MMCSA-SP0001

Canadian Space Agency

MULTI-MISSION OPERATION CENTER (MMOC)

Multi-Mission Antenna Reservation System (ARS) Requirements Document

Revision 2.9

July 13, 2015

NCAGE Code: L0889

Canadian Space Agency | Agence Spatiale Canadienne

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REVISION HISTORY

Rev.	Description	Initials	Date
IR	Initial Release Released by the approval of CSA CR ##	PC / JFL	February 6, 2014
1.1	Implementation of changes following SRR	JFL	May 6, 2014
1.3	Implementation of changes from RFI responses	JFL	August 12, 2014
1.4	Added ITSG security requirement [ARS590]	PC	October 2nd 2014
1.5	Cleaned up redlines, added Spacecraft Attitude Model/Ephemeris, RCM Time Requests, Standing Requests, preferred stations for time requests, Network Stations, operational personnel time constraints, moved process flow chart to ConOps document	JFL	October 30, 2014
1.6	Swapped Event 4 and Event 5. Consistency with new Process Flow Diagram. Instated admittance of contacts and definition.	JFL	November 5, 2014
1.7	Livelink bug	JFL	Dec 18, 2014
1.8	Livelink recover. Aligned with RCM definitions for Time Period	JFL	Dec 18, 2014
2.0	Release	JFL	Dec 22, 2014
2.1	Review of cost drivers, should and other possible cost options	PC	Jan 15, 2015
2.2	Vérification of previous review and cost drivers	JFL	Feb 3, 2015
2.3	Comments and Req vs Goal (shall/should) update	PC	
2.4	Integrated comments from R2 operations Integrated update from new RCM MPS ConOps resulting from TIM with Prime (notably the new Service for Contact Opportunity)	JFL/PC	April 21, 2015
2.5	Cleaned Up Redlines	JFL	April 21, 2015
2.6	Signature Block, integrated Gilles Brassard comments, added [ARS392], [ARS765], [ARS766]and deleted [ARS560],[ARS561], [ARS562], [ARS563], [ARS800], replaced CRITICAL by EMERGENCY	JFL	May 6, 2015
2.7	Accepted redlines from G. B and comments from Hany Fawzy, and added [ARS195] Accounting Report	JFL	May 13, 2015
2.8	Integration of CCMEO comments, and reviews from translation	JFL	June 17, 2015

Rev.	Description	Initials	Date
2.9	Update of Fig 4-1 (Service F4), Note on ARS191, ARS195, ARS030, ARS040, some typos and links corrected, ARS150 and ARS365 Notes corrected. Performance modification from 24h to 48h on ARS375, ARS390, and ARS392. Deleted ARS620 (ITSG-33)	JFL	July 13, 2015

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to specify the design requirements of the Antenna Reservation System (ARS) addressing the need for antenna resource coordination in the context of a multi-mission satellite control center. The ARS is a functional sub-system as part of the CSA's Multi-Mission Operation Center (MMOC) architecture. With respect to the RADARSAT Constellation Mission (RCM), the ARS is also a sub-system component of the Government Furnished Equipment (GFE) in support of the overall RCM Ground Segment (GS).

1.2 SCOPE

The ARS Requirement Document (SRD) complies with the requirements of actual missions and missions under development such as the RCM. This document comes with the ARS companion Interface Control Document (ICD) (AD-3) and the Concept of Operations (AD-1), which describes the interfaces with both the satellite missions and the ground station facilities.

1.3 APPLICABILITY

This document is applicable to both the supported Mission and Facilities interfaces, as per Definitions 2.2, in which case:

- All supported Missions will be flexible to accommodate the ARS interface, namely: Radarsat-2, Scisat, NEOSSat, M3MSat, RCM, Cassiope, TET-1, Terrasar-X, Tandem-X, and Grace,
- All supported Committed Facilities will accommodate the ARS interface; it is assumed that the following stations be considered Committed Facilities:
    - Polar-Epsilon 2 Facilities in Aldergrove (CAAL) and Masstown (CAMA),
    - All Network Stations as required by Radarsat and RCM,
- All supported RCM Canadian Facilities (Uncommitted Facilities) will be flexible to accommodate the ARS interface, namely:
    - CCMEO's Prince-Albert (PASS), Gatineau (GSS) and Inuvik Canadian Satellite Station (ICAN) (SXGT), and
- The ARS will be flexible to accommodate all other expected Uncommitted Facilities, which become applicable to this document, namely:
    - MDA's St-Hubert (SHUB) and Saskatoon (SASK) Facilities,
    - DRDC Shirley's Bay Satellite Facility (DRDC) in Ottawa,
    - NASA Facility in Fairbanks, Alaska,
    - KSAT's Facility operated from Norway,
    - SSC Facilities operated from Kiruna, Sweden,
    - DLR Facilities operated from Oberpfaffenhofen, Germany, and

- CNES Facilities.

2 DEFINITIONS

2.1 ACRONYMS AND ABBREVIATIONS

ACS	Attitude Control System
AD	Applicable Document
AOS	Acquisition of Signal
ARS	Antenna Reservation System
ASCII	American Standard Code for Information Interchange
CAAL	Canadian Aldergrove Facility
CAMA	Canadian Masstown Facility
CCMEO	Canada Centre for Mapping and Earth Observation
CM	Configuration Management
CNES	Centre National d'Études Spatiales
CSA	Canadian Space Agency
DCS	De-Conflict System
DLR	Deutches Zentrum für Luft- und Raumfart (German Space Agency)
DOY	Day of Year
DR	Data Reception
DRDC	Defence Research and Development Canada
GFE	Government Furnished Equipment
GS	Ground Segment
GSS	Gatineau Satellite Station
GUI	Graphic User Interface
HBR	High Bit Rate
ICAN	Inuvik Canadian Satellite Station
ICD	Interface Control Document
ID	Identification
kbps	Kilobit per second
KSAT	Kongsberg Satellite Services
LEOP	Launch and Early Operations Phase
LOS	Loss of Signal
MDA	MacDonald, Dettwiler and Associates Ltd.
MMOC	Multi-Mission Operation Center
MPS	Mission Planning Subsystem
NASA	National Aeronautics and Space Administration
NGT	Northern Ground Terminal

NORAD	North American Aerospace Defense Command
NRT	Near-Real-Time
OGD	Other Government Department
OSI	Open Systems Interconnection model
PASS	Prince-Albert Satellite Station
PD	Parent Document
PE2	Polar Epsilon 2
RCM	RADARSAT Constellation Mission
RD	Reference Document
RF	Radio Frequency
RNG	Ranging
RT	Real-Time
SAR	Synthetic Aperture Radar
SASK	Saskatoon Facility
SCS	Satellite Control Subsystem
SF	Store and Forward
SHUB	St-Hubert Facility
SOE	Satellite Orbit Ephemeris
SRD	System Requirement Document
SSC	Swedish Space Corporation
SXGT	S-Band and X-Band Ground Terminal
TBC	To Be Confirmed
TBD	To Be Determined
TC	Telecommand
TLE	Two-Line Elements
TM	Telemetry
TT&C	Telemetry, Tracking & Commanding
UTC	Coordinated Universal Time
YMD	Year Month Day
XML	Extensible Markup Language

2.2 TERMINOLOGY

TABLE 2-1 TERMINOLOGY DEFINITIONS

System Elements:	
System	Is the physical implementation (hardware and software) of the ARS functionalities. (Note: In addition to the System, the overall ARS may include other elements such as a Backup System, the Operator interface, the network connectivity, the voice interface, the System maintenance, the programmatic layer, etc.).
Operator	Is the personnel that commands and controls the System. The Operator has delegated rights to operate the ARS, approve Schedules, generate or edit Configurations, modify scheduling rules and algorithms, and manually reserve Antenna time. On the implementation side, there might be several classes of Operator allowing different levels of authorization and privileges on the System. However, the terminology Operator is referred to as the overarching element representing human control and decision making over the ARS.
Satellite	Consist of an Earth-orbiting spacecraft with one or multiple payloads that require ground infrastructure to allow its commanding and payload Data Reception (DR)
Mission	Consists of one or multiple Satellites, and appropriate ground segment functional elements and personnel required to conduct the mission operations such as the Mission Planning Subsystem (MPS).
Antenna	Is composed of a tracking dish reflector with RF components and baseband equipment required to conduct ranging, TT&C and/or Data Reception (DR) operations for a Satellite.
Facility	Consists of one or multiple unique ground station Antennas, and appropriate equipment, connectivity and personnel to enable either or both TT&C and DR operations.
Committed Facility	Is dedicated to the ARS for any one or all of its supported Missions and that is committed to fulfill the Committed Schedule that is being given to it by the ARS. A Schedule sent to an Committed Facility is assumed by the ARS to be blindly accepted and committed with the only exception of unforeseen events such as Antenna breakdown. It is expected that Committed Facilities be able to process the Committed Schedule within few minutes if they want to qualify for Missions that have Fast-Tasking requirements.

Uncommitted Facility	Is a Facility, domestic or foreign, that is controlled by a third-party organization but allows tasking of its Antennas through a request and confirmation process. The Approved Schedule is sent to the Uncommitted Facility in the form of an Antenna Access Request. The ARS is expecting a responsive Confirmation of the requested Schedule from the Facility by acceptance of the individual Satellite Contact entries on the submitted Antenna Access Request. Responsiveness of the Antenna Access Confirmation from the Uncommitted Facility is key to ARS' overall responsiveness in producing a Committed Schedule for the Missions Therefore, it is expected that Uncommitted Facilities be able to reply with the Confirmation within few minutes if they want to qualify for Missions that have Fast-Tasking requirements.
Network Station	Is an Antenna station used for local DR of commercial data dedicated to a commercial client of a given Mission. A Network Station is controlled by the data user and generally tasked by the user synchronously with the order of data from the Mission.
Satellite Orbit TLE	Is the orbital information at an epoch time required to propagate a Satellite's orbit and provided in a standard message format like the NORAD Two-Line Elements (TLE) (see AD-3)
Orbit Propagator	Is the module or set of functions (such as SGP4) required to extrapolate the Satellite's geographical position in the future from the TLE at Epoch in order to predict Satellite Contacts over Facilities. The Orbit Propagator does not necessarily require the orbit determination module to produce its own TLE from Satellite tracking data, as the TLE is generally provided by Missions or available from the online catalogue.
Satellite Attitude Ephemeris	Describes de satellite attitude in standard type like quaternion, which is required to determine RF contacts, particularly in the case of inertial pointing satellites and when the satellite antenna radiation pattern is far from the ideal isotropic case.
Satellite Antenna Definition	Describes the location, bore-sight and cone angle of receiver/transmitter antenna to be used in conjunction with the Satellite Attitude Ephemerides to determine RF contacts
Satellite Contact and Time	
Time Window	Is the time span referring to the Scheduling exercise. This may spans over several days or weeks depending on operational needs. It may also be specified to start in the future to prevent unnecessary rescheduling of imminent Committed Contacts.
Availability Time Window	Is a Time Window used in Configurations referring to the availability time of resource or personnel.

Satellite Contact	Is the time span where the Mission Satellite have a contact line-of-sight with a Facility Antenna resource, and which the resource can be allocated to the Mission on a Schedule.
Compliant Contact	Is a Satellite Contact that satisfies all the System, Mission and Facility Configuration Constraints while being a valid Contact as propagated from the Satellite Orbit TLE. The outcome of this validation process forms the Compliant Satellite Contact List.
Time Period	Is the time span specified in a Satellite Time Request within which the ARS has to allocate the Satellite Contact Times.
Satellite Contact Time	Is the total time duration specified in a Satellite Time Request to be allocated by the ARS within a Time Period The Satellite Contact Time can be sliced across more than one Satellite Contacts depending on the availability of Antennas within the Time Period and according to specific Mission constraints relative to minimal Contact Time.
Satellite Contact States:	(see AD-1 for Contact State Change Transition Diagram)
AVAILABLE	Is the status of a Contact Opportunity requested by the Mission through a Contact Opportunity Request that is *a priori* not in conflict with other GAS Committed or Reserved Satellite Contacts. However, an Available Contact does not guarantee that the Mission will be allocated the Contact upon a formal Satellite Contact Request.
UNKNOWN	Is the status of a Contact Opportunity requested by the Mission through a Contact Opportunity Request which availability is *a priori* not known to the GAS. This is mostly the case for all Contacts pertaining Uncommitted Facilities as the Facility has to accept the Requested Contact during the Antenna Access Request process.
CONFLICT	Is the status of a Contact Opportunity requested by the Mission through a Contact Opportunity Request that is *a priori* in conflict with another ARS Committed or Reserved Satellite Contact. The Mission may still request the Conflicted Contact to the ARS for tentative allocation with a formal Satellite Contact Request. That request may in some cases overrule (bump) the previous Contact during the de-conflicting and optimization process, either automatically or manually by the ARS Operator, and according to specific rules. Otherwise, the Requested Contact will still allow the rescheduling capability of the ARS to search for an alternate Satellite Contact for the Mission.

RECEIVED	Is the status of a requested Satellite Contact by the Mission through a Satellite Contact/Time Request that has been received by the ARS and nominally validated as Compliant but is pending Operator's admittance for scheduling.
ADMITTED	Is the status of a validated Satellite Contact that has been admitted by the Operator for scheduling.
REQUESTED	Is the status of a consolidated Satellite Contact/Time that is being processed by the Scheduler or has been submitted to the Facility through an Antenna Access Request.
RESERVED	Is the status of a Satellite Contact that has been manually reserved by the Operator from the Compliant Satellite Contact List and that is approved for scheduling along with Requested Contacts/Times.
ACCEPTED	Is the status of a requested Satellite Contact through an Antenna Access Request that has been accepted by the Facility but is pending commitment by the ARS Operator.
COMMITTED	Is the status of a Satellite Contact that has been accepted by the Facility and committed by the ARS.
WITHDRAWN	Is the status of a previously requested Satellite Contact that has been withdrawn by the Mission on a subsequent Satellite Contact/Time Request.
REJECTED	Is the status of a requested Satellite Contact that has been rejected either by the Facility or by the ARS.
CANCELLED	Is the status of a previously Accepted or Committed Satellite Contact that has now been cancelled by the Facility for exceptional reasons.
RESCHEDULED	Is the status of a requested Satellite Contact that has been rejected either by the Facility or by the ARS and that has been automatically rescheduled from another available Contact by the ARS. The replacement Contact will follow the acceptance and commitment process like any other requested Contact. Once Committed, the Rescheduled Contact will keep the Rescheduled label in order to notify the Mission/Facility of a time and/or Antenna change from the initial Request.
CONTINGENCY	Is the status of a Satellite Contact that has been added by the ARS as a backup to another EMERGENCY Contact on a different Antenna but without being formally allocated. The Contingency Contact is meant not to be de-conflicted, but just a fall-back option in case of urgent spacecraft emergency situation where the associated Committed EMERGENCY Contact has failed. At this stage, any bumping of pass will be handled live by the Operator

	and the Facility's Operator, on a case by case basis, and according to agreed upon rules.
ADDED (secondary internal state)	Is the status of a Satellite Contact that has been added by the ARS or the Operator and is not directly tied to a specific Satellite Contact/Time Request. This internal status is secondary and goes in addition to any other status pertaining the approval and commitment process of a Schedule.
LOCKED (secondary internal state)	Is the status of a Committed Contact that has been Locked by the Operator to prevent any future automatic unallocation or rescheduling by the System. This internal status is secondary and goes in addition to any other status pertaining the approval and commitment process of a Schedule.
Contact Criticality	Is the qualifier of a Contact that allows prioritization during the de-conflicting process in the computation of a Schedule. Criticality ratings could be defined in importance as EMERGENCY, IMPORTANT, ROUTINE, and PROFICIENCY.
Criticality Ratings:	
EMERGENCY	Is considered the highest priority Contact type and relates to the spacecraft Health & Safety (launch, collision avoidance, Satellite emergency recovery).
IMPORTANT	Is considered the second highest priority Contact type and relates to time-sensitive or emergency operations of the Mission (Fast-Tasking, Near-Real-Time (NRT) download, disaster monitoring, national security, etc.).
ROUTINE	Relates to all other nominal and operational Contacts.
PROFICIENCY	Is considered the lowest priority Contact type and relates to a contact that is required for periodical or ad-hoc validation and testing of the end-to-end ground systems with a specific Facility.
Schedule	
Schedule	Is a list of time-tagged Satellite Contacts for all Missions that have been allocated amongst the pool of Facility Antennas for a given Time Window. **A Schedule is conflict-free**, that is only a single Satellite Contact is allocated at any given time to an Antenna and with enough time margin to allow Antenna setup between Contacts. It contains, in addition, a set of fields describing for each Contact the Mission Satellite ID, the Facility Antenna ID, the Acquisition of Signal (AOS) time, Contact duration, Loss of Signal (LOS) time, maximum antenna elevation, RF bands, RF data rate, etc. The Schedule in the context of the ARS does not contain data

	downlink, processing or management information specific to the execution of the Data Reception contact for a given Mission. This detailed information has to be provided by the specific Mission to the Facility through another channel than the ARS.
Facility Schedule	Is a subset of the Schedule that represents only the Satellite Contacts and fields relevant to a given Facility.
Mission Schedule	Is a subset of the Schedule that represents only the Satellite Contacts and fields relevant to a given Mission.
Schedule States:	(see AD-1 for Schedule State Change Transition Diagram)
PRELIMINARY	Is the status of a Schedule that has been generated by the System but is pending Operator's approval before sending Antenna Access Requests to Uncommitted Facilities.
APPROVED	Is the status of a Preliminary Schedule that has been approved by the Operator for access request to Uncommitted Facilities.
ACCEPTED	Is the status of a Schedule containing all Accepted Contacts from Facilities but is pending Operator's final commitment.
COMMITTED	Is the status of an Accepted Schedule that has been approved by the Operator for distribution to Missions and Committed Facilities.
OBSOLETE	Is the status of a Schedule that has been overruled by a new Committed Schedule.
Interface Messages:	
Satellite Contact Request	Is a list of desired specific Satellite Contacts that are requested by the Mission for allocation by the System on the Schedule. A Request may also include added, removed and modified Contacts from a previous Request with respect to the same Schedule Time Window.
Satellite Time Request	Is a list of desired Satellite Contact Times over desired specific Time Periods that are requested by the Mission for allocation by the System on a Schedule. Those Contact Times may exceed any single Contact duration and overlap across several Contact opportunities or Facilities. The System requires advanced allocation processing in order to efficiently distribute and allocate time requests amongst specific Contact opportunities in conjunction with the other standard Satellite Contact Requests.
Standing Request	Is a specific Satellite Time Request that repeats itself periodically (i.e. daily, weekly or monthly) and for a finite Standing Time Period.
Request Validity Report	Is a Satellite Contact/Time Request that was checked and validated

	by the System against a Compliant Satellite Contact List. The Report includes an invalidity explanation field. The report is used internally by the ARS but also is intended to be used as a form of acknowledgment to a Satellite Contact/Time Request when sent back to the Mission.
Compliant Satellite Contact List	Is the list of all Compliant Contacts for all Satellites and all Antennas generated by the Orbit Propagator and associated with a defined Schedule Time Window.
HBR Contact List	Is the list all Compliant Contacts for all Satellites and all Antennas generated by the Orbit Propagator in conjunction with the propagation of the Satellite Attitude Model, when provided in the Mission Configuration. The HBR Contact List is therefore a more constrained version of the Compliant Satellite Contact List.
Contact Opportunity Report	Is the list of all Contact Opportunities over the qualified Antennas for the specified Satellites that are generated by the Contact Opportunity Request Handler and associated with a defined Schedule Time Window.
Contact Opportunity Request	Is a simple query from a Mission to obtain the Contact Opportunity Report over a Time Period.
Antenna Access Request	Is a list of Contact Times where the System requests access to Uncommitted Facility Antenna resources in support of Missions.
Request Acknowledgment	Is a return message acknowledging reception of a Satellite Contact/Time Request by the ARS or Antenna Access Request by the Uncommitted Facility.
Antenna Access Confirmation	Is a return message accepting, rejecting or canceling Satellite Contacts from the Schedule of an Antenna Access Request. Responsiveness of the Confirmation from the Uncommitted Facility is key to ARS' overall responsiveness in producing a Committed Schedule for the Missions.
Antenna Unavailability Report	Is a list of Time Windows where the Facility Antenna is not available for allocation to a Mission. Antenna Unavailability Reports are unsolicited by the ARS and could be received at any time from the Facilities. The reasons for Unavailability can be anything from planned Antenna maintenance to reserved time slots for any other Mission or reason at the Facility's discretion, in the case of an Uncommitted Facility. In the Case of an Committed Facility, as the Facility is dedicated to the ARS, it is not expected that the Committed Facility be unavailable for other commitments except for maintenance.
Scheduling Report	Is a summary of Mission requirements fulfillment and Facility usage resulting from a specific Schedule. This may include the total

	time allocated for each Mission Satellite on Facility Antennas, the unallocated/reallocated Satellite Contacts from Requests, and relative figures of merit of allocation time and requirement fulfillment.
Facility Scheduling Report	Is a subset of the Scheduling Report that displays the specific Antenna usage relevant to a Facility.
Mission Scheduling Report	Is a subset of the Scheduling Report that displays the Satellite Contact allocation relevant to a Mission.
Configuration	Is a set of user-configurable parameters that captures the definition, constraints and requirements of a Facility, a Mission or the System . Its format could be stored as readable, binary or XML file, or simply captured by a user interface. Every System, Facility and Mission Configuration use their respective structure type but each individual has its unique parameter Configuration.
Configuration Constraints	Is a subset of the Configuration parameters that specifically addresses constraints to be used during orbit propagation and also for validation of Satellite Contact/Time Requests.

3 DOCUMENTS

3.1 APPLICABLE DOCUMENTS

The following documents of the exact issue date and revision level shown are applicable and form an integral part of this document to the extent specified herein.

Ref #	Document Number	Revision	Title
AD-3	MMCSA-IC0003	2.7	Multi-Mission Antenna Reservation System (ARS) ICD
AD-4	MMCSA-IC0002	C	Live Schedule Board ICD
AD-5	RCM-IC-53-1948	2/1	RCM Reservation System ICD
AD-1	MM-CSA-CO-0001	1.5	Multi-Mission Antenna Reservation System (ARS) Concept of Operations

3.2 REFERENCE DOCUMENTS

The following documents provide additional information or guidelines that either may clarify the contents or are pertinent to the history of this document.

Ref #	Document Number	Revision	Title

4 ARS OVERVIEW

The ARS is a multi-mission tool part of the MMOC necessary to coordinate antenna resource allocation to multiple satellite missions. The ARS becomes more necessary when the number of satellites sharing the same pool of available antenna increases and when conflicts to antenna resource access occur more frequently. The ARS is therefore responsible to receive contact time requests from missions and best meet all mission requirements by carefully reserving antenna time to the various missions on a priority and performance basis.

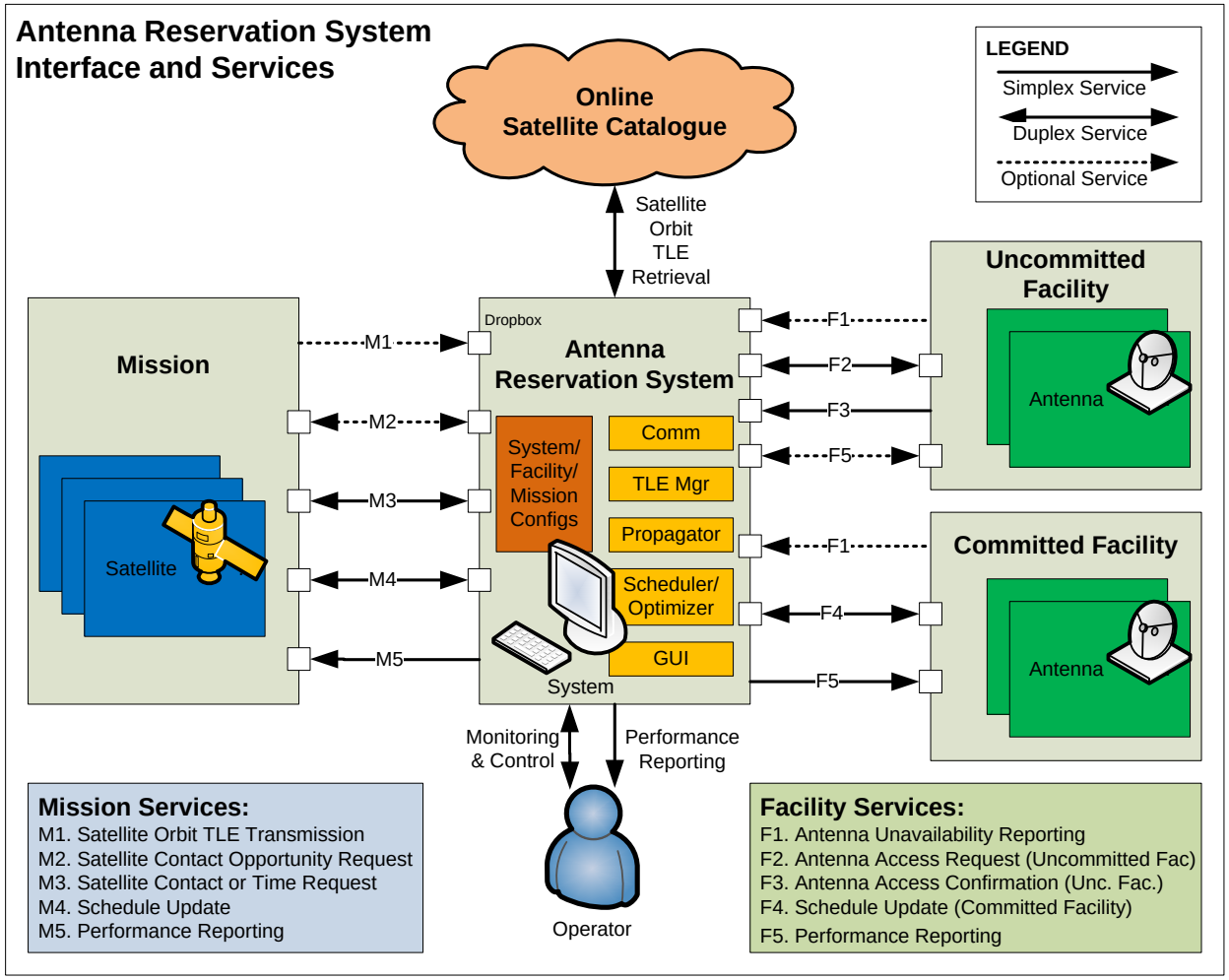

FIGURE 4-1 ARS INTERFACE AND SERVICES OVERVIEW

The ARS may be seen as the central point where all mission requests for antenna time converge to a single reservation system and where all facility resources are allocated for both TT&C and DR (For a detailed process flow diagram, refer to AD-1). The ARS does not deal with actual satellite operation requirements or direct commanding interfaces between the missions and the facilities (like the Spacecraft Control Subsystem (SCS)). However, the ARS does provide missions with a central antenna reservation tool to coordinate all Satellite Contacts and mitigate conflicts. In addition, the ARS does provide one interface definition to the missions therefore saving the missions from having to manage several scheduling interfaces with the various facilities. Finally, the ARS provides one point of decision making, through the Operator and

user-configurable System Configurations, when it's the time to handle different contact priority levels and mitigate conflicts.

For the detailed Service descriptions, refer to AD-3.

4.1 OPERATIONAL SEQUENCE OF EVENTS

The ARS typical nominal sequence of events goes as follow:

Event 1. Reception of an unsolicited message: The ARS receives any asynchronous and unsolicited message (stimulus) amongst:

a. Contact Opportunity Request from a Mission;

b. Satellite Contact/Time Request from a Mission;

c. Satellite Orbit TLE from a Mission or manually entered by the Operator;

d. Antenna Unavailability Report from either an Committed or an Uncommitted Facility;

e. Changes to a previously received Antenna Access Confirmation from an Uncommitted Facility.

Event 2. Generation of Compliant Satellite Contact List: Upon reception of stimuli (c), (d), or (e) from Event 1, the ARS automatically propagates the orbits from Satellite Orbit TLE and generates the List of all Satellite Contacts opportunities that are compliant to Mission and Facility Constraints.

Event 3. Generation of Contact Opportunity Schedule: Upon reception of stimuli (a) from Event 1, the ARS generates a Contact Opportunity Schedule from the Compliant Satellite Contact List and the previous Committed Schedule, then sends back a Request Validity Report to the Mission.

Event 4. Validation of Satellite Contact/Time Request: Upon reception of stimuli (b), (c), (d), or (e) from Event 1, the ARS (re-)verifies the validity of all Contacts or Times in the Satellite Contact/Time Request against the Compliant Satellite Contact List and then sends back a Request Validity Report to the Mission.

Event 5. Admittance of Satellite Contact/Time Request: The ARS submits the Request to the Operator for modification and admittance to scheduling. (Note that modification and admittance is made in accordance with operational procedures and directives from the Mission Control Board in order to insure proper operation of the ARS.)

Event 6. Consolidation of Satellite Contact/Time Requests: The ARS consolidates separate and complementary Requests that may cover different services or RF bands but pertaining the same Satellite Contact. (This especially addresses the RCM concept where TT&C and DR Requests are submitted independently by the MPS). The ARS also creates/spawns individual Satellite Contact Times from accepted Standing Requests and Mission Configuration (for Autonomous Contact Management) over the Schedule Time Window.

Event 7. Manual Contact Reservation: In parallel, the Operator may at this point directly reserve Contacts from the Compliant Satellite Contact List, with superseding

priority over the Satellite Contact/Time Requests. (Note that direct reservation is made in accordance with operational procedures and directives from the Mission Control Board in order to insure proper operation of the ARS.)

Event 8. Generation of the Preliminary Schedule: From accepted Satellite Contact/Time Requests and manually Reserved Contacts, the ARS automatically de-conflicts and computes a Preliminary Schedule based on priority and performance factors.

Event 9. Approval of Preliminary Schedule: The ARS submits the Preliminary Schedule to the Operator for approval. If approval is refused by the Operator, the Operator can change Configurations or Requests, thus forcing re-execution from Event 2, Event 5 or Event 7.

Event 10. Antenna Access Request: The ARS sends the Approved Schedule to Uncommitted Facilities in the form of Antenna Access Requests for their acceptance.

Event 11. Antenna Access Confirmation: Uncommitted Facilities reply with a Request reception acknowledgement and send an Accepted Schedule as a Antenna Access Confirmation. (Note that at any later time, an Uncommitted Facility could change its Schedule acceptance status by resubmitting an unsolicited modified Confirmation referring to the appropriate Antenna Access Request, in which case the ARS will be forced back to Event 6)

Event 12. Commitment of the Accepted Schedule: The ARS submits the Accepted Schedule from the Facilities to the Operator for commitment. If commitment is refused by the Operator, the Operator can change Configurations or Requests, thus forcing re-execution from Event 2, Event 5 or Event 7.

Event 13. Distribution of the Committed Schedule: The ARS distributes the Committed Schedule to Missions and Committed Facilities (Uncommitted Facilities are expected to abide by their own Antenna Access Confirmation at Event 11).

Event 14. Committed Schedule Acknowledgment: Missions and Committed Facilities reply with a Schedule reception acknowledgement.

Event 15. Distribution of Scheduling Reports: The ARS computes and sends Scheduling Reports to Missions and to the Operator.

In parallel to the whole sequence of events, the ARS retrieves periodically the Satellite Orbit TLE from online satellite catalogues to make sure the information is always up to date in case the Mission doesn't send it during Event 1.

Also, at any time, the Operator can manually abort and start the computation of a Preliminary Schedule and make changes to Configurations, thus forcing the re-execution of the Sequence from Event 2, Event 5 or Event 7.

For a detailed process flow diagram, refer to AD-1.

5 ARS REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS

[ARS010] Primary objective: The ARS shall manage Facility resource allocation for all supported Missions in a way to mitigate conflicts and maximize Satellite Contacts with respect to Facility Antennas availability.

5.1.1 Initialization of the System

[ARS020] Composition of the System Configuration: The ARS shall have a user-configurable System Configuration that includes:

- List of Missions with associated relative priority,
- List of Facilities with associated relative preference,
- Scheduling Time Window start time and duration,
- Operator's daily Availability Time Window,
- Uncommitted Facility Confirmation Timeout (as per [ARS380]),
- Optimal Schedule Solution Timeout (as per [ARS375]),
- Automatic scheduling enables [fixed-time fixed-interval, upon generation of Compliant Satellite Contact List, upon Contact Request, upon Antenna Access Confirmation] (as per [ARS100]), and
- User-selectable optimization cost function and weightings (as per [ARS120]),
- Automatic override of Operator's approval enables (as per [ARS270])
- Time Reference Format selection [YMD, Year-DOY].

Note 1: Having System Configurations specifying various stimuli for automatic computation does not preclude the Schedule to be computed for a different start time in the future and for a longer duration than 24h.

Note 2: Operator's daily Availability Time Window is useful to enable automatic rescheduling, especially for Fast-Tasking Requests, when the acceptance and commitment of Schedules are manually handled by the Operator.

[ARS030] Composition of the Facility Configuration: The ARS shall have one user-configurable Facility Configuration per schedulable Antenna resource that includes:

- Facility name,
- Antenna identifier,
- Antenna geographical location coordinates (longitude, latitude, altitude),

- Remote operator station,
- Facility type flag [Committed, Uncommitted],
- Confirmation Timeout time (for Uncommitted Facility only)
- Antenna access cost,
- Contact scheduling constraints:
  - Supported frequency bands [S, X, C, …],
  - Supported services [Ranging (RNG), Telecommanding (TC), Real-time telemetry (RT-TM), store & forward telemetry (SF-TM), Real-time data reception (RT-DR), store & forward data reception (SF-DR)],
  - Supported coherent mode [Y/N],
  - Supported polarizations [RHCP, LHCP, VP, HP],
  - Supported X-Band channels,
    - Channel 1
    - Channel 2
  - Pre-pass setup time,
  - Post-pass closeout time, and
  - Minimum Contact Time,
  - Daily Station operator Availability Time Window (for Fast-Tasking rescheduling capability if Station is not automated)
- Systematic/recurring unavailability constraint,
  - Transmission elevation mask,
  - Reception elevation mask, and
  - Key-hole.

Note: The ARS will take into account the Antenna elevation constraints (masks) both from the Facility Configuration and the Mission Configuration, applicable to all azimuth angles.

[ARS040] Composition of the Mission Configuration: The ARS shall have one user-configurable Mission Configuration per Satellite that includes:

- Mission name,
- Spacecraft identifier and catalogue number,
- Automatic override of Operator's approval enables (as per [ARS270]),
- Contact scheduling constraints:
  - List of qualified Facility Antennas (ordered by Mission's preference),

- Daily operational Time Window (real-time pass activities), where applicable,
- Daily planning Time Window (used for automatic contact rescheduling),
- Mission replanning lead time (used for automatic contact rescheduling),
- Orbit TLE obsolescence time (used to trigger automatic online update)

- Default Contact parameter constraints (when not specified in the Request):
  - Contact RF bands [S, X, C, …],
  - Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR],
  - Supported coherent mode [Y/N],
  - Polarizations [RHCP, LHCP, VP, HP],
  - Number of data channels,
  - Minimum Antenna elevation,
  - Minimum Contact Time, and
  - List of Preferred Antennas (especially useful for Satellite Time Requests targeting specific Network Stations for their data downlink),
- High Bit Rate (HBR) Contact constraints (for attitude propagation and HBR contact time estimation):
  - HBR constraint flag,
  - Spacecraft Antenna Definition, and
  - Spacecraft Attitude Model.

Note 1: Default constraints can be overruled by specifying optional Contact parameters in the Satellite Contact/Time Request as defined by AD-3.

Note 2: The ARS will take into account the Antenna elevation constraints (masks) both from the Facility Configuration and the Mission Configuration, applicable to all azimuth angles.

[ARS041] Augmented Mission Configuration: In the event that a Mission requires Autonomous Contact Management [ARS057], the Mission Configuration should also include:

- Autonomous Contact Management flag
- Scalable set of Contact Types (used for Autonomous Contact Management):
  - Contact Type name and identifier,
  - Spacecraft valid operational mode for Type [NOMINAL, LEOP, EMERGENCY, PROFICIENCY],
  - Autonomous Contact Management Constraints:

- Contact Type Criticality [PROFICIENTCY, ROUTINE, IMPORTANT, EMERGENCY],
- Contact RF bands [S, X, C, …],
- Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR],
- Polarizations [RHCP, LHCP, VP, HP],
- Number of data channels,
- Minimum Antenna elevation,
- Minimum Contact Time (superseding [ARS040]),

o Autonomous Contact Management Requirements:

- Minimum number of Contacts per day,
- Minimum and maximum gap between Contacts,
- Minimum total daily contact time.

5.1.2 Operational Sequence Event 1: Reception of Unsolicited Message

[ARS050] DELETED.

[ARS055] Contact and Time Requests: The ARS shall be able to receive and process both conventional Satellite Contact Requests and Satellite Time Requests as per AD-3 and AD-5.

Note: The Concept of Operations (AD-1) provides additional details of the interfaces.

[ARS056] Standing Requests: The ARS shall be able to receive and process Standing Requests for Satellite Contact Times that repeat periodically and for a finite Standing Time Period.

[ARS057] Autonomous Contact Management: The ARS should be able to autonomously manage and fulfill Mission Contact requirements based on predefined Augmented Mission Configuration [ARS041] as opposed to receiving Satellite Contact/Time Requests.

Note: Autonomous Contact Management is an advanced ARS feature that will allow antenna reservation based on Mission Requirements.

[ARS060] Update of Satellite Orbit TLE: The ARS shall keep Satellite Orbit TLE up to date by receiving it from Missions and by automatically retrieving it daily from online satellite catalogues (space-track.org, celestrak.com).

[ARS061] Default Satellite Orbit TLE: The ARS shall default to the online satellite catalogue data update only if the Mission did not provide updated Satellite Orbit TLE for a user-configurable obsolescence time ([ARS040]).

[ARS062] Satellite Orbit TLE Manager: The ARS shall manage and select the most relevant TLE at Epoch when a list of TLEs are provided to the ARS by the Mission or manually entered.

Note: Epoch time of a TLE and generation time of the TLE file may be in contradiction when the orbital data is projected in the future. Hence, generation time of the TLE file should be taken into account when deciding what is the more accurate orbital data to be taken at Epoch to make the orbit propagation.

5.1.3 Operational Sequence Event 2: Generation of Compliant Satellite Contact List

[ARS070] Orbit Propagator and Satellite Contacts prediction: The ARS shall propagate Satellite Orbit TLE and generate the Compliant Satellite Contact List within the configured Scheduler Time Window based on both Mission and Facility Configuration Constraints, as well as the Antenna Unavailability Reports.

Note: It is expected that the SGP4 algorithm be sufficient to meet antenna tracking accuracy requirements with the TLE being updated daily.

[ARS071] Satellite Contacts prediction constraints: The various constraints used in Contacts prediction shall be user-selectable and include:

- Facility Configuration scheduling constraints [ARS030],
- Mission Configuration Contact scheduling and default parameter constraints [ARS040], and
- Satellite Contact/Time Request specific parameters, when provided.

Note: A Satellite Contact/Time Request may cover a Schedule Time Window larger than that one specified in the System Configuration, in which case, the System Configuration may prevail (TBC), hence the Mission would be provided with a partial Schedule in answer to its Request.

[ARS072] Attitude Model Propagation: The ARS should propagate the Satellite Attitude Ephemeris according to the Mission Configuration Attitude Model and generate the HBR Contact List from the Compliant Satellite Contact List.

[ARS075] Automation of the orbit propagation and Satellite Contacts prediction: The ARS shall automatically compute a new Compliant Satellite Contact List upon reception of any of the input stimuli:

- every time an updated Satellite Orbit TLE is received (or manually entered),

- every time a new Satellite Contact/Time Request is received from a Mission, and
- every time a new Antenna Unavailability Report is received from a Facility.

5.1.4 Operational Sequence Event 3: Generation of Contact Opportunity Schedule.

[ARS078] Generation of Contact Opportunity Schedule: The ARS shall automatically compute and return the Contact Opportunity Schedule upon reception of Contact Opportunity Request from a Mission.

5.1.5 Operational Sequence Event 4: Validation of Satellite Contact/Time Request

[ARS080] Validation of a Satellite Contact/Time Request: The ARS shall validate Satellite Contact/Time Requests against the Compliant Satellite Contact List and generate a Request Validity Report.

Note: As the Satellite Contact Request is bound by constraints specified as optional parameters (AD-3) or indirectly through the Mission Configuration, validation refers to matching those constraints with the Facility Configuration constraints. The intent is to filter out all non-compliant Requests before they are needlessly processed by the Optimizer in Event 8.

[ARS090] Request Validity Report: The Request Validity Report shall contain the Request information plus a programmable invalidity qualifier field (e.g. antenna unavailable, wrong antenna, wrong frequency band, wrong service, wrong time, etc. (as per [ARS422])).

5.1.6 Operational Sequence Event 5: Admittance of Satellite Contact/Time Request

Not applicable for this Section

5.1.7 Operational Sequence Event 6: Consolidation of Satellite Contact/Time Requests

[ARS095] Pre-Screening of Schedule inputs: The ARS shall pre-screen new Satellite Contact/Time Requests and Compliant Satellite Contact List against the existing Committed Schedule to ensure the necessity for de-conflicting and optimization.

Note: This is intended to keep the previous commitments intact if there is no additional conflicts from the new inputs. However, an updated Schedule will still be produced to reflect the added entries, if required. This can be the case when a new Satellite Contact is requested and Antenna resource is already available for the time requested on the current Schedule, or when an Antenna resource is declared unavailable by the Facility but was not yet allocated for that same Time Window on the current Schedule.

[ARS096] Contact Time Spawning of Standing Requests: The ARS should spawn individual Satellite Contact Times from accepted Standing Requests over the Schedule Time Window.

[ARS097] Contact Time Spawning for Autonomous Contact Management: The ARS should spawn individual Satellite Contact Times in the event that a Mission is requiring Autonomous Contact Management based on predefined Augmented Mission Configuration [ARS041] as opposed to Contact/Time Requests.

[ARS098] Consolidation of Satellite Contact/Time Requests: The ARS shall consolidate separate and complementary Requests that may cover different services or RF bands but pertaining to the same Satellite Contact.

Note: This especially addresses the RCM concept where TT&C and DR Requests are submitted independently by the MPS, although requiring access to the same shared Facilities.

5.1.8 Operational Sequence Event 7: Manual Contact Reservation

Not applicable for this Section

5.1.9 Operational Sequence Event 8: Generation of Preliminary Schedule

[ARS099] Computation of the Schedule: The ARS shall compute a Schedule within the configured Scheduler Time Window, from accepted Satellite Contact/Time Requests and based on System Configuration Constraints.

Note 1: Refer to Definitions for implicit qualities and properties of a Schedule.

Note 2: Refer to [ARS220] for admittance of a request.

Note 3: It is expected that the ARS be able to allocate specific Contacts from the Compliant Satellite Contact List to Satellite Time Requests in order to allow the de-conflicting and optimization process against other conventional Satellite Contact Requests.

[ARS100] Automation of the Schedule computation: The ARS shall compute the Schedule automatically upon enabled internal and external stimuli as specified by the user-defined System Configuration,

- at a fixed-time fixed-interval,
- every time a new Compliant Satellite Contact List is generated,
- every time a new Satellite Contact/Time Request is approved (subject to ARS270), and
- every time a change to an Antenna Access Confirmation is received from an Uncommitted Facility.

Note 1: It is expected that the System will be operationally configured for all the above stimuli in order to meet Emergency requests and other Fast-Tasking requirements.

Note 2: It is assumed that no deadline be required for submitting a Satellite Contact/Time Request as the rescheduling functionality should take care of tight requests in order to mitigate processing time and specific Facility antenna setup times.

[ARS110] Schedule de-conflicting rules: The ARS shall compute a Schedule based on a set of user-configurable hard rules.

Note 1: Rules will be defined during de design phase of the project in order to best meet expected behaviour of the system.

Note 2: As per Definitions (Section 2.2), fast-tasking Contacts will be requested as IMPORTANT, and spacecraft emergency will be requested as EMERGENCY.

[ARS120] Schedule optimization factors and constraints: The ARS shall de-conflict the Compliant Satellite Contact List and compute a Schedule by optimizing a user-configurable weighted cost function based, on:

- Satellite Contact Requests fulfillment,
- Satellite Time Requests fulfillment:
  - required number of daily Contacts,
  - required total daily contact time,
- System Configuration priority factors:
  - Mission priority,
  - Facility preference,
  - Contact Criticality,
- Schedule performance factors:
  - total number of Satellite Contacts,
  - total Contact time duration, and
  - total Antenna access cost.

Note 1: It is assumed that the optimization cost function could be a linear equation made from the combination of one or more of the optimization factors and their respective user-configurable weighting parameters.

Note 2: Mission priorities are agreed upon by a board of Mission Managers and implemented by the Operator such as to meet expected behaviour of the System.

[ARS121] Advanced Schedule optimization algorithm: The ARS should use advanced de-conflicting and optimization algorithm not solely based on maximization of a linear cost function in order to improve the conflict resolution as well as the processing time.

Note: For instance, the ARS could leverage neuro-fuzzy or other optimization schemes to achieve a faster or more efficient solution.

[ARS130] Rescheduling of overruled Committed Satellite Contacts: The ARS shall automatically reschedule an overruled Committed Satellite Contact from the Compliant Satellite Contact List and in accordance with the value of the Contact Request reschedulability field (when provided on Satellite Contact/Time Request (defined in [ARS412]) and constrained by the Mission Configuration.

[ARS131] Contact Request Reschedulability Field: The Contact Request reschedulability field shall specify to:

- Drop the requested Contact completely, or
- Reschedule within a validity Time Period (e.g. opportunity window for fast-tasking requests), or
- Reschedule at best (no Time Period).

[ARS140] Tracking of Schedule changes: The ARS shall keep track of what Contacts are added and deleted from a previous Schedule applicable to the same Time Window.

[ARS141] Contact Update Field: The Schedule shall contain a separate Contact Update field to indicate whether the specific Contact is NEW or REMOVED from the previous Schedule.

Note: Tracking of added/removed Contacts between Schedule iterations should be independent of the Contact Request Status field on a given Schedule (as per [ARS431]).

[ARS150] Contingency Contact identification process: For each scheduled EMERGENCY Contact, the ARS should identify a duplicate Contingency Contact at the earliest possible time on another Facility Antenna that is also not in conflict with another EMERGENCY Contact.

Note: The Contingency Contact is not meant to be de-conflicted, but just a fall-back option in case of urgent spacecraft emergency situation where the scheduled EMERGENCY Contact has failed. At this stage, any bumping of pass will be handled live by the Operator and the Facility's operator, on a case by case basis, and according to agreed upon rules. It is understood that a Contingency Contact will only be triggered if the Operator is available and oversees execution of the EMERGENCY Contact. Also, it is expected that

identification of Contingency Contacts be constrained by the normal operation Time Windows at the Facility.

[ARS151] Contingency Contact allocation process: The Contingency Contact allocation process shall leave the Antenna resource unreserved and available to the System for normal de-conflicting and computing of the Schedule.

Note 1: This requirement is applicable only in combination with [ARS150].

Note 2: It is assumed that the Contingency Contact occurs after the de-conflicting and optimization process and thus does not increase the computational burden on the processor for finding a de-conflicted schedule solution.

[ARS152] Contingency Contact labeling: The Contingency Contact shall be shown on the Schedule as Contingency Contact.

Note 1: This requirement is applicable only in combination with [ARS150].

Note 2: the Contingency Contact will also show on the Antenna Reservation Request, but not necessarily de-conflicted from non-EMERGENCY Contacts.

[ARS153] DELETED.

5.1.10 Operational Sequence Event 9: Approval of Preliminary Schedule

[ARS160] Generation of Approved Schedule derived products: The ARS shall generate from the Approved Schedule one Facility Schedule specific to each Uncommitted Facility.

Note: The Approved Schedule specific to the Uncommitted Facility is used for the Antenna Reservation Request addressed by the interface requirement ARS510.

5.1.11 Operational Sequence Event 10: Antenna Access Request

Not applicable for this Section

5.1.12 Operational Sequence Event 11: Antenna Access Confirmation

Not applicable for this Section

5.1.13 Operational Sequence Event 12: Commitment of Accepted Schedule

[ARS170] Generation of Committed Schedule derived products: The ARS shall generate from the Committed Schedule one Facility Schedule specific to each Committed Facility and one Mission Schedule specific to each Mission.

Note: The submission of the specific Facility and Mission schedules are addressed with the interface requirements ARS540 and ARS430 respectively.

5.1.14 Operational Sequence Event 13: Distribution of Committed Schedule

Not applicable for this Section

5.1.15 Operational Sequence Event 14: Committed Schedule Acknowledgment

[ARS180] Committed Schedule retransmission: The ARS shall retransmit a Committed Schedule when Acknowledgment is not received within a user-configurable time.

Note: This is applicable to both Missions and Committed Facilities as per AD-1 Process Flow Diagram.

5.1.16 Operational Sequence Event 15: Distribution of Scheduling Report

[ARS190] Optimizer Scheduling Report: The ARS shall produce a Schedule optimizer Scheduling Report to the Operator that includes:

- Request fulfillment score indicating the number and proportion of Satellite Contacts allocated as per Request for each Mission,
- Requirement fulfillment score indicating the number of contacts and total contact time allocated as per Mission Configuration Requirement,
- Antenna total time usage and relative usage allocated to each Mission Satellite,
- Satellite total Contact time and relative Contact time allocated at each Facility Antenna,
- Number and proportion of rescheduled and unresolved conflicts per Mission and total, and
- Per Mission and per Facility and total Antenna access cost per day, and cumulative for the entire Schedule Time Window.

Note: It is expected that a Scheduling Report be produced along with and every time a new Committed Schedule is produced.

[ARS191] Facility Scheduling Report: The ARS shall produce a Facility Scheduling Report for each Facility including:

- Antenna total time usage and relative usage allocated to each Mission Satellite, Available unallocated Antenna time,
- Antenna Access Request fulfillment score indicating the number and proportion of Satellite Contacts allocated as per Request (for Uncommitted Facilities), and

- Number and proportion of Accepted, Rejected, and Cancelled Contacts (for Uncommitted Facilities).

Note: This requirement pertains only the Scheduling performance of the ARS, not taking into account the actual successful execution of the Schedule by the Facility, which requires some sort of feedback from the Facility. It is expected that feedback on successful execution of the Schedule be handled by the Mission through the appropriate ICD.

[ARS192] Mission Scheduling Report: The ARS shall produce a Mission Scheduling Report for each Mission including:

- Satellite total Contact time and relative Contact time allocated at each Facility Antenna,
- Request fulfillment score indicating the number and proportion of Satellite Contacts allocated as per Request, and
- Number and proportion of Committed, Withdrawn, Rejected, Cancelled and Rescheduled Contacts.

[ARS195] Accounting Report: The ARS shall produce an Accounting Report to the Operator for a user-specified Time Window that includes:

- The list of all Contacts including the Mission, Facility, Criticality level, and Contact Status fields,
- A summary of the number and proportion of Accepted, Withdrawn, Rejected, Cancelled, Rescheduled Contacts for each Mission and per Facility and Criticality level, and
- A summary of the number and proportion of Accepted, Rejected, Cancelled, Contacts for each Facility and per Mission and Criticality level.

Note: This requirement pertains only the Scheduling performance of the ARS, not taking into account the actual successful execution of the Schedule by the Facility, which requires some sort of feedback from the Facility. It is expected that feedback on successful execution of the Schedule be handled by the Mission through the appropriate ICD.

5.2 OPERATIONAL REQUIREMENTS

5.2.1 Operational Sequence Event 1: Reception of Unsolicited Message

[ARS200] Notification of Reception: The ARS shall notify the Operator when a Satellite Contact/Time Request, an Antenna Unavailability Report, or a change to an Antenna Access Confirmation is received.

Note: Notification is expected to be user-configurable in many forms from pop-up messages on the ARS interface accompanied with beeping alarm to email

notifications in order to insure attention from the Operator when prompted by the System.

5.2.2 Operational Sequence Event 2: Generation of Compliant Satellite Contact List

[ARS210] Manual entry of Satellite Orbit TLE: The ARS shall have a functionality for the Operator to manually enter or edit Orbit TLEs, for different Epoch times, and a way to overrule other TLE present in the System.

[ARS215] Manual generation of the Compliant Satellite Contact List: The ARS shall have a functionality for the Operator to manually launch the orbit propagation and Satellite Contacts prediction process.

Note: This functionality is particularly useful after the Manual entry of Satellite Orbit TLE in order to launch the process and obtain an updated Schedule.

5.2.3 Operational Sequence Event 3: Generation of Contact Opportunity Schedule.

Not applicable for this Section

5.2.4 Operational Sequence Event 4: Validation of Satellite Contact/Time Request

Not applicable for this Section

5.2.5 Operational Sequence Event 5: Admittance of Satellite Contact/Time Request

[ARS220] Admittance of Satellite Contact/Time Request: The ARS shall have a functionality for the Operator to individually accept, remove or add Contacts and reattribute Contact Criticality level on Satellite Contact/Time Requests.

Note 1: modification and admittance is made in accordance with operational procedures and directives from the Mission Control Board in order to insure proper operation of the ARS.

Note 2: The Mission is informed of any changes made by the Operator through the Committed Mission Schedule (defined in [ARS431]).

5.2.6 Operational Sequence Event 6: Consolidation of Satellite Contact/Time Requests

Not applicable for this Section

5.2.7 Operational Sequence Event 7: Manual Contact Reservation

[ARS230] Manual reservation of Satellite Contacts: The ARS shall have a functionality for the Operator to manually reserve Contacts on the Compliant Satellite Contact List before the computation of a Schedule.

[ARS231] Manual reservation priority: The manual reservation mechanism shall come before and have superseding rights over any priority decision making of the optimizer during the computation of a Schedule.

5.2.8 Operational Sequence Event 8: Generation of Preliminary Schedule

[ARS240] Manual override of automatic Schedule computation: The ARS shall have a functionality for the Operator to override the automatic computation of a Schedule, and manually start and abort its computation at any time.

5.2.9 Operational Sequence Event 9 and Event 12

[ARS250] Approval of Preliminary and Accepted Schedules: The ARS shall submit Preliminary and Accepted Schedule to the Operator for approval/commitment before promoting the Schedule from Preliminary to Approved state and from Accepted to Committed state.

Note 1: As per Definitions (Section 2.2), Accepted Schedule relates to the acceptance of an Antenna Access Request by the Facility from ARS and the Operator has to commit the Schedule after confirmation of the Request from the Facility.

Note 2: It is assumed that, if not bypassed ([ARS270]), Operators approval is required at any cost and would occur in a timely fashion as the Operator is expected to be available. Otherwise, no limit or cut-off time is imposed on the approval process (yet), thus this may lead to obsolete Contacts at the time of approval or commitment of the Schedule.

Note 3: Updated Schedule that overlaps a previous Committed Schedule is expected to change the status of overruled/bumped Contacts to REJECTED by the ARS until the contact is successfully rescheduled elsewhere in order to finally make it RESCHEDULED.

[ARS251] Backlog of previous Committed Schedules: The previous Committed Schedule shall become Obsolete but remain accessible and recoverable by the Operator at any later time.

Note 1: It is assumed that the backlog of previous Schedule be used in situations when the Operator makes changes to the optimized schedule and wants to revert back to the optimized one, assuming that no new information came from the Mission or the Facility.

Note 2: It is not expected that the backlog of previous Schedule be an issue on the ARS storage capacity, and it is expected that the Operator can clean up the backlog as needed.

[ARS252] Restoring of backlog Schedule: The ARS shall have a functionality for the Operator to re-commit a previous Schedule that was declared Obsolete.

Note: This reverse functionality will be used to recover from any operational mistake happening during the approval process of a Schedule.

[ARS260] Locking of Committed Contacts: The ARS shall have a functionality for the Operator to individually lock Committed Contacts on a Schedule to prevent any future automatic rescheduling process from overruling the Locked Contact.

[ARS261] Notification of Conflict with Locked Contacts: The ARS shall issue a warning to the Operator when a new Antenna Unavailability Report gets in conflict with a Committed Contact that was previously locked by the Operator.

[ARS270] Automatic override of Operator's approval processes: The ARS shall have provision for bypassing the Operator's approval/commitment processes (ARS250) in accordance to a user-configurable System parameter ([ARS020]) specifying different levels of autonomy as follow:

- Always bypass Operator's approval,
- Bypass only when there are no conflicts,
- Bypass only during off hours, or
- Never bypass.

Note: It is assumed that this Operator bypass functionality will only be used when the stability of the scheduling is understood and fully controlled, and when there is a need for emergency or fast-tasking request in the absence of an Operator to approve the Schedule. Usage of this functionality will have to go through performance review and risk analysis.

5.2.10 Operational Sequence Event 10: Antenna Access Request

Not applicable for this Section

5.2.11 Operational Sequence Event 11: Antenna Access Confirmation

Not applicable for this Section

5.2.12 Operational Sequence Event 12: Commitment of Accepted Schedule

Not applicable for this Section

5.2.13 Operational Sequence Event 13: Distribution of Committed Schedule

Not applicable for this Section

5.2.14 Operational Sequence Event 14: Committed Schedule Acknowledgment

Not applicable for this Section

5.2.15 Operational Sequence Event 15: Distribution of Scheduling Report

Not applicable for this Section

5.3 PERFORMANCE REQUIREMENTS

[ARS350] Scalability: The ARS shall be scalable to accommodate a variable number of Facility and Mission Configurations.

Note: it is expected that the number of Satellites can go as high as 20 and the number of Antennas can go as high as 100 (when considering Network Stations as part of the requirements).

[ARS360] Orbit Propagator computation time: The ARS shall propagate Satellite Orbit TLE and generate the Compliant Satellite Contact List in less than one (1) minute per day of Scheduling Time Window when up to 10 Mission Satellites and up to 25 Facility Antennas are used.

[ARS361] Orbit Propagator computation time goal: The ARS should propagate Satellite Orbit TLE and generate the Compliant Satellite Contact List in less than three (3) minute per day of Scheduling Time Window when up to 20 Mission Satellites and 100 Facility Antennas are used.

[ARS365] Contact Opportunity Schedule computation time: The ARS shall compute and return the Contact Opportunity Schedule within one (1) minute upon reception of Reception of Contact Opportunity Request from a Mission.

Note: This computation time assumes that the Compliant Satellite Contact List is already computed and up to date for the specified Time Window.

[ARS370] Schedule computation time: The ARS shall compute an optimal Preliminary Schedule solution in less than five (5) minutes per days of Scheduling Time Window when up to 10 Mission Satellites and up to 25 Facility Antennas are used.

[ARS371] Schedule computation time goal: The ARS should compute an optimal Preliminary Schedule solution in less than ten (10) minutes per days of Scheduling Time Window when up to 20 Mission Satellites and 100 Facility Antennas are used.

[ARS375] Schedule computation timeout: The ARS shall compute a feasible close-to-optimal or optimized Preliminary Schedule solution within a user-configurable Optimal Schedule Solution Timeout time [ARS030] for a Schedule Time Window covering 48 hours.

Note: This requirement presses the need for quick turn-around time to produce the close-to-optimal Schedule in order to accommodate urgent or Fast-Tasking requests, regardless of the number of Satellites or Antennas. The timeout will not be smaller than 1 minute but is expected to be configured at around 5 minutes in order to meet the timeline of [ARS390].

[ARS380] Antenna Access Request timeout: In the event that the ARS did not receive the Antenna Access Confirmation from the Uncommitted Facility within a user-configurable Uncommitted Facility Confirmation Timeout time [ARS030], the ARS shall consider the requested Contacts as Refused by the Uncommitted Facility.

Note: It is expected that Uncommitted Facilities will reply with a Confirmation within few minutes, but the timeout is there to insure meeting the timeline of [ARS390].

[ARS390] Satellite Contact/Time Request overall processing time (48 hours Schedule Time Window): With the exclusion of the Operator's interventions and Uncommitted Facility Confirmation Timeout time, the ARS shall process a Satellite Contact/Time Request upon reception, compute and return a Schedule to the Mission in less than ten (10) minutes for the Schedule Time Window covering 48 hours.

Note 1: This performance requirement assumes the same load as specified in [ARS360].

Note 2: This requirement represents the end-to-end time to process a request from the Mission less the Antenna Access Request turnaround time (subject to default 5 minutes timeout) and to return a Schedule. It includes the time to propagate the orbits (as per [ARS360] and, to compute the optimal Schedule solution (as per [ARS375]). It also includes provision time for the various ARS communication handling with the Missions and with the Facilities (e.g dropbox polling) . It also assumes full-automated mode (Operator's approval times are excluded).The ultimate intent is to guarantee the turnaround time of a Schedule to the Mission within 15 minutes upon reception of a Satellite Contact/Time Request, including an Antenna Access Request turnaround time of 5 minutes.

[ARS391] Satellite Contact/Time Request overall processing time goal (7 days Schedule Time Window): With the exclusion of the Operator's interventions and Uncommitted Facility Confirmation Timeout time, the ARS should process a Satellite Contact/Time Request upon reception, compute and return a Schedule

to the Mission in less than ten (10) minutes for the Schedule Time Window covering the next 7 days.

Note: This performance requirement is subject to the same notes as per [ARS390].

[ARS392] Satellite Contact/Time Request overall processing time goal (48 hours Schedule Time Window): With the exclusion of the Operator's interventions and Uncommitted Facility Confirmation Timeout time, the ARS should process a Satellite Contact/Time Request upon reception, compute and return a Schedule to the Mission in less than five (5) minutes for the Schedule Time Window covering 48 hours.

Note: This performance requirement is subject to the same notes as per [ARS390].

Note 2: The ultimate goal is to reduce the turnaround time of a Schedule to the Mission down to 10 minutes or better upon reception of a Satellite Contact/Time Request, including an Antenna Access Request turnaround time of 5 minutes.

5.4 INTERFACE REQUIREMENTS

Note: It is expected that wherever a user-configurable format is required for a given message, the interface will have an editable parsing layer to adapt with any specific Facility or Mission interface. However, it is expected that the parsing instances be delivered only for the specific interfaces described in AD-3.

5.4.1 Mission Service Requirements

Note: Refer to Figure 4-1 and AD-1 for more details about services.

5.4.1.1 Service M1: Satellite Orbit TLE Transmission

[ARS400] Reception of Satellite Orbit TLE: The ARS shall be capable of receiving and propagating the Satellite Orbit TLE from the Missions up to twice per day without performance degradation.

Note: The generic message format is provided in AD-3

[ARS401] DELETED.

5.4.1.2 Service M2: Satellite Contact Opportunity Request

[ARS405] Reception of Contact Opportunity Request: The ARS shall be capable of receiving and processing Contact Opportunity Requests from respective Missions.

[ARS406] Transmission of Contact Opportunity Report: The ARS shall automatically generate and transmit a Contact Opportunity Report to the respective Mission within one (1) minute after reception of the Request.

[ARS407] Configurable Contact Opportunity Report: The specific Contact Opportunity Report format shall be user-configurable through a description file for each Mission.

[ARS408] Contact Opportunity Report fields: The Contact Opportunity Report specific format shall support a scalable number of fields including:

- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Facility/Antenna Identifier,
- Contact Identifier,
- Contact AOS and LOS times, and
- Contact Status [AVAILABLE, UNKNOWN, CONFLICT].

Note: A contact marked Conflict does not preclude possible allocation and overruling (bumping) during the de-conflicting and optimization process. A contact marked Available does not guarantee acceptance by an Uncommitted Facility during the Antenna Access Request process.

5.4.1.3 Service M3: Satellite Contact or Time Request

[ARS410] Reception of Satellite Contact/Time Request: The ARS shall be capable of receiving and processing Satellite Contact/Time Requests from respective Missions (which includes new submission, update and cancellation of a Request).

[ARS411] Configurable Satellite Contact/Time Request: The specific Satellite Contact/Time Requests format shall be user-configurable through a description file for each Mission.

Note: The generic message format is provided in AD-3.

[ARS412] Satellite Contact Request fields: The specific Satellite Contact Request format shall support a scalable number of fields including:

- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Facility/Antenna Identifier,

- Contact Identifier,
- Contact Request Action [ADD, DELETE],
- Contact AOS and LOS times,
- Optional constraint parameters:
  - Contact RF bands [S, X, C, …],
  - Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR],
  - Coherent Mode [Y/N]
  - Polarizations [RHCP, LHCP, VP, HP],
  - Required Data Reception channels [X1, X2, X1+X2]
  - Minimum antenna elevation,
  - Minimum Contact Time,
- Contact Criticality [ROUTINE, IMPORTANT, EMERGENCY, PROFICIENCY], and
- Contact Reschedulability [DROP, RESCHEDULE, <Time Period>].

Note: Modification of a Contact on a Request will be handled through the Request Action by Deletion of the Contact and the Addition of a new Contact replacing the former one. The new contact will have a new Contact Identifier.

[ARS413] Satellite Time Request fields: The specific Satellite Time Request format shall support a scalable number of fields including:

- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Time Identifier,
- Time Request Action [ADD, DELETE],
- Time Period,
- Optional constraint parameters:
  - Contact RF bands [S, X, C, …],
  - Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR],
  - Coherent Mode [Y/N]
  - Polarizations [RHCP, LHCP, VP, HP],
  - Required Data Reception channels [X1, X2, X1+X2],
  - Minimum antenna elevation,
  - Minimum Contact Time,

- Requested Facility/Antenna Identifier list.

- Criticality [ROUTINE, IMPORTANT, EMERGENCY, PROFICIENCY].

[ARS414] Standing Request fields: The specific Standing Request format shall contain all fields from the Satellite Time Request in addition to:

- the Time Period describing the validity horizon,
- the minimum time segment (if not specified by the Minimum Contact Time in the Mission Configuration), and
- the list of compliant Antennas (to specify downlink at specific Network Station for instance

Note: This requirement is applicable only in combination with [ARS096].

[ARS420] Acknowledgment of Satellite Contact/Time Request: The ARS shall automatically send a Request Validity Report to the respective Mission within one (1) minute after reception of a Request.

[ARS421] Configurable Request Validity Report: The specific Request Validity Report format shall be user-configurable through a description file for each Mission.

[ARS422] Request Validity Report fields: The Request Validity Report specific format shall support a scalable number of fields including:

- All fields from the Satellite Contact/Time Request,
- Contact Request Status [DELETED (by mission), RECEIVED, REJECTED (by ARS)] (see Definitions), and
- Contact Rejected Reason [OVERRULED, INCOMPLIANT ANTENNA, WRONG RF BAND, WRONG SERVICE, WRONG TIME].

Note: This requirement is only a message acknowledgement. Status COMMITTED will only come with the Committed Schedule (as per [ARS430]) after the Operator has approved the replied Schedule from Uncommitted Facilities.

5.4.1.4 Service M4: Schedule Update

[ARS430] Transmission of Committed Mission Schedule: The ARS shall send Committed Mission Schedules to the respective Missions.

[ARS431] Configurable Mission Schedule: The specific Mission Schedule format shall be user-configurable through a description file for each Mission.

Note: The generic message format is provided in AD-3.

[ARS432] Mission Schedule fields: The specific Mission Schedule format shall support a scalable number of fields including:

- Originator and recipient,
- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Facility/Antenna Identifier,
- Contact Identifier,
- Contact Request Status [RECEIVED, COMMITTED, DELETED (by Mission), REJECTED (by ARS), CANCELLED (by Facility), RESCHEDULED, CONTINGENCY] (see Definitions),
- Contact AOS and LOS times, and
- Contact Criticality [ROUTINE, IMPORTANT, EMERGENCY, PROFICIENCY].

[ARS440] Reception of Mission Schedule Acknowledgment: The ARS shall manage Mission Schedule Acknowledgments from the Missions and automatically retransmit as required (TBD, mission-specific).

5.4.2 Generic Mission Interface Requirements

[ARS450] Communication scheme with the Mission: All transactions between the ARS and the Missions shall use a dropbox scheme where files are pushed from the originator to the client system.

Note: The generic interface with the Missions is defined in AD-3.

[ARS460] DELETED.

[ARS461] DELETED.

[ARS462] Mission message inspection: The ARS shall inspect all incoming messages from the Mission against the expected format and return a negative acceptance message if incoming validation fails.

[ARS465] Reservation web-based interface: The ARS should have an alternate Satellite Contact/Time Request interface using a browser or web-based GUI to allow Missions for online direct submission and monitoring of Requests.

Note: Usage of this alternate interface will be subject to network and firewall policies of the CSA operation center.

5.4.3 Mission-specific Requirements

[ARS470] DELETED.

[ARS471] DELETED.

[ARS472] DELETED.

[ARS473] DELETED.

5.4.4 Facility Service Requirements

Note: Refer to Figure 4-1 and AD-1 for more details about services.

5.4.4.1 Service F1: Antenna Unavailability Reporting

[ARS500] Reception of Antenna Unavailability Report: The ARS shall be capable of receiving and processing Antenna Unavailability Reports from Facilities.

[ARS501] Configurable Antenna Unavailability Report: The specific Antenna Unavailability Report format shall be user-configurable through a description file for each Facility.

Note: The generic message format is provided in AD-3. The specific message formats are defined by the respective Facility ICD provided in Reference.

[ARS502] DELETED.

5.4.4.2 Service F2: Antenna Access Request

[ARS510] Transmission of Antenna Access Request: The ARS shall send Approved Schedules as Antenna Access Requests to Uncommitted Facilities.

[ARS511] Configurable Antenna Access Request: The specific Antenna Access Request format shall be user-configurable through a description file for each Facility.

Note: The generic message format is provided in AD-3. The specific message formats are defined by the respective Facility ICD provided in Reference.

[ARS512] Antenna Access Request fields: The specific Antenna Access Request format shall support a scalable number of fields including:

- Originator and recipient,
- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Facility/Antenna Identifier,

- Contact Identifier,
- Contact Request Action [ADD, DELETE],
- Contact AOS and LOS times,
- Orbit number,
- Contact RF ON/OFF times,
- Contact RF bands [S, X, C],
- Required Data Reception channels [X1, X2, X1+X2],
- Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR], and
- Coherent Mode [Y/N],
- Contact Criticality [ROUTINE, IMPORTANT, EMERGENCY, PROFICIENCY].

Note 1: It is assumed that the Uncommitted Facilities will keep track of all Contacts that were requested by handling the Contact Request Action field from subsequent Antenna Access Requests.

Note 2: A subsequent Request will not edit a Contact definition. Modification of a Contact on a Request will be handled through the Request Action by Deletion of the Contact and the Addition of a new Contact replacing the former one. The new contact will have a new Contact Identifier.

[ARS513] DELETED.

[ARS520] Reception of Antenna Access Request Acknowledgment: The ARS shall manage Antenna Access Request Acknowledgments from Facilities.

[ARS521] Configurable Antenna Access Request Acknowledgment: The specific Antenna Access Request Acknowledgment format shall be user-configurable through a description file for each Facility.

Note: The generic message format is provided in AD-3. The specific message formats are defined by the respective Facility ICD provided in Reference.

[ARS522] DELETED.

5.4.4.3 Service F3: Antenna Access Confirmation

[ARS530] Reception of Antenna Access Confirmation: The ARS shall manage Antenna Access Confirmations from Facilities.

[ARS531] Configurable Antenna Access Confirmation: The specific Antenna Access Confirmation format shall be user-configurable through a description file for each Facility.

Note: The generic message format is provided in AD-3. The specific message formats are defined by the respective Facility ICD provided in Reference.

[ARS532] Antenna Access Confirmation fields: The generic Antenna Access Confirmation format shall support a scalable number of fields:

- All fields from the Antenna Access Request,
- Contact Request Status [ACCEPTED, REJECTED, CANCELLED], and
- Rejected or Cancelled Reason [UNAVAILABLE, WRONG RF BAND, WRONG SERVICE, WRONG TIME].

Note: It is not expected that Facilities will reply with status RESCHEDULED as rescheduling is the task of the ARS.

[ARS533] DELETED.

5.4.4.4 Service F4: Schedule Update

[ARS540] Transmission of Committed Facility Schedule: The ARS shall send Committed Facility Schedules to Committed Facilities.

[ARS541] Configurable Committed Facility Schedule: The specific Committed Facility Schedule format shall be user-configurable through a description file for each Facility.

Note: The generic message format is provided in AD-3. The specific message formats are defined by the respective Facility ICD provided in Reference.

[ARS542] Committed Facility Schedule fields: The generic Committed Facility Schedule format shall support a scalable number of fields including:

- Originator and recipient,
- Request message generation date and time,
- Applicable Schedule Time Window,
- Mission/Satellite Identifier,
- Facility/Antenna Identifier,
- Contact AOS and LOS times,
- Orbit number,
- Contact RF ON/OFF times,
- Contact Status [COMMITTED, DELETED, RESCHEDULED, CONTINGENCY] (see Definitions),
- Contact RF bands [S, X, C],
- Contact required services [RNG, TC, RT-TM, SF-TM, RT-DR, SF-DR], and

- Contact Criticality [ROUTINE, IMPORTANT, EMERGENCY, PROFICIENCY].

[ARS545] Reception of Committed Facility Schedule Acknowledgment: The ARS shall manage Committed Facility Schedule Acknowledgments from Facilities and automatically retransmit as required (TBD, facility-specific).

5.4.4.5 Generic Facility Interface Requirements

[ARS550] Communication format with the Facilities: All transactions between the ARS and the Facilities shall be based on XML.

[ARS551] Format conversion of Facility messages: The ARS shall convert any inbound transaction from Facilities into the XML format as required, and convert any outbound transaction to a format compatible with the Facilities.

Note: The Facility message formats are defined by the respective Facility ICD provided in Reference.

[ARS552] Facility message inspection: The ARS shall inspect incoming messages from the Facility against the expected format and return a negative acceptance message if incoming validation fails.

5.4.5 Facility-specific Requirements

[ARS560] DELETED

[ARS561] DELETED

[ARS562] DELETED

[ARS563] DELETED

5.4.6 Internal Interfaces

[ARS580] Interface with Live Schedule Board: The ARS shall interface with the CSA operational Live Schedule Board (AD-4).

Note: It is assumed that the Live Schedule Board interface will conform to the ARS.

5.5 QUALITY FACTORS

5.6 SECURITY REQUIREMENTS

[ARS600] System security: The ARS shall have control mechanisms to prevent unauthorized personnel to access or temper the System and its data.

[ARS610] System accounts and privileges: The ARS shall allow more than one Operator login account with different level of authorities and privileges to create a hierarchy of authenticated functionalities.

Note: It is expected as a minimum that the following account types be possible:

Administrator: able to assign privileges to different user accounts and completely configure the System.

Programmer: able to edit the ARS code, change the de-conflicting rules and edit the optimizer cost function or algorithm.

Configurator: able to create and edit System, Mission, and Facility Configurations and change the cost function weightings.

Operator: able to process, generate and approve Schedules and manage Backlogs.

[ARS620] DELETED

5.7 DESIGN AND CONSTRUCTION REQUIREMENTS

[ARS700] Operational redundancy: The ARS shall be composed of an operational Primary System and a Backup System.

Note: It is assumed that the Backup System will be a copy of the Primary System.

[ARS701] Backup handover latency: The handover to the Backup System shall take less than 5 minutes upon detection of System failure.

[ARS702] Automatic failure detection and failover: The ARS should have an automatic failure detection and failover Backup System capability to maintain availability of all System's functionalities in case of Primary System failure.

[ARS705] Data persistency and accessibility in case of System failure: The current Configurations, previous Committed Schedules, Satellite Contact/Time Requests and Antenna Unavailability Reports shall be accessible to the Backup System in case of Primary System failure.

[ARS710] Deployability: The ARS Primary System shall be able to hold and operate with all its dependable libraries and third-party software on a single desktop computer system.

Note: However, the design shall not preclude or exclude implementation on a server-based or virtualized hardware solution.

[ARS720] Portability: The ARS shall be portable (movable) from one computer system to another while keeping its integrity and functionality.

[ARS730] Availability: Including the backup capability, the ARS shall have an availability of 99.7% over the expected lifetime of the System (equivalent downtime of 1 day on average per year).

[ARS740] Lifetime: Reasonable measures shall be taken to design custom software so as to not introduce any known constraints that would preclude use for 20 years, and to choose COTS software and hardware to facilitate satisfaction of system requirements, particularly to those related to availability and reliability.

[ARS750] Accessibility of Data: The ARS shall store Configurations and Schedules in user-readable files on the System.

[ARS760] Backlog of Data: The ARS shall keep an history of all Configuration and Schedule files on the System.

[ARS761] Safeguarding of Data: The ARS shall allow storage, locking and printing of Configurations in order to facilitate formal configuration management (CM) process.

[ARS765] Event Log File: The ARS shall maintain an Event Log File and insert a new event entry to the log upon:

- Reception of any message or file from any Mission or Facility,
- Transmission of any message or file to any Mission or Facility,
- Generation of a new Preliminary Schedule
- Any operator's manual intervention to:
  - Change a Mission, Facility or System Configuration
  - Enter Manual Contact
  - Admit a Request from a Mission
  - Approve a Preliminary Schedule
  - Commit a Schedule
  - Edit or Delete Backlog Data

[ARS766] Event Log File fields: The Event Log File shall include the following fields:

- Date and time of event,
- Originator [Mission ID, Facility ID, Operator ID, ARS],
- Event Type (or file message type)
- Event Title or Filename

[ARS770] Display of Schedule for the Operator: The ARS shall have an interactive Graphic User Interface (GUI) to display the Preliminary or Committed Schedule on a dynamic and time scale-able graph.

Note: The intent is to allow easy operational comprehension of the Schedule and possible conflicts by the Operator for all the supported Missions and Facilities.

[ARS771] Flexibility of the Schedule view: The GUI shall allow the Operator to select which Mission/Satellite(s) or Facility/Antenna(s) to be displayed on the active Schedule view.

[ARS772] Printability of the Schedule view: The GUI shall allow the Operator to print the active Schedule view.

[ARS780] Time Reference: All time references on the System shall use UTC time standard.

[ARS781] Time Reference Format: The Time Reference format on the system shall be user-configurable to support both Year-Month-Day and Year-Day-of-Year formats.

Note: see [ARS020] for System Configurations.

[ARS790] Active Memory Margin: The System shall be provided with 50% active memory margin at maximum load.

[ARS791] DELETED.

5.8 QUALIFICATION AND VERIFICATION REQUIREMENTS

[ARS800] DELETED

APPENDICES

A COMPLIANCE MATRIX WITH RCM

To be done in next release.