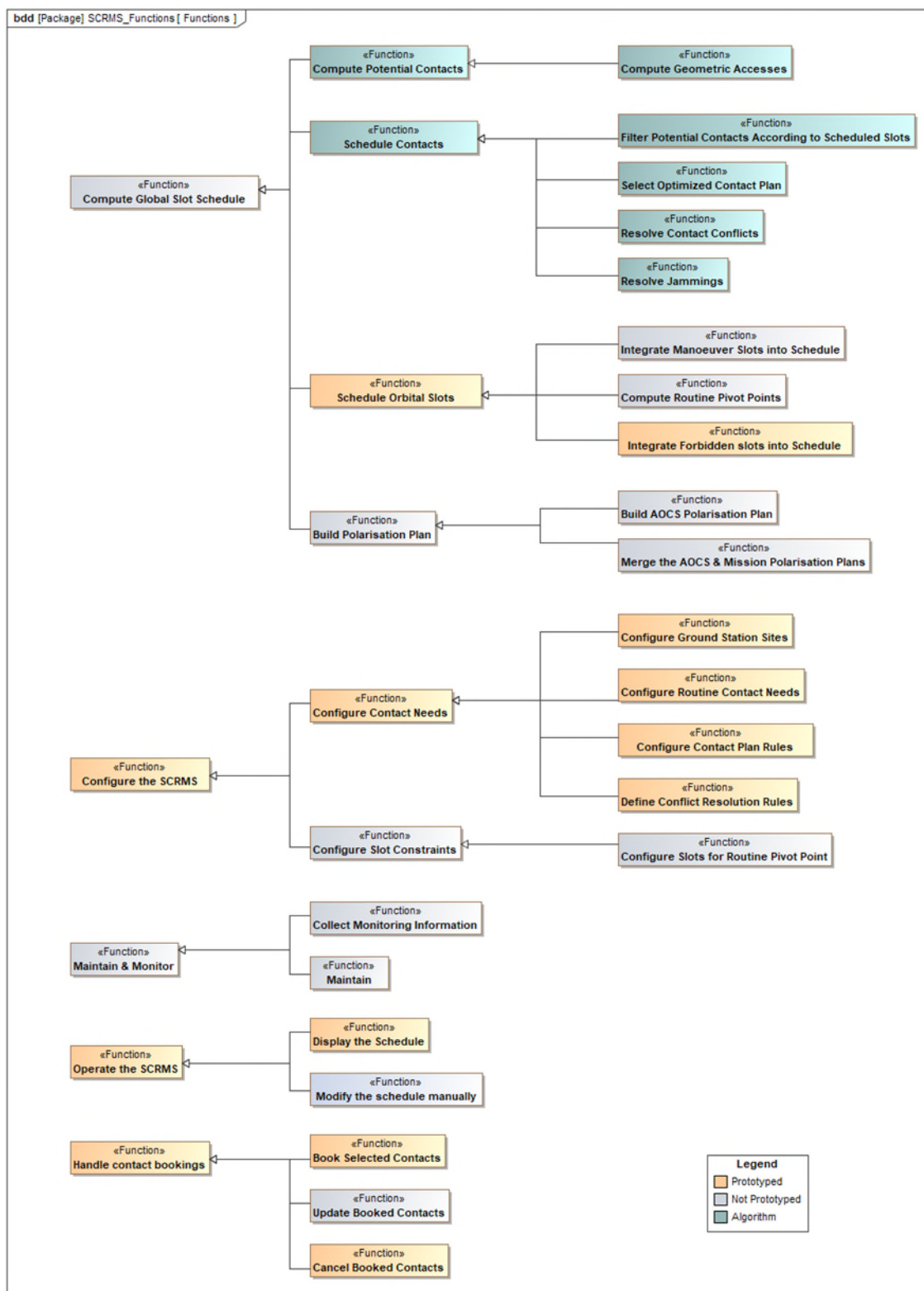


Figure 9: SCRMS functions.



5.1 Configure the SCRMS

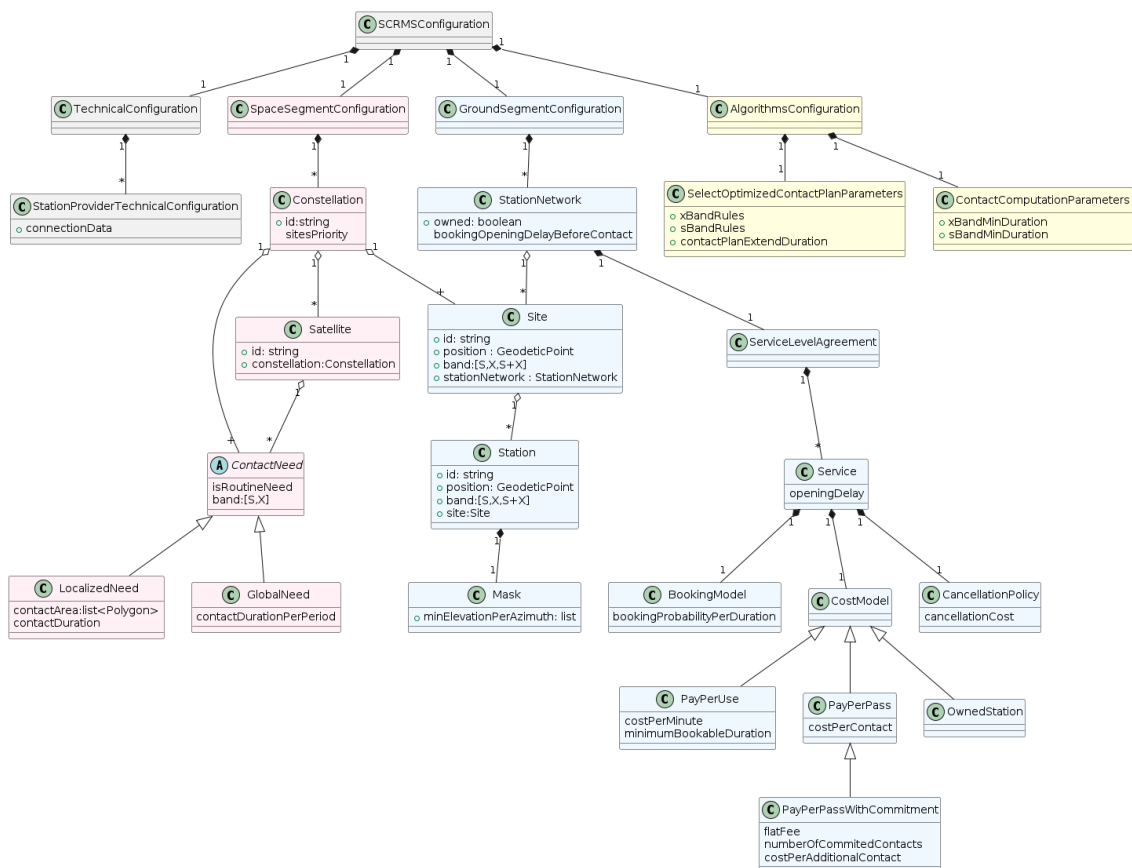


Figure 10 : SCRMS configuration structure

5.1.1 Configure Contact Needs

5.1.1.1 Configure Ground Station Sites

5.1.1.1.1 Network definition



[\[DE-BOOK-REQ-50100\] Ground Station Network Definition](#)

The **SCRMS** shall allow the operator to define the network of Ground Station Sites that can be used for contacts (TM/TC and ITM).

- Network ID
- Whether the network is owned or as a Service
- Service Level Agreement
- List of available sites. This list can be empty.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: A Station Network typically represents a network of owned station or a GSaaS Provider.

[ReqEnd]

[\[DE-BOOK-REQ-50200\] Ground Station Site Definition](#)

The **SCRMS** shall allow the operator to define the Ground Station Sites that can be used for contacts (TM/TC and ITM):

- Site ID
- Site coordinates (WGS84 longitude, latitude, altitude)
- Available bands: [S, X, S+X]
- List of available stations. This list can be empty.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-50300\] Ground Station Definition](#)

The **SCRMS** shall allow the operator to define the Ground Stations that can be used for contacts (TM/TC and ITM):

- Station ID
- Station coordinates (WGS84 longitude, latitude, altitude)
- Mask
- Available bands: [S, X, S+X]

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

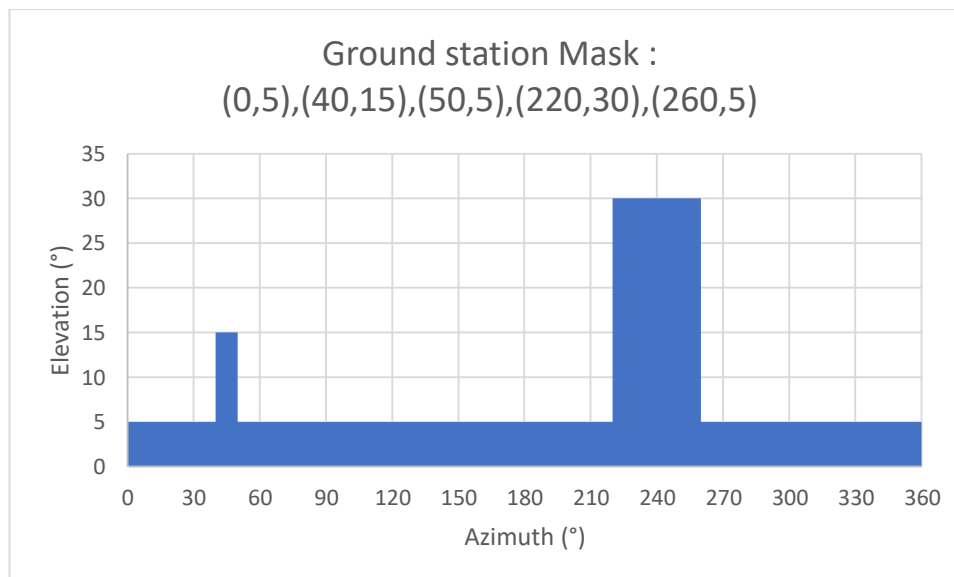
DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DX-SCRMS-REQ-50400\] Station mask](#)

The **SCRMS** shall allow the operator to define a station mask for each Ground Station. A mask is a list of azimuth / elevation couples. Each couple is valid in direct order of azimuth until the azimuth of the next couple.

Example:



DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DX-SCRMS-REQ-50500\] GSaaS Provider Access](#)

The **SCRMS** shall allow the operator to define the parameters required to access the GSaaS Provider portal to interact with them through the API (for booking, availability check, contact preparation).

The parameters are any technical information, specific to the provider, such as the portal URL and authentication.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.1.1.1.2 Service Level agreement

The exchanges with the GSaaS providers are contracted in a Service Level Agreement. This defines the opening periods of booking, the cost of the bookings, as well as the cancellation policy. The following diagram shows some guidelines of the definition of an SLA.

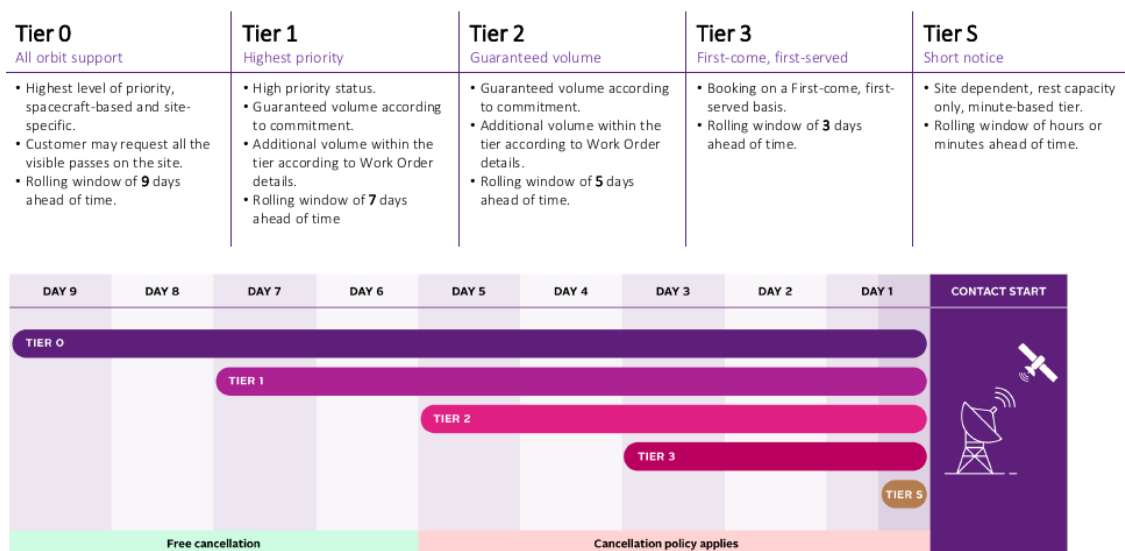


Figure 11 : Service Level Agreement overview

[\[DX-SCRMS-REQ-50600\] Service Level Agreement](#)

The **SCRMS** shall allow the operator to define Service Level Agreement for a GSaaS Provider’s network. This comprises a scale of Provided Services that will be used depending on the delay between the booking date and the Contact start date.

- DEBOOK_Product Version Applicability: V0
- DEBOOK_Verification Method: R, T
- DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DX-SCRMS-REQ-50700\] Provider's Service](#)

The **SCRMS** shall allow the operator to define Provider's Service, which is defined by:

- An open period of booking
- A Booking Model
- A Cost Model
- A Cancellation Model

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DX-SCRMS-REQ-50800\] Booking model](#)

The **SCRMS** shall allow the operator to define a booking model for a Provider's Service. This model defines the probability of booking a slot given the delay between the booking request and the start of the slot.

The probability is derived from the Provider's commitment at this Service Level. It can be constant on the open booking period of the Service, or variable (typically decreasing) while the booking request date approaches the Contact start.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: When the SLA provides no commitment on the availability of the contacts, the Provider only ensures "Best effort" in accepting the booking requests.

In this case, the booking model could be initialized with operator experience, and improved with SCRMS experience over time.

For instance, the probability could go from 80% 12 hours before the Contact start, down to 20% 2 hours before the Contact start.

[ReqEnd]

[\[DX-SCRMS-REQ-50900\] Cost Model](#)

The **SCRMS** shall allow the operator to define a Cost model for a GSaaS Provider's Service. This cost model can be:

- Pay per pass with a cost per pass
 - o With commitment on the number of contacts, the cost is fixed up to this number of contacts. Any additional contact adds to the cost. If the SCRMS

books fewer Contacts than the commitment number, then the cost is that of the committed number of Contacts.

- Pay per use with a cost per minute plus a minimum contact fee, and a minimum bookable duration

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DX-SCRMS-REQ-51000\] Cancellation Policy](#)

The **SCRMS** shall allow the operator to define a Cancellation Policy for the Provider's Service. This indicates whether cancellation is possible, and the cost of the cancellation. The cost could be constant, or variate along with the delay between cancellation and the Contact start.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.1.1.2 Configure Routine Contact Needs

Contact needs define what is needed for a satellite to perform its mission, in terms of TM-TC and ITM contacts.

[\[DE-BOOK-REQ-51100\] Constellation Definition](#)

The **SCRMS** shall allow the operator to define Satellite Constellations:

- Constellation ID
- List of satellites. This list can be empty.
- List of usable Ground Station Sites with their respective priorities

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-51200\] Satellite Definition](#)

The **SCRMS** shall allow the operator to define a Satellite:

- Satellite ID
- List of Contact Needs.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-51300\] Routine Contact Need Definition](#)

The **SCRMS** shall allow the configuration of a Routine Contact Need. This Need can be Global or Localized.

A contact need only concern one band : S or X.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-51400\] Global Contact Need Definition](#)

The **SCRMS** shall allow the operator to define a Global Contact Need, as a minimum contact duration per period of time.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-51500\] Localized Contact Need Definition](#)

The **SCRMS** shall allow the operator to define a Localized Contact Need, as a minimum contact duration per period of time, for a given Contact Area.

The **SCRMS** shall select in the configuration the Sites that are in the Contact Area.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.1.1.3 Configure Contact Plan Rules

Contact rules define the tuning the Contact Plan Optimization Algorithms.

[\[DE-BOOK-REQ-51600\] Contact Plan Rules](#)

The **SCRMS** shall allow the operator to define Contact Selection Rules for the Select Optimized Contact Plan algorithm.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The rules are shortcuts in the Contact Plan algorithm. For instance, the Contacts with higher priority stations, such as owned stations, are selected first. Or, between two Contacts which would produce the same KPI, the algorithm selects the longest. These rules will be defined during the prototyping phase.

[ReqEnd]

5.1.1.4 Define Conflict Resolution Rules

[\[DE-BOOK-REQ-51700\] Conflict Resolution Rules](#)

The **SCRMS** shall allow the operator to define Conflict Resolution Rules for the Select Optimized Contact Plan algorithm.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: for instance, when two Contacts are overlapping, the rule could indicate that both could be reduced, with the separation placed so that the Contacts have the closest durations.

These rules will be defined during the prototyping phase.

[ReqEnd]

5.2 Compute Global Slot Schedule

One of the central notions of the **SCRMS** is the Contact between a station and a satellite. Through its various functions, the **SCRMS** updates the status of the Contacts and is able to communicate the Contacts to the stakeholders. The following diagram presents the Contacts cycle of life.

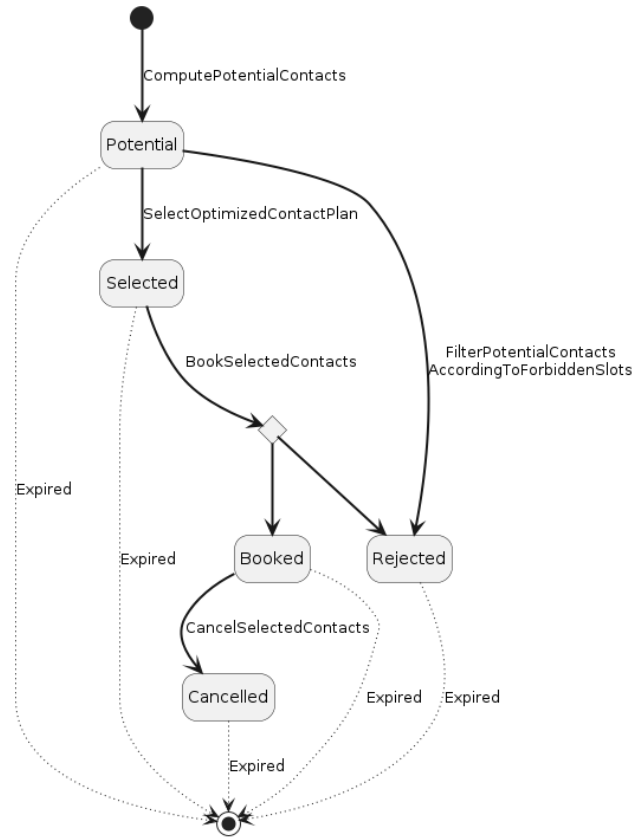


Figure 12 : Contacts cycle of life

[\[DE-BOOK-REQ-51800\] Global Slot Schedule](#)

The **SCRMS** shall permanently maintain a Global Schedule that includes:

- A list of planned Forbidden Slots
- A Contact Plan (gathering a set of communication contacts)
- The SCRMS configuration as well as inputs (such as Workload-driven Needs) used for the Select Optimized Contact Plan to produce the current Contact Plan

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: This allows the SCRMS to serve the other Dominos with the data they require at any time.

The SCRMS configuration and inputs of the computation are stored for investigation purpose, so as to be able to reproduce an error during SCRMS maintenance.

[ReqEnd]

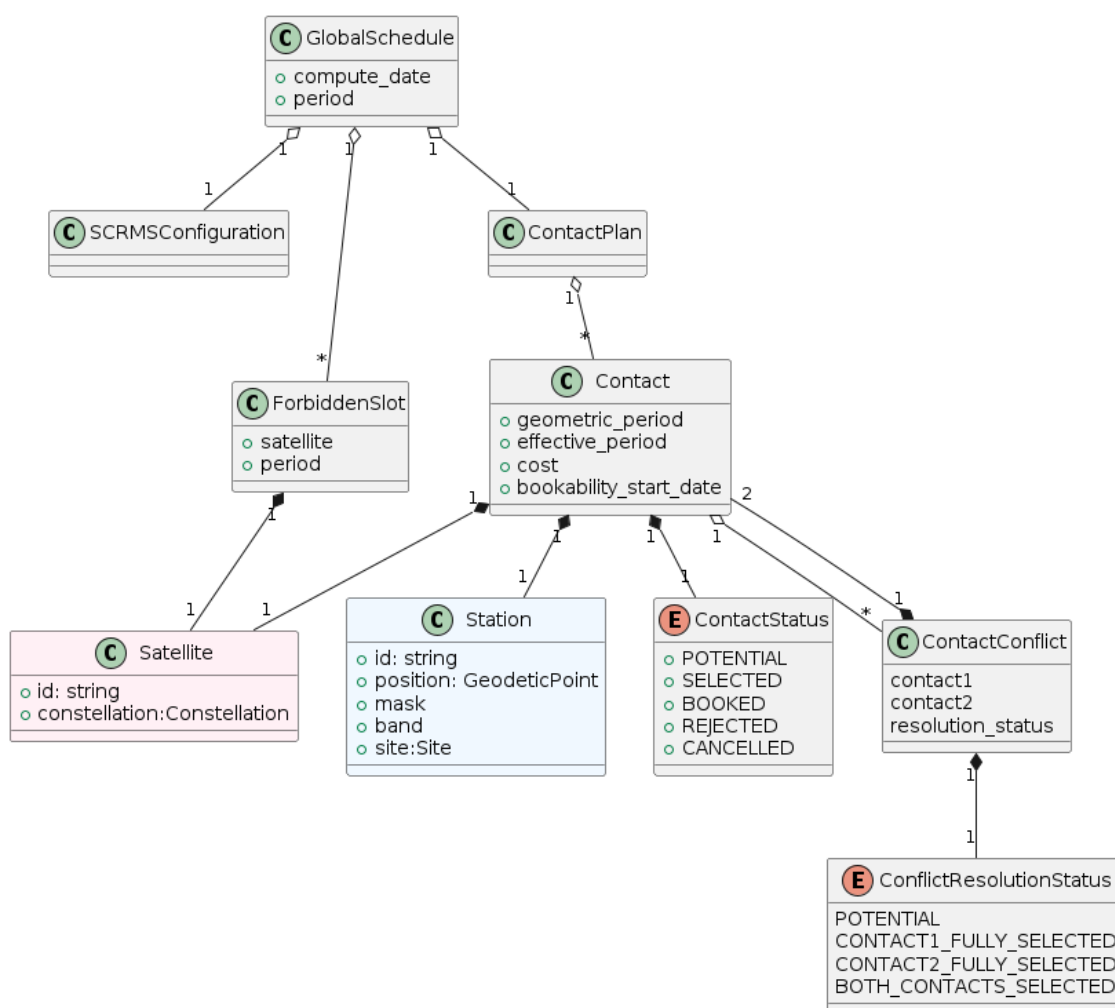


Figure 13 : SCRMS state



[\[DE-BOOK-REQ-51900\] Global Slot Schedule Extension](#)

The **SCRMS** shall extend the routine schedule periodically, with the period specified in the **SCRMS** configuration.

This extended part will have to be further than the booking delay.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The period could be once a day. This extension will ensure that the operator can review the schedule before any booking has taken place, and that the SCRMS can plan the booking at the best moment to maximize the probability of booking.

[ReqEnd]

[\[DE-BOOK-REQ-52000\] Global Slot Schedule Update](#)

Upon modification of the configuration, the **SCRMS** shall update the Contact Plan accordingly.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: This goes along with the periodic extension of the schedule, to ensure the Global Schedule is always up to date.

[ReqEnd]

5.2.1 *Schedule Contacts*

5.2.1.1 Compute Potential Contacts

5.2.1.1.1 Compute Geometric Accesses

[\[DE-BOOK-REQ-52100\] Reference Orbit Retrieval](#)

The **SCRMS** shall retrieve the Reference Orbit of each sovereign satellite from the [SCMS].

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The interface is defined into the Domino-X ICD [AD01]

[ReqEnd]

[\[DE-BOOK-REQ-52200\] Geometric Access Computation](#)

The **SCRMS** shall compute the Potential Contacts by computing the geometric accesses of the Contact Sites by the satellite based on the reference orbit (from the [SCMS]) or the predicted orbit (from the [FDS]) depending on the time interval considered.

The geometric access computation shall take into account the Ground Stations configuration defined by the operator.

The new Potential Contacts are added to the Contact Plan with the POTENTIAL state.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: For the period of time near the computation time, Predicted Orbit may be available and should be used instead of the Reference Orbit since they have a better precision.

[ReqEnd]

5.2.1.2 Select Optimized Contact Plan

5.2.1.2.1 Filter Potential Contacts According to Forbidden Slots

[\[DE-BOOK-REQ-52300\] Filter Potential Contacts According to Forbidden Slots](#)

The **SCRMS** shall discard from the Potential Contacts computed the ones whose time period is included in a Forbidden Slot.

When a Potential Contact only intersects a Forbidden Slot, its time period shall be reduced accordingly.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.2.1.2.2 Select Optimized Contact Plan

The **SCRMS** uses an optimization algorithm to build a satisfactory contact plan. In this chapter, this algorithm will be referred to as the Select Algorithm.

[\[DE-BOOK-REQ-52400\] Compute Contact Plan](#)

The **SCRMS** shall be able to compute a contact plan on a given time period, that satisfies a given set of contact needs.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The time period is used either to extend the routine contact plan, or to update it on a specific time period.

[ReqEnd]

[\[DE-BOOK-REQ-52500\] Compute Contact Plan Inputs](#)

The **Select Algorithm** inputs are:

- An optional Contact Plan, with Contacts in any state (Potential, Booked, Rejected...)
- An optional set of Workload-Driven Need
- The system and SCRMS configuration

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The input Contact Plan typically comes from a previous run of the Select Algorithm. New Potential Contacts are added by the Compute Potential Contacts step.

[ReqEnd]

[\[DE-BOOK-REQ-52600\] Workload-Driven Contact Needs](#)

The Select Algorithm shall take into account the actual workload of the system. In order to do so, the Select Algorithm can take as input a set of Workload-Driven Contact Needs.

These needs use the same structures as the Routine Contact Needs.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-52700\] Contact Need priority](#)

Workload-driven Contact Needs take precedence over Routine Contact Needs.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: When they are given, the Select Algorithm shall consider the Workload-Drive Contact Needs. The purpose of the Routine Contact Needs is to be able to provide a Contact Plan that covers the average needs of the system, even if the actual Workload is not known, for instance at the beginning of the system's operation.

[ReqEnd]

[\[DE-BOOK-REQ-52800\] Compute Contact Plan Outputs](#)

The **Select Algorithm** outputs an optimized Contact Plan. The Select Algorithm can position Potential Contacts to the Selected state.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-52900\] Select Algorithm optimization objectives](#)

The **Select Algorithm** shall optimize the Contact Plan with respect to the following KPIs:

- Minimize the cost of the solution
- Maximize the simplicity of the contact plan: when the other KPIs are equivalent, it is preferable to have a few complete Contacts than
- Maximize the even temporal repartition of the Contact Plan

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: The goal with the even repartition of the Contact Plan is to minimize the delays between upload and acquisition, and between acquisition and download.

[ReqEnd]

[\[DE-BOOK-REQ-53000\] Select Algorithm Deterministic Behaviour](#)

The **Select Algorithm** shall be deterministic: with a given set of inputs, it shall always produce the same output.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-53100\] Select Algorithm stability](#)

The **Select Algorithm** shall be as stable as possible: the cancellation of Booked Contacts shall be minimized.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: Cancellation is not transparent as it requires a confirmation from the Station Network Provider. This depends on the cancellation policy of the provider. Too many cancellations could hurt the relation with the Provider, and lead to reducing the chance of booking a slot.

[ReqEnd]

[\[DE-BOOK-REQ-53200\] Resolve Contact Conflicts](#)

The **Select Algorithm** shall solve the Contact conflicts using the pre-computed data as well as Conflict Resolution Rules.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-53300\] Resolve Contact Jammings](#)

The **Select Algorithm** shall solve the Contact jammings using the pre-computed data as well as Conflict Resolution Rules.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.2.1.2.3 Resolve Contact Conflicts

[\[DE-BOOK-REQ-53400\] Detect Contact Conflicts](#)

The **SCRMS** shall be able to detect Contact conflicts. The detection takes place before the Select Optimized Contact Plan step.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-53500\] Resolve Contact Conflicts](#)

The **SCRMS** shall be able to resolve Contact conflicts automatically. The decisions on the conflict resolutions take place during the Select Optimized Contact Plan step.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.2.1.2.4 Resolve Contact Jammings

[\[DE-BOOK-REQ-53600\] Detect Contact Jammings](#)

The **SCRMS** shall be able to detect Contact jammings. The detection takes place before the Select Optimized Contact Plan step.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-53700\] Resolve Contact Conflicts](#)

The **SCRMS** shall be able to resolve Contact jammings automatically. The decisions on the jammings resolutions take place during the Select Optimized Contact Plan step.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

5.2.2 Schedule Orbital Slots

5.2.2.1 Integrate Unavailability Slots into Schedule

The complete SCRMS will handle a variety of orbital slots, such as station-keeping orbital manoeuvres, collision avoidance manoeuvres, technical operations, or other unavailability slots. Each has a defined priority with respect to the others, and with various elements of the mission (download, acquisition). In the current DominoE context, this complexity is masked under the general term Forbidden slot, which precedes any other satellite activity.

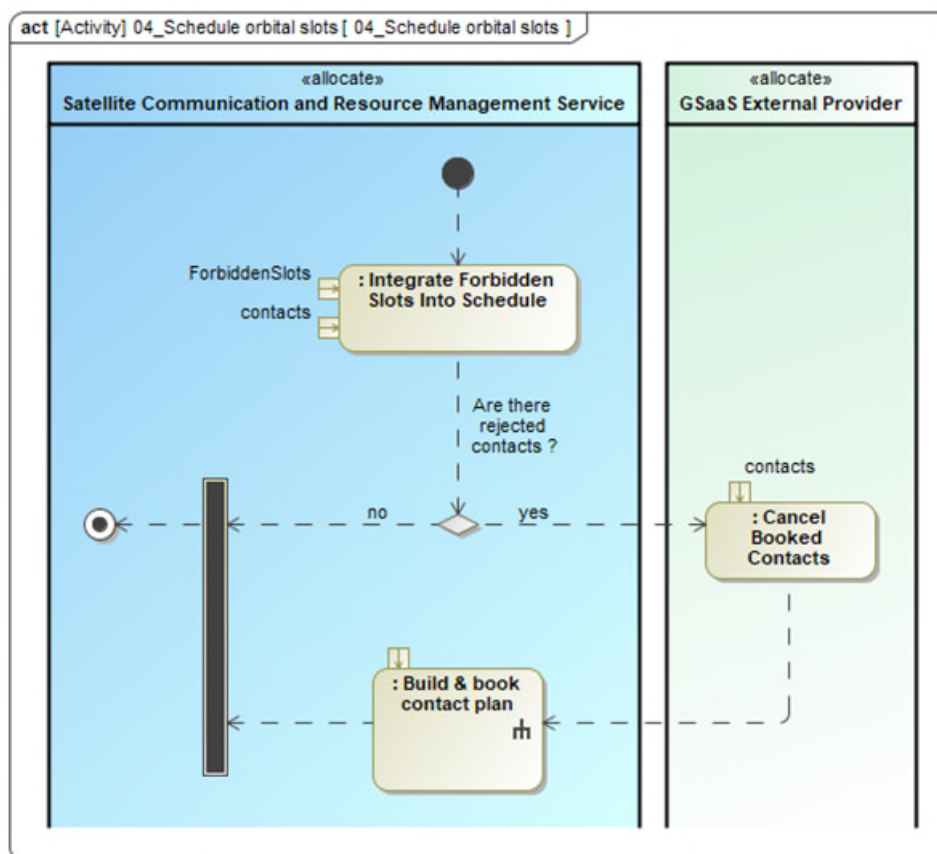


Figure 14 : Handle Forbidden Slot Deposit

[\[DE-BOOK-REQ-53800\] Forbidden Slot Definition](#)

The **SCRMS** shall allow the operator to define manually forbidden slots into the schedule for a given satellite. No other slot nor contact can be scheduled during this forbidden period.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: During the forbidden, no mission can be programmed.

[ReqEnd]

[\[DE-BOOK-REQ-53900\] Global Slot Schedule Update](#)

Upon modification of the forbidden slots, the **SCRMS** shall update the Contact Plan accordingly.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: This goes along with the periodic extension of the schedule, to ensure the Global Schedule is always up to date.

[ReqEnd]

5.3 Compute Global Slot Schedule

5.3.1 *Book Selected Contacts*

The **SCRMS** is the sole point of contact with the Ground Station Network Providers. Once the Optimized Contact Plan has been computed, there is a list of contacts to be booked. The **SCRMS** is able to discriminate which selected contacts are open for booking. It contacts the Ground Station Network Providers to book, and handles the booking confirmation.

[\[DE-BOOK-REQ-54000\] Book Selected Contacts](#)

The **SCRMS** shall be able to book a list of Selected Contacts.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-54100\] Handle Contact Open Booking Period](#)

Each Provider defines an open booking period, depending on the Service Level Agreement contracted. The **SCRMS** shall handle the opening period of the Contacts, and book them as soon as possible.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note : example opening period

[ReqEnd]

[\[DE-BOOK-REQ-54200\] Handle Contact Booking Inside its Booking Period](#)

For Contacts Selected during the open booking period, the **SCRMS** shall reach the Provider to book the contact right away.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-54300\] Handle Contact Booking Outside of its Booking Period](#)

For Contacts Selected outside of the booking period, the **SCRMS** shall plan the booking of each Contact at the beginning of its booking period.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-54400\] Handle Contact Booking Confirmation](#)

The **SCRMS** shall treat the returned status of the booking of each Contact. The SCRMS shall tag the Contact as Booked or Rejected depending on the confirmation of the booking.

In case of Rejected Contacts, the SCRMS shall optimize the Contact Plan again.

DEBOOK_Product Version Applicability: V0
 DEBOOK_Verification Method: R, T
 DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

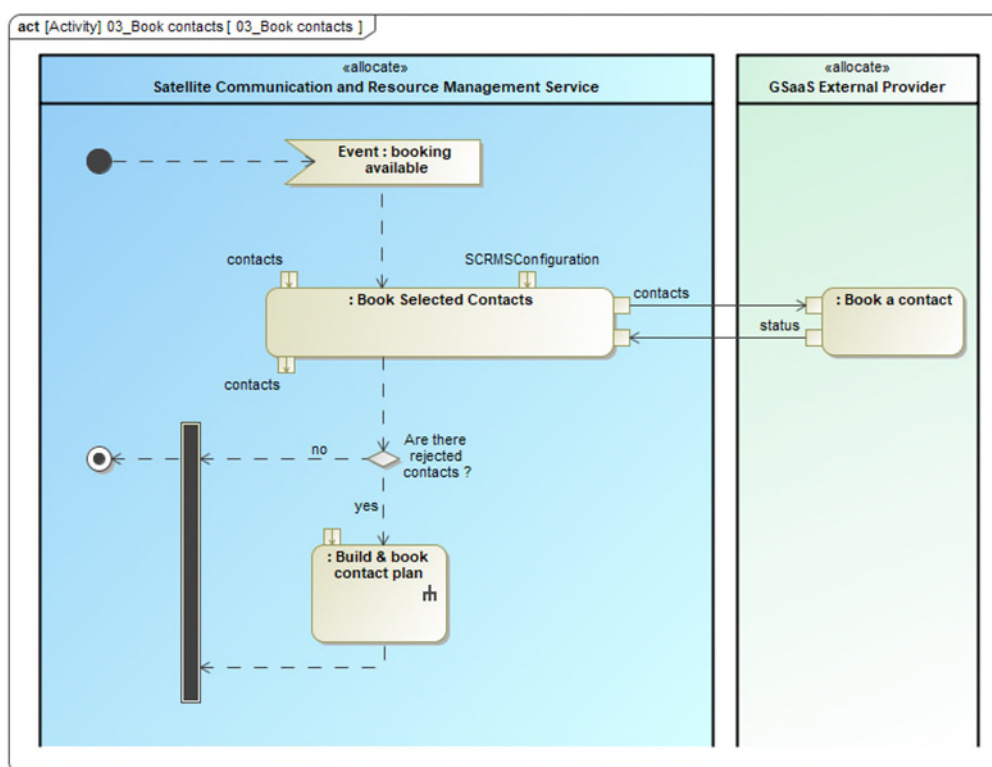


Figure 15 : Handle Booking Event

5.3.2 Cancel Booked Contacts

[\[DE-BOOK-REQ-54500\] Contact Booking Cancellation](#)

The **SCRMS** shall be able to cancel the booking of a contact, by communicating with the GSaaS provider through its API.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

[\[DE-BOOK-REQ-54600\] Handle Contact Booking Cancellation Confirmation](#)

The **SCRMS** shall treat the returned status of the cancellation of each Contact. The SCRMS shall tag the Contact as Cancelled upon success, and keep it Booked upon cancellation failure.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

[ReqEnd]

6. DEPLOYMENT REQUIREMENTS

7. OPERATIONAL REQUIREMENTS

7.1 RAMS

TBD

7.2 Operations, Maintenance

TBD

7.3 Graphical User Interface Requirements

TBD

7.4 Installation Requirements

TBD

7.5 System Start and Stop

TBD

8. PERFORMANCE AND SIZING

8.1 Performances

TBD

8.2 Sizing

TBD

9. SECURITY

TBD

10. EXTERNAL INTERFACES

[\[DX-SCRMS-REQ-10100\] SCRMS Interfaces](#)

The **SCRMS** shall implement the interfaces as defined in the Domino-X Master ICD [AD01].

DXSCRMS_Product Version Applicability: V0

DXSCRMS_Verification Method: T

DXSCRMS_Rationale: Requirement rationale text.

Note: Requirement complementary information.

[ReqEnd]

11. DESIGN AND DEVELOPMENT REQUIREMENTS

This section contains the design requirements of the <COMPONENT NAME> component. Please note that several other design requirements are gathered in the Subsystems Common Requirements Document [AD01].

11.1 Portability

TBD

11.2 Technology

[\[DE-BOOK-REQ-11100\] Implementation language](#)

The **SCRMS** shall be implemented in Java.

DEBOOK_Product Version Applicability: V0

DEBOOK_Verification Method: R, T

DEBOOK_Rationale: Requirement rationale text.

Note: This ensures coherence with the other dominos.

[ReqEnd]

11.3 Development

TBD

11.4 Reusability

TBD

11.5 Scalability

TBD

12. TESTABILITY REQUIREMENTS

TBD

13. EXPORT CONTROL REQUIREMENTS

TBD

14. ANNEXE 1

This table is an extract from the Domino-X Master ICD. It contains every interface involving the SCRMS in Domino-X architecture. This table shows which interfaces will be used in Domino-E.

Interface	Used in Domino-E WP4000	Description
[FOS]_[SCRMS]_Booked_Contacts	Yes	The FDS asks the TM/TC contacts booked on a certain horizon
[FS]_[SCRMS]_Contact_Request	Yes	Additional contact requested by FS for urgent request
[MPS]_[SCRMS]_Booked_Contacts	Yes	The "Booked Contacts" Interface allows clients to straightforwardly retrieve a list of booked contacts for a given band (X, S, etc.), constellation and period.
[MPS]_[SCRMS]_Unavailability_Slots	Yes	The "Unavailability Slots" Interface allows clients to straightforwardly retrieve a list of unavailability slots (slots unavailable for the mission) and that for a given constellation, satellite and period.
[SCRMS]_[FDS]_Predicted_Orbits	Yes	The "Predicted Orbits" Interface allows clients to retrieve a list predicted orbit files for a given constellation, satellite and period.
[SCRMS]_[SCMS]_Reference_orbits	Yes	Reference orbits allowing the SCRMS to compute the physical accesses
[SCRMS]_[GSAAS]_Booking_Request	Yes	Booking request for a contact to a GSaaS Provider each time a contact needs to be booked (periodically or for additional contacts)
[SCRMS]_[GSAAS]_Booking_Cancellation	Yes	Booking request cancellation can be triggered by the operator or automatically by the SCRMS at schedule update
[FDS]_[SCRMS]_Contact_Request	No	FDS request for additional contact in case of urgent CAM
[FOS]_[SCRMS]_Contact_Request	No	FOS requests for additional contact in case of on-board anomaly

[FOS]_[SCRMS]_Polarization_Plan	No	FOS requests for the applicable polarization plan to be used for TM/TC contacts
[MPS]_[SCRMS]_Manoeuvre_Slots	No	The "Manoeuvre Slots" Interface allows clients to straightforwardly retrieve a list of manoeuvre slots for a given constellation, satellite and period.
[PPS]_[SCRMS]_Booked_Contacts	No	The "Booked Contacts" Interface allows clients to straightforwardly retrieve a list of booked contacts for a given band (X, S, etc.), constellation and period.
[SCRMS]_[FDS]_Manoeuvre_Slots	No	The "Manoeuvre Slots" Interface allows clients to straightforwardly retrieve a list of manoeuvre slots for a given constellation, satellite and period.
[MPS]_[SCRMS]_Mission_Polarisation_Plan	No	The "Polarization Plan" Interface allows clients to retrieve a list polarization plan files for a given constellation, satellite and period.
[SCRMS]_[GSAAS]_Contact_Preparation	No	Information needed by the Ground Station fews minutes before a contact (that includes the up to date TLE)
[SCRMS]_[GSAAS]_Booking_Availability	No	Availability information about a contact slot/site provided by the GSaaS Provider
[MPS]_[SCRMS]_Routine_Pivot_Point_Slots	No	MPS retrieves the Routine Pivot Points computed by the SCRMS before each plan computation
[MPS]_[SCRMS]_Contact_Request	No	In case of additional contact needs, MPS requests new contacts

END OF DOCUMENT