

BS ISO 18442:2016



BSI Standards Publication

**Space data and information
transfer systems — Space
link extension — Application
program interface for return all
frames service**

National foreword

This British Standard is the UK implementation of ISO 18442:2016. It supersedes BS ISO 18442:2013 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2016.
Published by BSI Standards Limited 2016

ISBN 978 0 580 93380 6

ICS 49.140

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2016.

Amendments/Corrigenda issued since publication

| Date | Text affected |
|------|---------------|
|------|---------------|

INTERNATIONAL
STANDARD

ISO
18442

Second edition
2016-11-15

**Space data and information transfer
systems — Space link extension —
Application program interface for return
all frames service**

*Systèmes de transfert des informations et données spatiales — Extension de
liaisons spatiales — Interface du programme d'application pour service de
retour par tout réseau*



Reference number
ISO 18442:2016(E)



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
copyright@iso.org
Web www.iso.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

ISO 18442 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 915.1-M-2, September 2015) and was adopted (without modifications except those stated in clause 2 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.

This second edition cancels and replaces the first edition (ISO 18442:2013), which has been technically revised.

AUTHORITY

| | |
|-----------|-------------------------------|
| Issue: | Recommended Practice, Issue 2 |
| Date: | September 2015 |
| Location: | Washington, DC, USA |

This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS documents is detailed in *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-4), and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the e-mail address below.

This document is published and maintained by:

CCSDS Secretariat
National Aeronautics and Space Administration
Washington, DC, USA
E-mail: secretariat@mailman.ccsds.org

STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of its members. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommendations** and are not in themselves considered binding on any Agency.

CCSDS Recommendations take two forms: **Recommended Standards** that are prescriptive and are the formal vehicles by which CCSDS Agencies create the standards that specify how elements of their space mission support infrastructure shall operate and interoperate with others; and **Recommended Practices** that are more descriptive in nature and are intended to provide general guidance about how to approach a particular problem associated with space mission support. This **Recommended Practice** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommended Practice** is entirely voluntary and does not imply a commitment by any Agency or organization to implement its recommendations in a prescriptive sense.

No later than five years from its date of issuance, this **Recommended Practice** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or (3) be retired or canceled.

In those instances when a new version of a **Recommended Practice** is issued, existing CCSDS-related member Practices and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each member to determine when such Practices or implementations are to be modified. Each member is, however, strongly encouraged to direct planning for its new Practices and implementations towards the later version of the Recommended Practice.

FOREWORD

This document is a technical **Recommended Practice** for use in developing ground systems for space missions and has been prepared by the **Consultative Committee for Space Data Systems** (CCSDS). The Application Program Interface described herein is intended for missions that are cross-supported between Agencies of the CCSDS.

This **Recommended Practice** specifies service type-specific extensions of the Space Link Extension Application Program Interface for Transfer Services specified by CCSDS (reference [3]). It allows implementing organizations within each Agency to proceed with the development of compatible, derived Standards for the ground systems that are within their cognizance. Derived Agency Standards may implement only a subset of the optional features allowed by the **Recommended Practice** and may incorporate features not addressed by the **Recommended Practice**.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CCSDS has processes for identifying patent issues and for securing from the patent holder agreement that all licensing policies are reasonable and non-discriminatory. However, CCSDS does not have a patent law staff, and CCSDS shall not be held responsible for identifying any or all such patent rights.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Standard is therefore subject to CCSDS document management and change control procedures, which are defined in *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-4). Current versions of CCSDS documents are maintained at the CCSDS Web site:

<http://www.ccsds.org/>

Questions relating to the contents or status of this document should be sent to the CCSDS Secretariat at the e-mail address indicated on page i.

At time of publication, the active Member and Observer Agencies of the CCSDS were:

Member Agencies

- Agenzia Spaziale Italiana (ASI)/Italy.
- Canadian Space Agency (CSA)/Canada.
- Centre National d'Etudes Spatiales (CNES)/France.
- China National Space Administration (CNSA)/People's Republic of China.
- Deutsches Zentrum für Luft- und Raumfahrt (DLR)/Germany.
- European Space Agency (ESA)/Europe.
- Federal Space Agency (FSA)/Russian Federation.
- Instituto Nacional de Pesquisas Espaciais (INPE)/Brazil.
- Japan Aerospace Exploration Agency (JAXA)/Japan.
- National Aeronautics and Space Administration (NASA)/USA.
- UK Space Agency/United Kingdom.

Observer Agencies

- Austrian Space Agency (ASA)/Austria.
- Belgian Federal Science Policy Office (BFSP0)/Belgium.
- Central Research Institute of Machine Building (TsNIIMash)/Russian Federation.
- China Satellite Launch and Tracking Control General, Beijing Institute of Tracking and Telecommunications Technology (CLTC/BITTT)/China.
- Chinese Academy of Sciences (CAS)/China.
- Chinese Academy of Space Technology (CAST)/China.
- Commonwealth Scientific and Industrial Research Organization (CSIRO)/Australia.
- Danish National Space Center (DNSC)/Denmark.
- Departamento de Ciência e Tecnologia Aeroespacial (DCTA)/Brazil.
- Electronics and Telecommunications Research Institute (ETRI)/Korea.
- European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)/Europe.
- European Telecommunications Satellite Organization (EUTELSAT)/Europe.
- Geo-Informatics and Space Technology Development Agency (GISTDA)/Thailand.
- Hellenic National Space Committee (HNSC)/Greece.
- Indian Space Research Organization (ISRO)/India.
- Institute of Space Research (IKI)/Russian Federation.
- KFKI Research Institute for Particle & Nuclear Physics (KFKI)/Hungary.
- Korea Aerospace Research Institute (KARI)/Korea.
- Ministry of Communications (MOC)/Israel.
- National Institute of Information and Communications Technology (NICT)/Japan.
- National Oceanic and Atmospheric Administration (NOAA)/USA.
- National Space Agency of the Republic of Kazakhstan (NSARK)/Kazakhstan.
- National Space Organization (NSPO)/Chinese Taipei.
- Naval Center for Space Technology (NCST)/USA.
- Scientific and Technological Research Council of Turkey (TUBITAK)/Turkey.
- South African National Space Agency (SANSA)/Republic of South Africa.
- Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.
- Swedish Space Corporation (SSC)/Sweden.
- Swiss Space Office (SSO)/Switzerland.
- United States Geological Survey (USGS)/USA.

DOCUMENT CONTROL

| Document | Title | Date | Status |
|--------------------|---|-------------------|---|
| CCSDS 915.1-M-1 | Space Link Extension—Application Program Interface for Return All Frames Service, Recommended Practice, Issue 1 | October 2008 | Original issue, superseded |
| CCSDS 915.1-M-2 | Space Link Extension—Application Program Interface for Return All Frames Service, Recommended Practice, Issue 2 | September 2015 | Current issue: <ul style="list-style-type: none"> – updates text to accommodate changes in current version of SLE service specification; – differentiates applicability by SLE service specification version; – updates references. |

NOTE – Substantive changes from the previous issue are marked with change bars in the inside margin.

CONTENTS

| <u>Section</u> | <u>Page</u> |
|---|-------------|
| 1 INTRODUCTION | 1-1 |
| 1.1 PURPOSE..... | 1-1 |
| 1.2 SCOPE..... | 1-1 |
| 1.3 APPLICABILITY..... | 1-2 |
| 1.4 RATIONALE..... | 1-2 |
| 1.5 DOCUMENT STRUCTURE..... | 1-3 |
| 1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS..... | 1-5 |
| 1.7 REFERENCES..... | 1-8 |
| 2 OVERVIEW | 2-1 |
| 2.1 INTRODUCTION..... | 2-1 |
| 2.2 PACKAGE RAF SERVICE INSTANCES..... | 2-1 |
| 2.3 PACKAGE RAF OPERATIONS..... | 2-5 |
| 2.4 SECURITY ASPECTS OF THE SLE RAF TRANSFER SERVICE..... | 2-8 |
| 3 RAF SPECIFIC SPECIFICATIONS FOR API COMPONENTS | 3-1 |
| 3.1 API SERVICE ELEMENT..... | 3-1 |
| 3.2 SLE OPERATIONS..... | 3-6 |
| 3.3 SLE APPLICATION..... | 3-7 |
| 3.4 SEQUENCE OF DIAGNOSTIC CODES..... | 3-7 |
| ANNEX A RAF SPECIFIC INTERFACES (NORMATIVE) | A-1 |
| ANNEX B ACRONYMS (INFORMATIVE) | B-1 |
| ANNEX C INFORMATIVE REFERENCES (INFORMATIVE) | C-1 |

Figure

| | |
|---|-----|
| 1-1 SLE Services and SLE API Documentation..... | 1-4 |
| 2-1 RAF Service Instances..... | 2-2 |
| 2-2 RAF Operation Object Interfaces..... | 2-7 |

Table

| | |
|---|-----|
| 2-1 RAF Configuration Parameters..... | 2-4 |
| 2-2 RAF Status Information..... | 2-5 |
| 2-3 Mapping of RAF Operations to Operation Object Interfaces..... | 2-6 |

1 INTRODUCTION

1.1 PURPOSE

The Recommended Practice *Space Link Extension—Application Program Interface for Transfer Services—Core Specification* (reference [3]) specifies a C++ API for CCSDS Space Link Extension Transfer Services. The API is intended for use by application programs implementing SLE transfer services.

Reference [3] defines the architecture of the API and the functionality on a generic level, which is independent of specific SLE services and communication technologies. It is thus necessary to add service type-specific specifications in supplemental Recommended Practices. The purpose of this document is to specify extensions to the API needed for support of the Return All Frames (RAF) service defined in reference [2].

1.2 SCOPE

This Recommended Practice defines extensions to the SLE API in terms of:

- a) the RAF-specific functionality provided by API components;
- b) the RAF-specific interfaces provided by API components; and
- c) the externally visible behavior associated with the RAF interfaces exported by the components.

It does not specify

- a) individual implementations or products;
- b) the internal design of the components; and
- c) the technology used for communications.

This Recommended Practice defines only interfaces and behavior that must be provided by implementations supporting the Return All Frames service in addition to the specification in reference [3].

1.3 APPLICABILITY

The Application Program Interface specified in this document supports three versions of the Return All Frames service, namely:

- a) Generation 1 identified by the version number 1 in the BIND operation, as specified by reference [C2];
- b) Generation 2 identified by the version number 2 in the BIND operation, as specified by reference [C3];
- c) Generation 3 identified by the version number 4 in the BIND operation, as specified by reference [2].

NOTE – The use of the term ‘Generation’ follows the definition in the API Core Specification (reference [3]) where it is used to classify all SLE Transfer Services.

Support for Generation 1 and Generation 2 of this service is included for backward compatibility purposes for a limited time and may not be continued in future versions of this specification. Support for Generation 1 (i.e., version 1 of the RAF service) implies that SLE API implementations of this specification are able to interoperate with peer SLE systems that comply with the specification of the Transport Mapping Layer (TML) in ‘Specification of a SLE API Proxy for TCP/IP and ASN.1’, ESOC, SLES-SW-API-0002-TOS-GCI, Issue 1.1, February 2001. For Generation 2 and 3 of these services, SLE API implementations of this specification are able to interoperate with peer SLE systems that comply with the specification of the Transport Mapping Layer (TML) in reference [C5].

Provisions within this Recommended Practice that are specific for one or more generations are marked as follows:

- [Gn:] for provisions specific to Generation n;
- [Gn,m:] for provisions specific to Generation n and Generation m.

Provisions that apply to all generations are not marked. That implies that for a Recommended Practice supporting all generations with the same application program interface, no generation markers are present.

1.4 RATIONALE

This Recommended Practice specifies the mapping of the RAF service specification to specific functions and parameters of the SLE API. It also specifies the distribution of responsibility for specific functions between SLE API software and application software.

The goal of this Recommended Practice is to create a standard for interoperability between:

- a) application software using the SLE API and SLE API software implementing the SLE API; and
- b) service user and service provider applications communicating with each other using the SLE API on both sides.

This interoperability standard also allows exchangeability of different products implementing the SLE API, as long as they adhere to the interface specification of this Recommended Practice.

1.5 DOCUMENT STRUCTURE

1.5.1 ORGANIZATION

This document is organized as follows:

- a) section 1 provides purpose and scope of this specification, identifies conventions, and lists definitions and references used throughout the document;
- b) section 2 provides an overview of the RAF service and describes the API model extension including support for the RAF service;
- c) section 3 contains detailed specifications for the API components and for applications using the API;
- d) annex A provides a formal specification of the API interfaces and data types specific to the RAF service;
- e) annex B lists all acronyms used within this document;
- f) annex C lists informative references.

1.5.2 SLE SERVICE DOCUMENTATION TREE

The SLE suite of Recommended Standards is based on the cross support model defined in the SLE Reference Model (reference [1]). The services defined by the reference model constitute one of the three types of Cross Support Services:

- a) Part 1: SLE Services;
- b) Part 2: Ground Domain Services; and
- c) Part 3: Ground Communications Services.

The SLE services are further divided into SLE service management and SLE transfer services.

The basic organization of the SLE services and SLE documentation is shown in figure 1-1. The various documents are described in the following paragraphs.

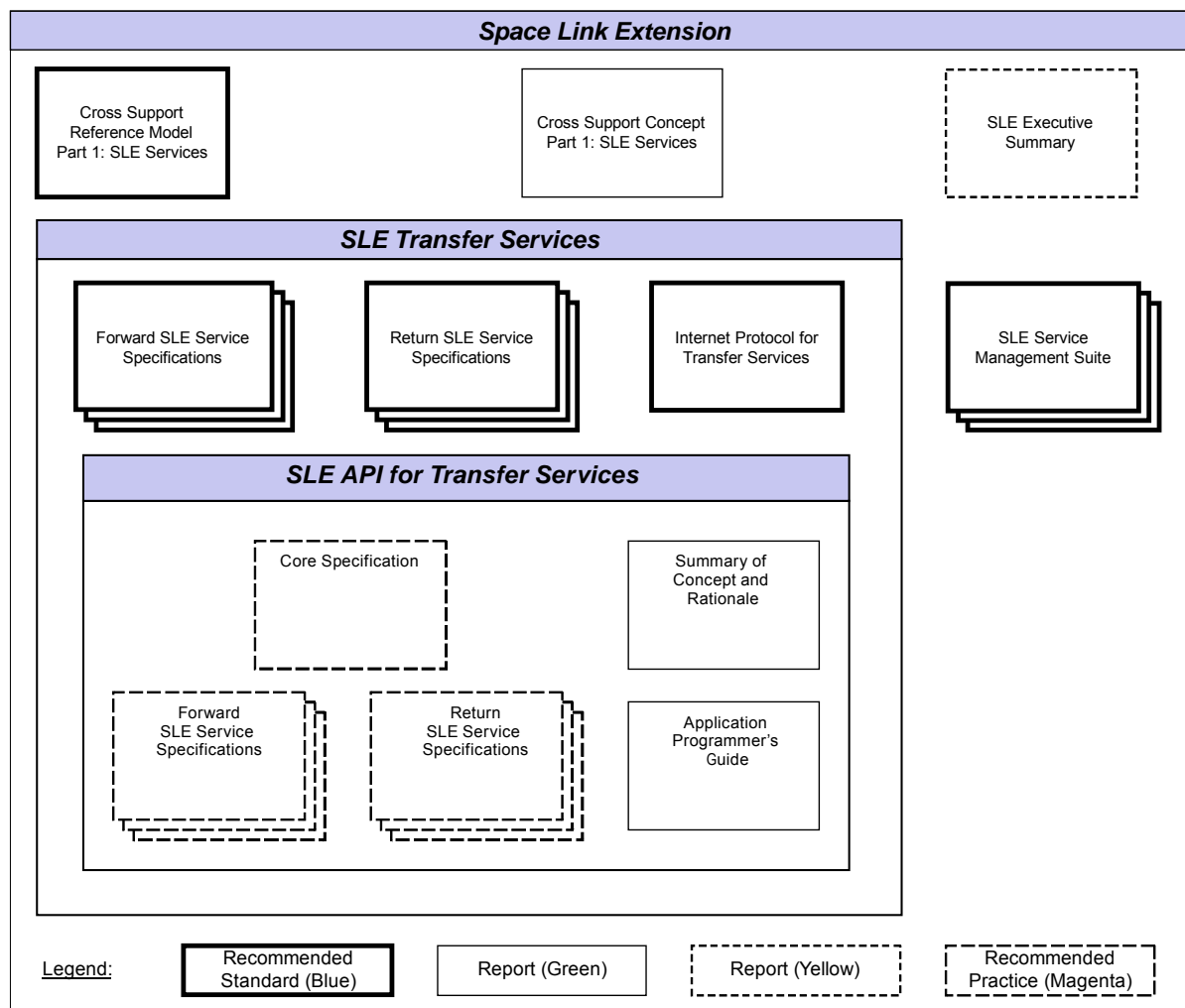


Figure 1-1: SLE Services and SLE API Documentation

- a) *Cross Support Reference Model—Part 1: Space Link Extension Services*, a Recommended Standard that defines the framework and terminology for the specification of SLE services.
- b) *Cross Support Concept—Part 1: Space Link Extension Services*, a Report introducing the concepts of cross support and the SLE services.
- c) *Space Link Extension Services—Executive Summary*, an Administrative Report providing an overview of Space Link Extension (SLE) Services. It is designed to assist readers with their review of existing and future SLE documentation.
- d) *Forward SLE Service Specifications*, a set of Recommended Standards that provide specifications of all forward link SLE services.
- e) *Return SLE Service Specifications*, a set of Recommended Standards that provide specifications of all return link SLE services.

- f) *Internet Protocol for Transfer Services*, a Recommended Standard providing the specification of the wire protocol used for SLE transfer services.
- g) *SLE Service Management Specifications*, a set of Recommended Standards that establish the basis of SLE service management.
- h) *Application Program Interface for Transfer Services—Core Specification*, a Recommended Practice document specifying the generic part of the API for SLE transfer services.
- i) *Application Program Interface for Transfer Services—Summary of Concept and Rationale*, a Report describing the concept and rationale for specification and implementation of a Application Program Interface for SLE Transfer Services.
- j) *Application Program Interface for Return Services*, a set of Recommended Practice documents specifying the service type-specific extensions of the API for return link SLE services.
- k) *Application Program Interface for Forward Services*, a set of Recommended Practice documents specifying the service type-specific extensions of the API for forward link SLE services.
- l) *Application Program Interface for Transfer Services—Application Programmer's Guide*, a Report containing guidance material and software source code examples for software developers using the API.

1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS

1.6.1 DEFINITIONS

1.6.1.1 Definitions from SLE Reference Model

This Recommended Practice makes use of the following terms defined in reference [1]:

- a) Return All Frames service (RAF service);
- b) operation;
- c) service provider (provider);
- d) service user (user);
- e) SLE transfer service instance;
- f) SLE transfer service production;
- g) SLE transfer service provision.

1.6.1.2 Definitions from RAF Service

This Recommended Practice makes use of the following terms defined in reference [2]:

- a) association;
- b) communications service;
- c) confirmed operation;
- d) delivery mode;
- e) invocation;
- f) latency limit;
- g) lock status;
- h) notification;
- i) offline processing latency;
- j) parameter;
- k) performance;
- l) port identifier;
- m) production status;
- n) return;
- o) service instance provision period;
- p) transfer buffer;
- q) unconfirmed operation.

1.6.1.3 Definitions from ASN.1 Specification

This Recommended Practice makes use of the following terms defined in reference [5]:

- a) Object Identifier;
- b) Octet String.

1.6.1.4 Definitions from UML Specification

This Recommended Practice makes use of the following terms defined in reference [C9]:

- a) Attribute;

- b) Base Class;
- c) Class;
- d) Data Type;
- e) Interface;
- f) Method.

1.6.1.5 Definitions from API Core Specification

This Recommended Practice makes use of the following terms defined in reference [3]:

- a) Application Program Interface;
- b) Component.

1.6.2 NOMENCLATURE

1.6.2.1 Normative Text

The following conventions apply for the normative specifications in this Recommended Standard:

- a) the words ‘shall’ and ‘must’ imply a binding and verifiable specification;
- b) the word ‘should’ implies an optional, but desirable, specification;
- c) the word ‘may’ implies an optional specification;
- d) the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

1.6.2.2 Informative Text

In the normative sections of this document, informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

- Overview;
- Background;
- Rationale;
- Discussion.

1.6.3 CONVENTIONS

This document applies the conventions defined in reference [3].

The RAF-specific model extensions in section 2 are presented using the Unified Modeling Language (UML) and applying the conventions defined in reference [3].

The RAF-specific specifications for API components in section 3 are presented using the conventions specified in reference [3].

The RAF-specific data types and interfaces in annex A are specified in the notation of the C++ programming language using the conventions defined in reference [3].

1.7 REFERENCES

The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All publications are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the publications indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS publications.

NOTE – A list of informative references is provided in annex C.

- [1] *Cross Support Reference Model—Part 1: Space Link Extension Services*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 910.4-B-2. Washington, D.C.: CCSDS, October 2005.
- [2] *Space Link Extension—Return All Frames Service Specification*. Issue 3. Recommendation for Space Data System Standards (Blue Book), CCSDS 911.1-B-3. Washington, D.C.: CCSDS, January 2010.
- [3] *Space Link Extension—Application Program Interface for Transfer Services—Core Specification*. Issue 2. Recommendation for Space Data System Practices (Magenta Book), CCSDS 914.0-M-2. Washington, D.C.: CCSDS, September 2015.
- [4] *Programming Languages—C++*. 3rd ed. International Standard, ISO/IEC 14882:2011. Geneva: ISO, 2011.
- [5] *Information Technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation*. 4th ed. International Standard, ISO/IEC 8824-1:2008. Geneva: ISO, 2008.

2 OVERVIEW

2.1 INTRODUCTION

This section describes the extension of the SLE API model in reference [3] for support of the RAF service. Extensions are needed for the API components API Service Element and SLE Operations.

In addition to the extensions defined in this section, the component API Proxy must support encoding and decoding of RAF-specific protocol data units.

2.2 PACKAGE RAF SERVICE INSTANCES

2.2.1 OVERVIEW

The RAF extensions to the component API Service Element are defined by the package RAF Service Instances. Figure 2-1 provides an overview of this package. The diagram includes classes from the package API Service Element specified in reference [3], which provide applicable specifications for the RAF service.

The package adds two service instance classes:

- a) RAF SI User, supporting the service user role; and
- b) RAF SI Provider, supporting service provider role.

These classes correspond to the placeholder classes I<SRV>_SI User and I<SRV>_SI Provider defined in reference [3].

Both classes are able to handle the specific RAF operations.

For the class RAF SI User, this is the only extension of the base class SI User.

The class RAF SI Provider adds two new interfaces:

- a) IRAF_SIAdmin by which the application can set RAF-specific configuration parameters; and
- b) IRAF_SIUpdate by which the application must update dynamic status information, required for generation of status reports.

These interfaces correspond to the placeholder interfaces I<SRV>_SIAdmin and I<SRV>_SIUpdate defined in reference [3].

RAF-specific configuration parameters are defined by the internal class RAF Configuration. The class RAF Status Information defines dynamic status parameters maintained by the service instance.

All specifications provided in this section refer to a single service instance. If more than one service instance is used, each service instance must be configured and updated independently.

2.2.2 COMPONENT CLASS RAF SI USER

The class defines a RAF service instance supporting the service user role. It ensures that SLE PDUs passed by the application and by the association are supported by the RAF service and handles the RAF operation objects defined in 2.3. It does not add further features to those provided by the base class SI User.

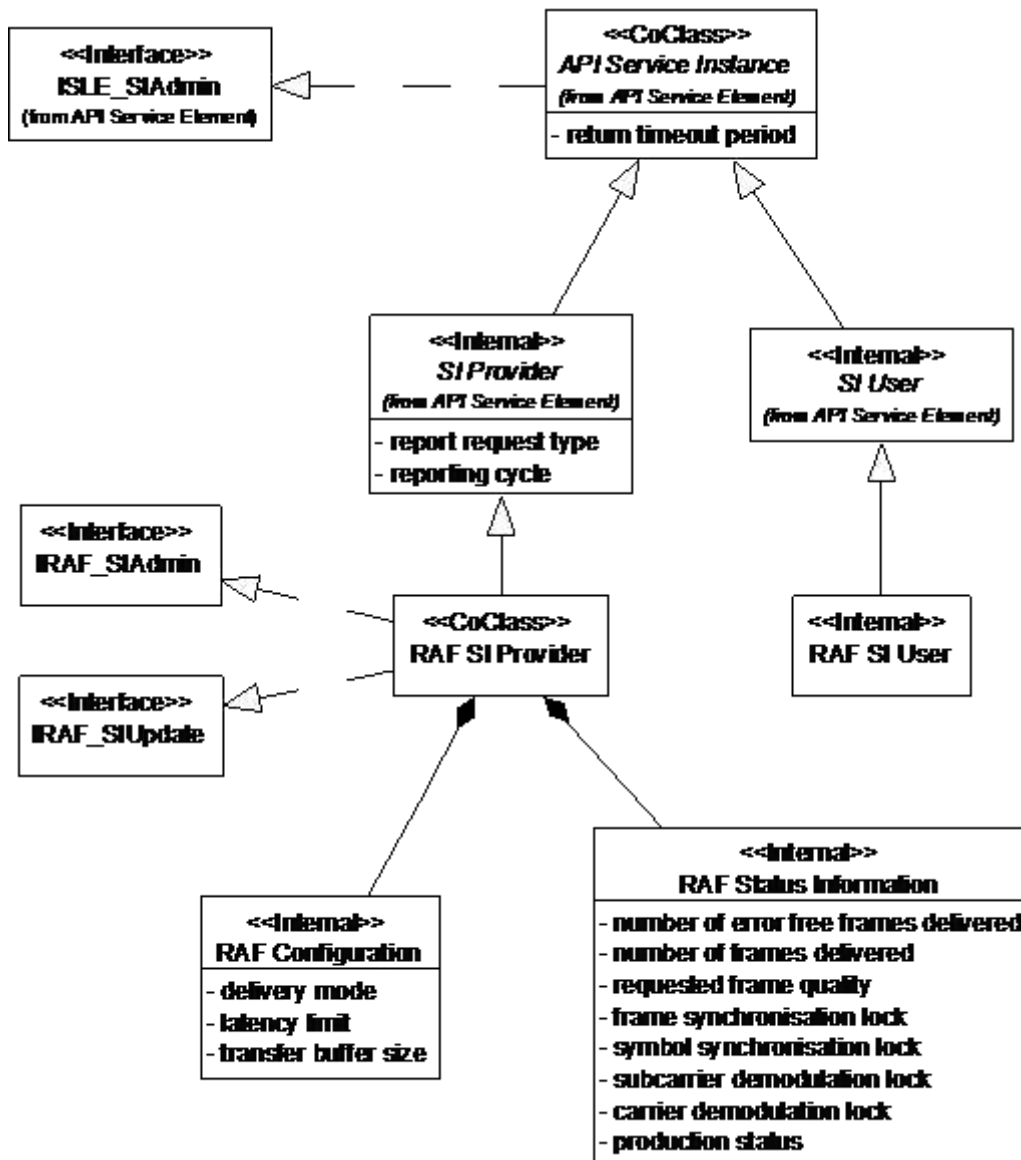


Figure 2-1: RAF Service Instances

2.2.3 COMPONENT CLASS RAF SI PROVIDER

2.2.3.1 General

The class defines a RAF service instance supporting the service provider role. It exports the interfaces `IRAF_SIAAdmin` for configuration of the service instance after creation and `IRAF_SIUUpdate` for update of dynamic status parameters during operation.

2.2.3.2 Responsibilities

2.2.3.2.1 Service Specific Configuration

The service instance implements the interface `IRAF_SIAAdmin` to set the RAF-specific configuration parameters defined by the class `RAF Configuration`. The methods of this interface must be called after creation of the service instance. When all configuration parameters (including those set via the interface `ISLE_SIAAdmin`) have been set, the method `ISLE_SIAAdmin::ConfigCompleted()` must be called. This method verifies that all configuration parameters values are defined and are in the range defined in reference [2].

In addition, the interface `IRAF_SIAAdmin` provides read access to the configuration parameters.

2.2.3.2.2 Update of Dynamic Status Parameters

The class implements the interface `IRAF_SIUUpdate`. The methods of this interface update status parameters defined by the class `RAF Status Information`. In order to ensure that the status information is always up to date, all changes of status parameters must be reported to the service instance during its complete lifetime, independent of the state of the service instance.

In addition, the class derives some of the parameters in `RAF Status Information` from `RAF PDUs` exchanged between the service provider and the service user. The method used to update each of the parameters is defined in 2.2.5.

The interface `IRAF_SIUUpdate` provides read access to all status parameters.

2.2.3.2.3 Handling of the RAF-GET-PARAMETER Operation

The class responds autonomously to `RAF-GET-PARAMETER` invocations. It generates the appropriate `RAF-GET-PARAMETER` return using the parameters maintained by the classes `RAF Configuration` and `RAF Status Information`.

2.2.3.2.4 Status Reporting

The class generates RAF-STATUS-REPORT invocations when required using the parameters maintained by the class RAF Status Information.

2.2.3.2.5 Processing of RAF Protocol Data Units

The class ensures that SLE PDUs passed by the application and by the association are supported by the RAF service and handles the RAF operation objects defined in 2.3.

2.2.4 INTERNAL CLASS RAF CONFIGURATION

The class defines the configuration parameters that can be set via the interface IRAF_SIAdmin. These parameters are defined by reference [2]. Table 2-1 describes how the service instance uses these parameters.

2.2.5 INTERNAL CLASS RAF STATUS INFORMATION

The class defines dynamic status parameters handled by the service instance. The parameters are defined by reference [2]. Table 2-2 describes how the service element updates each of the parameters and how it uses the parameters.

Table 2-1: RAF Configuration Parameters

| Parameter | Used for |
|----------------------|--|
| delivery-mode | handling of the transfer buffer (enables / disables discarding of data) checking of PDUs RAF-GET-PARAMETER returns |
| latency-limit | handling of the transfer buffer in the 'timely online' and 'complete online' delivery modes RAF-GET-PARAMETER returns |
| transfer-buffer-size | handling of the transfer buffer RAF-GET-PARAMETER returns |

Table 2-2: RAF Status Information

| Parameter | Update | Used for |
|---------------------------------------|---|-------------------|
| number-of-error-free-frames-delivered | count of RAF-TRANSFER-DATA invocations transmitted with the parameter 'frame quality' set to 'good' | status reports |
| number-of-frames-delivered | count of RAF-TRANSFER-DATA invocations transmitted | status reports |
| requested-frame-quality | set to 'undefined' at configuration time extracted from accepted RAF-START invocations set to 'undefined' after RAF-STOP, RAF-PEER-ABORT and protocol abort | RAF-GET-PARAMETER |
| frame-sync-lock-status | set by a method of IRAF_SIUpdate | status reports |
| symbol-sync-lock-status | set by a method of IRAF_SIUpdate | status reports |
| subcarrier-lock-status | set by a method of IRAF_SIUpdate | status reports |
| carrier-lock-status | set by a method of IRAF_SIUpdate | status reports |
| production-status | set by a method of IRAF_SIUpdate | status reports |

2.3 PACKAGE RAF OPERATIONS

Figure 2-2 shows the operation object interfaces required for the RAF service. The package RAF Operations adds operation objects for the following RAF operations:

- a) RAF-START;
- b) RAF-TRANSFER-DATA;
- c) RAF-SYNC-NOTIFY;
- d) RAF-STATUS-REPORT;
- e) RAF-GET-PARAMETER.

For other operations the API uses the common operation objects defined in reference [3].

Table 2-3 maps RAF operations to operation object interfaces.

Table 2-3: Mapping of RAF Operations to Operation Object Interfaces

| RAF Operation | Operation Object Interface | Defined in Package |
|------------------------------|----------------------------|--------------------|
| RAF-BIND | ISLE_Bind | SLE Operations |
| RAF-UNBIND | ISLE_Unbind | SLE Operations |
| RAF-START | IRAF_Start | RAF Operations |
| RAF-STOP | ISLE_Stop | SLE Operations |
| RAF-TRANSFER-DATA | IRAF_TransferData | RAF Operations |
| RAF-SYNC-NOTIFY | IRAF_SyncNotify | RAF Operations |
| [TRANSFER-BUFFER] (see note) | ISLE_TransferBuffer | SLE Operations |
| RAF-SCHEDULE-STATUS-REPORT | ISLE_ScheduleStatusReport | SLE Operations |
| RAF-STATUS-REPORT | IRAF_StatusReport | RAF Operations |
| RAF-GET-PARAMETER | IRAF_GetParameter | RAF Operations |
| RAF-PEER-ABORT | ISLE_PeerAbort | SLE Operations |

NOTE – TRANSFER-BUFFER is a pseudo-operation used to handle the transfer buffer defined in reference [2].

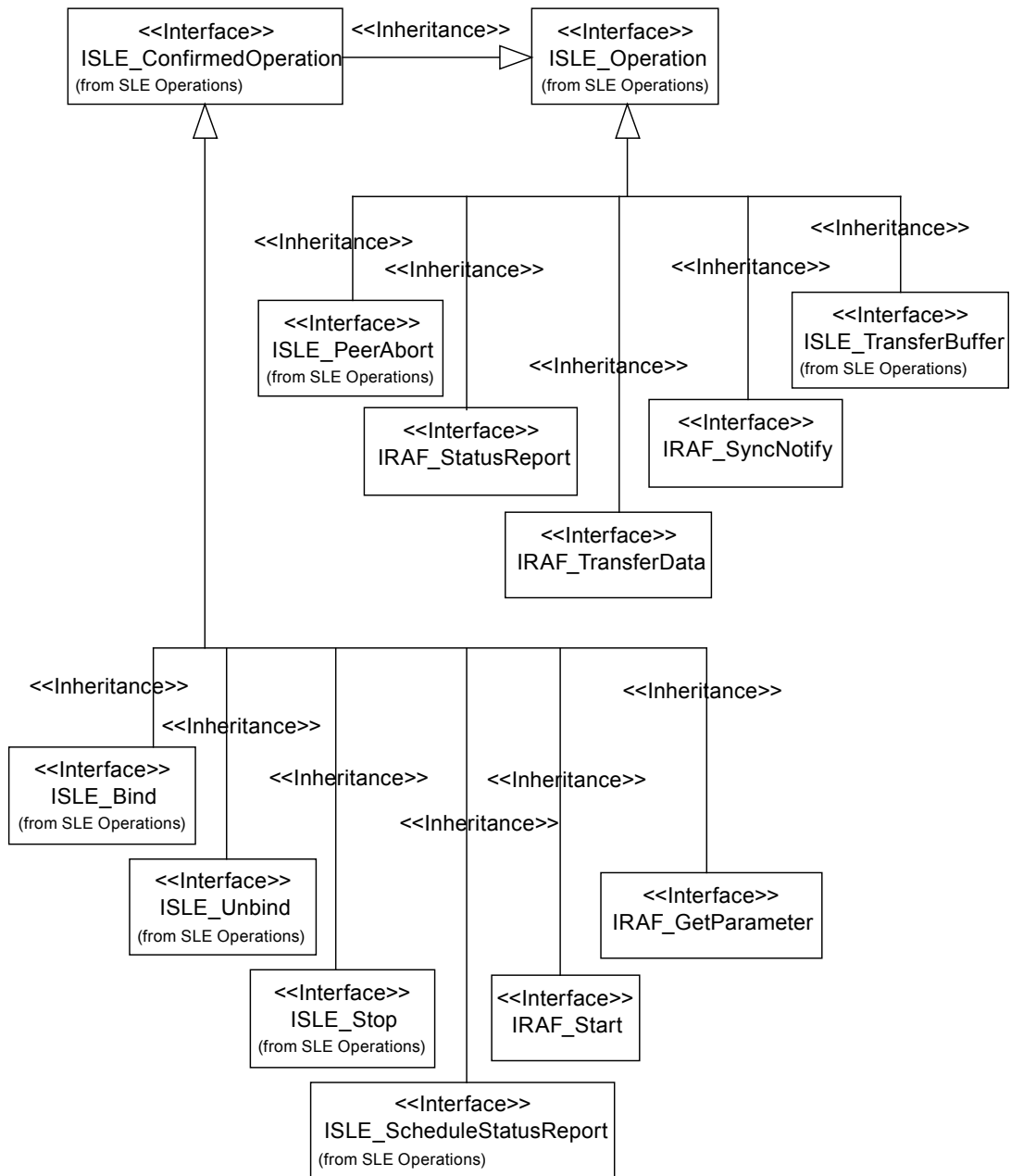


Figure 2-2: RAF Operation Object Interfaces

2.4 SECURITY ASPECTS OF THE SLE RAF TRANSFER SERVICE

2.4.1 SECURITY BACKGROUND/INTRODUCTION

The SLE transfer services explicitly provide authentication and access control. Additional security capabilities, if required, are levied on the underlying communication services that support the SLE transfer services. The SLE transfer services are defined as layered application services operating over underlying communication services that must meet certain requirements but which are otherwise unspecified. Selection of the underlying communication services over which real SLE implementations connect is based on the requirements of the communicating parties and/or the availability of CCSDS-standard communication technology profiles and proxy specifications. Different underlying communication technology profiles are intended to address not only different performance requirements but also different security requirements. Missions and service providers are expected to select from these technology profiles to acquire the performance and security capabilities appropriate to the mission. Specification of the various underlying communication technologies, and in particular their associated security provisions, are outside the scope of this Recommendation.

The SLE RAF transfer service transfers data that originates on a mission spacecraft. As such, the SLE RAF transfer service has custody of the data for only a portion of the end-to-end data path between mission spacecraft and MDOS. Consequently the ability of an SLE transfer service to secure the transfer of mission spacecraft data is limited to that portion of the end-to-end path that is provided by the SLE transfer service (i.e., the terrestrial link between the MDOS and the ground termination of the space-ground link to the mission spacecraft). End-to-end security must also involve securing the data as it crosses the space-ground link, which can be provided by some combination of securing the mission data itself (e.g., encryption of the mission data within CCSDS space packets) and securing the space-ground link (e.g., encryption of the physical space-ground link). Thus while the SLE RAF transfer service plays a role in the end-to-end security of the data path, it does not control and cannot ensure that end-to-end security. This component perspective is reflected in the security provisions of the SLE transfer services.

2.4.2 STATEMENTS OF SECURITY CONCERNS

2.4.2.1 Overview

This subsection identifies RAF transfer service support for capabilities that responds to these security concerns in the areas of data privacy, data integrity, authentication, access control, availability of resources, and auditing.

2.4.2.2 Data Privacy (Also Known As Confidentiality)

This SLE RAF transfer service specification does not define explicit data privacy requirements or capabilities to ensure data privacy. Data privacy is expected to be ensured outside of the SLE transfer service layer, by the mission application processes that communicate over the SLE transfer service, in the underlying communication service that lies under the SLE transfer service, or some combination of both. For example, mission application processes might apply end-to-end encryption to the contents of the CCSDS space link data units carried as data by the SLE transfer service. Alternatively or in addition, the network connection between the SLE entities might be encrypted to provide data privacy in the underlying communication network.

2.4.2.3 Data Integrity

The SLE RAF transfer service defines and enforces a strict sequence of operations that constrain the ability of a third party to inject operation invocations or returns into the transfer service association between a service user and provider (see 4.2.2 in reference [2]). This constrains the ability of a third party to seize control of an active RAF transfer service instance without detection.

The SLE RAF transfer service requires that the underlying communication service transfer data in sequence, completely and with integrity, without duplication, with flow control that notifies the application layer in the event of congestion, and with notification to the application layer in the event that communication between the service user and the service provider is disrupted (see 1.3.1 in reference [2]). No specific mechanisms are identified, as they will be an integral part of the underlying communication service.

2.4.2.4 Authentication

This SLE RAF transfer service specification defines authentication requirements (see 3.1.5 in reference [2]), and defines `initiator-identifier`, `responder-identifier`, `invoker-credentials`, and `performer-credentials` parameters of the service operation invocations and returns that are used to perform SLE transfer service authentication. The procedure by which SLE transfer service operation invocations and returns are authenticated is described in annex F of the Cross Support Service Green Book (reference [C4]). The SLE transfer service authentication capability can be selectively set to authenticate at one of three levels: authenticate every invocation and return, authenticate only the BIND operation invocation and return, or perform no authentication. Depending upon the inherent authentication available from the underlying communication network, the security environment in which the SLE service user and provider are operating, and the security requirements of the spaceflight mission, the SLE transfer service authentication level can be adapted by choosing the SLE operation invocation and returns that shall be authenticated. Furthermore the mechanism used for generating and checking the credentials and thus the

level of protection against masquerading (simple or strong authentication) can be selected in accordance with the results of a threat analysis.

2.4.2.5 Access Control

This SLE RAF transfer service specification defines access control requirements (see 3.1.4 in reference [2]), and defines `initiator-identifier` and `responder-identifier` parameters of the service operation invocations and returns that are used to perform SLE transfer service access control. The procedure by which access to SLE transfer services is controlled is described in annex F of the Cross Support Service Green Book (reference [C4]).

2.4.2.6 Availability of Resources

The SLE transfer services are provided via communication networks that have some limit to the resources available to support those SLE transfer services. If these resources can be diverted from their support of the SLE transfer services (in what is commonly known as “denial of service”) then the performance of the SLE transfer services may be curtailed or inhibited. This SLE RAF transfer service specification does not define explicit capabilities to prevent denial of service. Resource availability is expected to be ensured by appropriate capabilities in the underlying communication service. The specific capabilities will be dependent upon the technologies used in the underlying communication service and the security environment in which the transfer service user and provider operate.

2.4.2.7 Auditing

This SLE RAF transfer service specification does not define explicit security auditing requirements or capabilities. Security auditing is expected to be negotiated and implemented bilaterally between the spaceflight mission and the service provider.

2.4.3 POTENTIAL THREATS AND ATTACK SCENARIOS

The SLE RAF transfer service depends on unspecified mechanisms operating above the SLE transfer service (between a mission spacecraft application process and its peer application process on the ground), underneath the SLE transfer service in the underlying communication service, or some combination of both, to ensure data privacy (confidentiality). If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could read the spacecraft telemetry data contained in the RAF protocol data units as they traverse the WAN between service user and service provider.

The SLE RAF transfer service constrains the ability of a third party to seize control of an active SLE transfer service instance, but it does not specify mechanisms that would prevent an attacker from intercepting the protocol data units and replacing the contents of the `data`

parameter. The prevention of such a replacement attack depends on unspecified mechanisms operating above the SLE transfer service (between a mission spacecraft application process and its peer application process on the ground), underneath the SLE transfer service in the underlying communication service, in bilaterally agreed extra capabilities applied to the SLE transfer service (e.g., encryption of the `data` parameter) or some combination of the three. If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could substitute telemetry data without detection.

If the SLE transfer service authentication capability is not used and if authentication is not ensured by the underlying communication service, attackers may somehow obtain valid `initiator-identifier` values and use them to initiate SLE transfer service instances by which they could gain access to spacecraft telemetry data.

The SLE RAF transfer service depends on unspecified mechanisms operating in the underlying communication service to ensure that the supporting network has sufficient resources to provide sufficient support to legitimate users. If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could prevent legitimate users from receiving telemetry from their spacecraft.

If the provider of SLE RAF transfers service provides no security auditing capabilities, or if a user chooses not to employ auditing capabilities that do exist, then attackers may delay or escape detection while stealing or altering telemetry data.

2.4.4 CONSEQUENCES OF NOT APPLYING SECURITY

The consequences of not applying security to the SLE RAF transfer service are possible degradation and loss of ability to receive telemetry from the spacecraft, or the substitution of altered telemetry data.

3 RAF SPECIFIC SPECIFICATIONS FOR API COMPONENTS

3.1 API SERVICE ELEMENT

3.1.1 SERVICE INSTANCE CONFIGURATION

3.1.1.1 The service element shall provide the interface `IRAF_SIAAdmin` for configuration of a provider-side service instance after creation.

3.1.1.2 The interface shall provide methods to set the following parameters, which the service element needs for handling of the transfer buffer and delivers to the user in response to a `RAF-GET-PARAMETER` invocation:

- a) `delivery-mode`;
- b) `transfer-buffer-size`, i.e., the maximum number of `RAF-TRANSFER-BUFFER` invocations and `RAF-SYNC-NOTIFY` invocations that can be stored to a transfer buffer PDU submitted to the service user; and
- c) `latency-limit`, if the delivery mode is either 'timely online' or 'complete online'.

NOTE – These parameters are defined in reference [2] for the operation `RAF-GET-PARAMETER`. Handling of the transfer buffer by the service element is defined in reference [3].

3.1.1.3 The interface shall provide methods to set the following parameters, which the service instance uses to initialize parameters of the status report:

- a) the value of the production status at the time the service instance is configured;
- b) the lock status of the frame synchronization process at the time the service instance is configured;
- c) the lock status of the symbol synchronization process at the time the service instance is configured;
- d) the lock status of the sub-carrier demodulation process at the time the service instance is configured;
- e) the lock status of the carrier demodulation process at the time the service instance is configured.

NOTES

- 1 For the delivery mode 'offline', status reporting is not supported. Therefore, these parameters need not be specified.

- 2 Further configuration parameters must be set using the interface ISLE_SIAAdmin specified in reference [3]. These include the parameter return-timeout-period required for the RAF-GET-PARAMETER operation.

3.1.1.4 All configuration parameters must be set before the method `ConfigCompleted()` of the interface ISLE_SIAAdmin is called. If one of the parameters is omitted or the value of a parameter is not within the range specified by reference [2], the method `ConfigCompleted()` shall return an error.

NOTES

- 1 As defined in reference [3], the service element shall start processing of the service instance only after successful configuration.
- 2 The range of specific parameter values might be further constrained by service management. The service element shall only perform checks on the limits specified by reference [2].

3.1.1.5 If the delivery mode is 'offline', the service element shall accept the configuration when the parameters defined in 3.1.1.3 have not been specified.

3.1.1.6 Configuration parameters must not be modified after successful return of the method `ConfigCompleted()` defined in the interface ISLE_SIAAdmin. The effect of an attempt to set these parameters after completion of the configuration is undefined.

3.1.1.7 The values of all configuration parameters shall remain unmodified following a RAF-UNBIND or RAF-PEER-ABORT operation and following a protocol-abort.

3.1.1.8 The interface IRAF_SIAAdmin shall provide methods to retrieve the values of the configuration parameters. The values returned by these methods before configuration has been completed are undefined.

3.1.2 STATUS INFORMATION

3.1.2.1 The service element shall maintain status parameters for every service instance and uses them for generation of status reports and for RAF-GET-PARAMETER returns.

NOTES

- 1 The parameters are defined in reference [2] for the operations RAF-STATUS-REPORT and RAF-GET-PARAMETER.
- 2 Handling of the parameter `reporting-cycle` defined for the RAF-GET-PARAMETER operation is specified in reference [2].

3.1.2.2 The service element shall update the following status parameters in the methods of the interface `IRAF_SIUpdate` described in 3.1.2.6:

- a) `frame-sync-lock-status`;
- b) `symbol-sync-lock-status`;
- c) `subcarrier-lock-status`;
- d) `carrier-lock-status`;
- e) `production-status`.

NOTE – The initial values of these parameters following configuration of the service instance are defined in A4.2.

3.1.2.3 The service element shall handle the parameter `number-of-error-free-frames-delivered` as defined by the following specifications:

- a) the parameter shall be set to zero when the service instance is configured;
- b) when a `TRANSFER-BUFFER` PDU is transmitted to the service user, the parameter shall be incremented by the number of `RAF-TRANSFER-DATA` invocations in that PDU, for which the parameter `frame-quality` is set to 'good'.

NOTE – Frames in a `TRANSFER-BUFFER` PDU that is discarded shall not be included in the count of error free frames delivered.

3.1.2.4 The service element shall handle the parameter `number-of-frames-delivered` as defined by the following specifications:

- a) the parameter shall be set to zero when the service instance is configured;
- b) when a `TRANSFER-BUFFER` PDU is transmitted to the service user, the parameter shall be incremented by the number of `RAF-TRANSFER-DATA` invocations in that PDU.

NOTE – Frames in a `TRANSFER-BUFFER` PDU that is discarded shall not be included in the count of frames delivered.

3.1.2.5 The service element shall handle the parameter `requested-frame-quality` as defined by the following specifications:

- a) the parameter shall be set to 'undefined' when the service instance is configured;
- b) when the application transmits a `RAF-START` return with a positive result, the value of the parameter shall be extracted from the `RAF-START` invocation;
- c) the parameter shall be set to 'undefined' following an accepted `RAF-STOP` invocation, and following `RAF-PEER-ABORT` and protocol abort.

NOTE – The parameter `requested-frame-quality` can be requested by a `RAF-GET-PARAMETER` invocation.

3.1.2.6 The service element shall provide the interface `IRAF_SIUUpdate` for every service instance. This interface must be used by the application to update the status parameters defined in 3.1.2.2.

3.1.2.7 If more than one service instance exists, each service instance must be updated independently.

3.1.2.8 In order to keep the status information up to date and consistent, the methods of the interface `IRAF_SIUUpdate` must be invoked for every change, independent of the state of the service instance.

3.1.2.9 The interface `IRAF_SIUUpdate` shall provide read access to all status parameters, including those that are derived by other means.

NOTE – In the delivery mode ‘offline’, status reporting is not supported. Therefore, the application can opt not to update status information in that mode. If status information is not initialized and not updated, retrieval methods shall return the initial parameter values defined in A4.2.

3.1.2.10 The service element shall keep the status parameters defined in 3.1.2.3, 3.1.2.4, and 3.1.2.5 up to date for all delivery modes including the delivery mode ‘offline’.

3.1.2.11 Except for the parameter `requested-frame-quality`, status parameters defined in this specification shall not be modified as result of `RAF-UNBIND`, `RAF-PEER-ABORT`, or protocol abort.

3.1.3 PROCESSING OF RAF PROTOCOL DATA UNITS

NOTES

- 1 The service element shall process RAF PDUs according to the general specifications in reference [3]. This section only addresses additional checks and processing steps defined for the RAF service. RAF-specific checks defined in reference [2], but not listed in this section, must be performed by the application.
- 2 It is noted that 3.1.2 defines further processing requirements for PDUs with respect to update of status information. Annex subsection A3 defines the checks that operation objects perform when the methods `VerifyInvocationArguments()` and `VerifyReturnArguments()` are called. Reference [3] contains specifications defining how the service element handles error codes returned by these methods.

3.1.3.1 RAF START

3.1.3.1.1 When receiving a RAF-START invocation, the service element shall perform the following checks:

- a) if the delivery mode is 'offline', the start time must not be null;
- b) if the start time is defined and the delivery mode is 'online':
 - 1) the start time must be equal to or later than the start time of the scheduled provision period of the service instance, and
 - 2) the start time must be earlier than the stop time of the scheduled provision period;
- c) if the delivery mode is 'offline':
 - 1) the stop time must not be null, and
 - 2) the stop time must be earlier than current time;

NOTE – Reference [2] defines an `offline-processing-latency` and requires that the stop time plus the offline processing latency be earlier than current time. If the application makes use of the offline processing latency, the associated checks must be performed by the application.

- d) if the stop time is defined and the delivery mode is online, the stop time must be earlier than or equal to the stop time of the scheduled provision period.

NOTES

- 1 If the start time and the stop time are defined, the start time must be earlier than the stop time. This check shall be performed by the operation object.
- 2 The service element shall not check the production status, as this could change before the PDU is processed by the application.

3.1.3.1.2 If any of the checks defined in 3.1.3.1.1 fail, the service element on the provider side shall not forward the PDU to the application but shall respond with a RAF-START return with a negative result and the appropriate diagnostic.

NOTE – As specified in reference [3], the service element shall reject PDUs with errors received from the local application with an appropriate result code.

3.1.3.2 RAF SYNC NOTIFY

When receiving a RAF-SYNC-NOTIFY invocation, the service element on the provider side shall perform the following checks:

- a) if the delivery mode is 'offline', the notification type must not be 'loss of frame synchronization', 'production status change', or 'data discarded due to excessive backlog';
- b) if the delivery mode is 'timely online', the notification type must not be 'data discarded due to excessive backlog'.

NOTE – This check cannot be performed on the user side, because the service element does not have the required information.

3.1.4 SERVICE INSTANCE SPECIFIC OPERATION FACTORY

For RAF service instances, the interface `ISLE_SIOpFactory` specified in reference [3] shall support creation and configuration of operation objects for the operations specified in 3.2 with exception of the interfaces `IRAF_StatusReport` and `ISLE_TransferBuffer`.

NOTES

- 1 The initial values of parameters that shall be set for RAF-specific operation objects are defined in annex A.
- 2 Status reports and the transfer buffer shall be handled by the API Service Element without involvement of the application.

3.2 SLE OPERATIONS

3.2.1 The component SLE Operations shall provide operation objects for the following RAF operations in addition to those specified in reference [3]:

- a) RAF-START;
- b) RAF-TRANSFER-DATA;
- c) RAF-SYNC-NOTIFY;
- d) RAF-STATUS-REPORT; and
- e) RAF-GET-PARAMETER.

3.2.2 The operation factory shall create the operation objects specified in 3.2.1 when the requested service type is RAF.

3.2.3 The operation factory shall additionally create the following operation objects specified in reference [3] when the requested service type is RAF:

- a) SLE-BIND;
- b) SLE-UNBIND;
- c) SLE-PEER-ABORT;
- d) SLE-STOP; and
- e) SLE-SCHEDULE-STATUS-REPORT.

3.3 SLE APPLICATION

NOTE – This subsection summarizes specific obligations of a RAF provider application using the SLE API.

3.3.1 Following creation of a service instance, and setting of the configuration parameters defined in reference [3], the application shall set the configuration parameters defined in 3.1.1 via the interface `IRAF_SIAAdmin`.

3.3.2 The application shall update every service instance in the service element with the status information defined in 3.1.2 by invocation of the appropriate methods in the interface `IRAF_SIUpdate`.

3.4 SEQUENCE OF DIAGNOSTIC CODES

3.4.1 GENERAL

3.4.1.1 Reference [3] requires provider applications that do not perform checks in the sequence of the diagnostic codes defined in the Recommended Standard to document the sequence in which checks are actually performed.

3.4.1.2 The specification in 3.1.3.1 does not preserve the sequence of the diagnostic codes defined in reference [2] for the operation RAF-START. This subsection defines the actual sequence of checks performed by the API Service Element. For the checks that remain to be performed by the provider application, the sequence defined in reference [2] is maintained. Applications applying a different sequence must provide a modified documentation.

3.4.2 SEQUENCE OF RAF START DIAGNOSTIC CODES

3.4.2.1 Codes set by the API Service Element

- a) ‘duplicate invoke id’;
- b) ‘invalid start time’;

- c) 'invalid stop time'; and
- d) 'missing time value'.

3.4.2.2 Codes set by the Application

- a) 'out of service';
- b) 'unable to comply';
- c) 'invalid stop time' (for the delivery mode 'offline' if an offline processing latency is used); and
- d) 'other'.

ANNEX A

RAF SPECIFIC INTERFACES

(NORMATIVE)

A1 INTRODUCTION

This annex specifies RAF-specific

- a) data types;
- b) interfaces for operation objects; and
- c) interfaces for service instances.

The specification of the interfaces follows the design patterns, conventions and the additional conventions described in reference [3].

The presentation uses the notation and syntax of the C++ programming language as specified in reference [4].

A2 RAF TYPE DEFINITIONS

File RAF_Types.h

The following types have been derived from the ASN.1 module CCSDS-SLE-TRANSFER-SERVICE-RAF-STRUCTURES in reference [2]. The source ASN.1 type is indicated in brackets. For all enumeration types is defined a special value, ‘invalid’, which is returned if the associated value in the operation object has not yet been set, or is not applicable in case of a choice.

Antenna Id Format [AntennaId]

```
typedef enum RAF_AntennaIdFormat
{
    rafAF_global           = 0,
    rafAF_local           = 1,
    rafAF_invalid         = -1
} RAF_AntennaIdFormat;
```

Reference [2] defines a local form (LF) and a global form (GF) for the antenna identifier. The local form is a string of octets and the global form is an ASN.1 object identifier.

RAF Get Parameter Diagnostic [DiagnosticRafGet]

```
typedef enum RAF_GetParameterDiagnostic
{
    rafGP_unknownParameter = 0,
    rafGP_invalid          = -1
} RAF_GetParameterDiagnostic;
```

RAF Start Diagnostic [DiagnosticRafStart]

```
typedef enum RAF_StartDiagnostic
{
    rafSD_outOfService     = 0,
    rafSD_unableToComply  = 1,
    rafSD_invalidStartTime = 2,
    rafSD_invalidStopTime = 3,
    rafSD_missingTimeValue = 4,
    rafSD_invalid          = -1
} RAF_StartDiagnostic;
```

Delivered Frame Quality [FrameQuality]

```
typedef enum RAF_FrameQuality
{
    rafFQ_good           = 0,
    rafFQ_erred          = 1,
    rafFQ_undetermined   = 2,
    rafFQ_invalid        = -1
} RAF_FrameQuality;
```

Lock Status [LockStatus]

```
typedef enum RAF_LockStatus
{
    rafLS_inLock           = 0,
    rafLS_outOfLock       = 1,
    rafLS_notInUse        = 2, /* for sub-carrier lock */
    rafLS_unknown         = 3,
    rafLS_invalid         = -1
} RAF_LockStatus;
```

Notification Type [Notification]

```
typedef enum RAF_NotificationType
{
    rafNT_lossFrameSync   = 0,
    rafNT_productionStatusChange = 1,
    rafNT_excessiveDataBacklog = 2,
    rafNT_endOfData       = 3,
    rafNT_invalid         = -1
} RAF_NotificationType;
```

Production Status [RafProductionStatus]

```
typedef enum RAF_ProductionStatus
{
    rafPS_running          = 0,
    rafPS_interrupted      = 1,
    rafPS_halted           = 2,
    rafPS_invalid          = -1
} RAF_ProductionStatus;
```

Requested Frame Quality [RequestedFrameQuality]

```
typedef enum RAF_RequestedFrameQuality
{
    rafRQ_goodFramesOnly   = 0,
    rafRQ_erredFramesOnly  = 1,
    rafRQ_allFrames        = 2,
    rafRQ_invalid          = -1
} RAF_RequestedFrameQuality;
```

Parameter Frame Quality Requested [RafGetParameter]

```
typedef enum RAF_ParFrameQuality
{
    rafPQ_goodFramesOnly   = 0,
    rafPQ_erredFramesOnly  = 1,
    rafPQ_allFrames        = 2,
    rafPQ_undefined        = 3,
    rafPQ_invalid          = -1
} RAF_ParFrameQuality;
```

This type is used to report the requested frame quality in RAF GET-PARAMETER returns. The value 'undefined' is set when the state of the service instance is 'ready'.

RAF Parameter Names [RafGetParameter]

```
typedef enum RAF_ParameterName
{
    rafPN_bufferSize           = 4,
    rafPN_deliveryMode         = 6,
    rafPN_latencyLimit         = 15,
    rafPN_reportingCycle       = 26,
    rafPN_requestedFrameQuality = 27,
    rafPN_returnTimeoutPeriod  = 29,
    rafPN_invalid              = -1
} RAF_ParameterName;
```

Parameters that can be read using a RAF-GET-PARAMETER operation. The parameter name values are taken from the type ParameterName in ASN.1 module CCSDS-SLE-TRANSFER-SERVICE-COMMON-TYPES in reference [2].

Delivery Modes

```
typedef enum RAF_DeliveryMode
{
    rafDM_timelyOnline      = sleDM_rtnTimelyOnline,
    rafDM_completeOnline   = sleDM_rtnCompleteOnline,
    rafDM_offline           = sleDM_rtnOffline,
    rafDM_invalid           = -1
} RAF_DeliveryMode;
```

The delivery modes are defined as a subset of SLE_DeliveryMode in reference [3].

A3 RAF OPERATION OBJECTS

A3.1 RAF START OPERATION

Name IRAF_Start
GUID {2F5AEB20-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown - ISLE_Operation - ISLE_ConfirmedOperation
File IRAF_Start.H

The interface provides access to the parameters of the confirmed operation RAF- START.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_ConfirmedOperation.H>
interface ISLE_Time;

#define IID_IRAF_Start_DEF { 0x2f5aeb20, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_Start : ISLE_ConfirmedOperation
{
    virtual const ISLE_Time*
        Get_StartTime() const = 0;
    virtual const ISLE_Time*
        Get_StopTime() const = 0;
    virtual RAF_RequestedFrameQuality
        Get_RequestedFrameQuality() const = 0;
    virtual RAF_StartDiagnostic
        Get_StartDiagnostic() const = 0;
    virtual void
        Set_StartTime( const ISLE_Time& time ) = 0;
    virtual void
        Put_StartTime( ISLE_Time* ptime ) = 0;
    virtual void
        Set_StopTime( const ISLE_Time& time ) = 0;
    virtual void
        Put_StopTime( ISLE_Time* ptime ) = 0;
    virtual void
        Set_RequestedFrameQuality(RAF_RequestedFrameQuality quality) = 0;
    virtual void
        Set_StartDiagnostic( RAF_StartDiagnostic diagnostic ) = 0;
};
```

Methods

const ISLE_Time* Get_StartTime() const;

Returns the reception time of the first frame to be delivered, or NULL if the parameter is not defined.

```
const ISLE_Time* Get_StopTime() const;
```

Returns the reception time of the last frame to be delivered, or NULL if the parameter is not defined.

```
RAF_RequestedFrameQuality Get_RequestedFrameQuality() const;
```

Returns the requested frame quality.

```
RAF_StartDiagnostic Get_StartDiagnostic() const;
```

Returns the value of the diagnostic code.

Precondition: the result is negative, and the diagnostic type is set to ‘specific’.

```
void Set_StartTime( const ISLE_Time& time );
```

Copies the argument to the receive time of the first frame to be delivered.

```
void Put_StartTime( ISLE_Time* ptime );
```

Stores the argument as receive time of the first frame to be delivered.

```
void Set_StopTime( const ISLE_Time& time );
```

Copies the argument to the receive time of the last frame to be delivered.

```
void Put_StopTime( ISLE_Time* ptime );
```

Stores the argument as receive time of the last frame to be delivered.

```
void Set_RequestedFrameQuality(RAF_RequestedFrameQuality quality);
```

Sets the requested frame quality to the value of the argument.

```
void Set_StartDiagnostic( RAF_StartDiagnostic diagnostic );
```

Sets the result to ‘negative’, the diagnostic type to ‘specific’, and stores the value of the diagnostic code passed by the argument.

Initial Values of Operation Parameters after Creation

| Parameter | Created directly | Created by Service Instance |
|-------------------------|------------------|-----------------------------|
| start time | NULL (not used) | NULL (not used) |
| stop time | NULL (not used) | NULL (not used) |
| requested frame quality | 'invalid' | 'invalid' |
| START diagnostic | 'invalid' | 'invalid' |

Checking of Invocation Parameters

| Parameter | Required condition |
|-------------------------|---|
| start time | if the start and the stop time are used, must be earlier than stop time |
| stop time | if the start and the stop time are used, must be later than start time |
| requested frame quality | must not be 'invalid' |

Additional Return Codes for `VerifyInvocationArguments`

`SLE_E_TIMERANGE` specification of the start and stop times is inconsistent.

Checking of Return Parameters

| Parameter | Required condition |
|------------------|---|
| START diagnostic | must not be 'invalid' if the result is 'negative' and the diagnostic type is 'specific' |

A3.2 RAF TRANSFER DATA OPERATION

Name IRAF_TransferData
GUID {2F5AEB21-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown - ISLE_Operation
File IRAF_TransferData.H

The interface provides access to the parameters of the operation RAF-TRANSFER-DATA.

Synopsis

```

#include <RAF_Types.h>
#include <ISLE_Operation.H>
interface ISLE_Time;

#define IID_IRAF_TransferData_DEF { 0x2f5aeb21, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_TransferData : ISLE_Operation
{
    virtual const ISLE_Time*
        Get_EarthReceiveTime() const = 0;
    virtual RAF_AntennaIdFormat
        Get_AntennaIdFormat () const = 0;
    virtual const SLE_Octet*
        Get_AntennaIdLF( size_t& size ) const = 0;
    virtual const int*
        Get_AntennaIdGF( int& length ) const = 0;
    virtual char*
        Get_AntennaIdGFString() const = 0;
    virtual int
        Get_DataLinkContinuity() const = 0;
    virtual RAF_FrameQuality
        Get_FrameQuality() const = 0;
    virtual const SLE_Octet*
        Get_PrivateAnnotation( size_t& size ) const = 0;
    virtual SLE_Octet*
        Remove_PrivateAnnotation( size_t& size ) = 0;
    virtual const SLE_Octet*
        Get_Data( size_t& size ) const = 0;
    virtual SLE_Octet*
        Remove_Data( size_t& size ) = 0;
    virtual void
        Set_EarthReceiveTime( const ISLE_Time& time ) = 0;
    virtual void
        Put_EarthReceiveTime( ISLE_Time* ptime ) = 0;
    virtual void
        Set_AntennaIdLF ( const SLE_Octet* id, size_t size ) = 0;
    virtual void
        Set_AntennaIdGF ( const int* id, int length ) = 0;
    virtual void
        Set_AntennaIdGFString( const char* id) = 0;
    virtual void
        Set_DataLinkContinuity( int numFrames ) = 0;
    virtual void
        Set_FrameQuality( RAF_FrameQuality quality ) = 0;
    virtual void
        Set_PrivateAnnotation( const SLE_Octet* pannotation,

```

```

        size_t size ) = 0;
    virtual void
        Put_PrivateAnnotation( SLE_Octet* pannotation,
                               size_t size ) = 0;
    virtual void
        Set_Data( const SLE_Octet* pdata, size_t size ) = 0;
    virtual void
        Put_Data( SLE_Octet* pdata, size_t size ) = 0;
};

```

Methods

```
virtual const ISLE_Time* Get_EarthReceiveTime() const;
```

Returns the earth receive time of the frame delivered, if the parameter has been set in the object. Returns NULL otherwise.

```
RAF_AntennaIdFormat Get_AntennaIdFormat () const;
```

Returns the format of the antenna identifier (octet string or object identifier) or ‘invalid’ when the parameter has not been set.

```
const SLE_Octet* Get_AntennaIdLF( size_t& size ) const;
```

Returns the antenna identifier in the local form, i.e., a string of octets.

Arguments

size the number of octets in the antenna ID (1 to 16)

Precondition: Get_AntennaIdFormat returns rafAF_local.

```
const int* Get_AntennaIdGF( int& length ) const;
```

Returns the antenna identifier in the global form, i.e., an object identifier as defined by ASN.1. In C++ this is represented as a sequence of integers.

Arguments

length the number of elements in the antenna ID

Precondition: Get_AntennaIdFormat returns rafAF_global.

```
char* Get_AntennaIdGFString() const;
```

Returns the antenna ID as a character string formatted as a dot separated list of numbers. The string is allocated on the heap and must be deleted by the client.

Precondition: Get_AntennaIdFormat returns rafAF_global.


```
int Get_DataLinkContinuity() const;
```

Returns the data link continuity parameter, if the parameter has been set in the object, or -2 if the parameter has not been set. A valid value can be -1, 0, or any positive number.

```
RAF_FrameQuality Get_FrameQuality() const;
```

Returns the quality of the delivered frame.

```
const SLE_Octet* Get_PrivateAnnotation( size_t& size ) const;
```

Returns a pointer to the private annotation in the object or NULL if the private annotation has not been set.

Arguments

length the length of the private annotation in bytes

```
SLE_Octet* Remove_PrivateAnnotation( size_t& size );
```

Returns the private annotation data and removes them from the object. The memory allocated by the parameter must be released by the client. If the parameter has not been set returns NULL.

Arguments

length the length of the private annotation in bytes

```
const SLE_Octet* Get_Data( size_t& size ) const;
```

Returns a pointer to the frame in the object or NULL if the frame has not been inserted.

Arguments

length the length of the frame in bytes

```
SLE_Octet* Remove_Data( size_t& size );
```

Returns the frame and removes it from the object. The memory allocated by the frame must be released by the client. If the parameter has not been set returns NULL.

Arguments

length the length of the frame in bytes

```
void Set_EarthReceiveTime( const ISLE_Time& time );
```

Copies the value of the argument to the earth receive time.

```
void Put_EarthReceiveTime( ISLE_Time* ptime );
```

Stores the argument to the parameter earth receive time.

```
void Set_AntennaIdLF ( const SLE_Octet* id, size_t size );
```

Sets the antenna id format to 'local form' and the antenna id to the value of the argument. The local form of the antenna id is a string of octets.

```
void Set_AntennaIdGF ( const int* id, int length );
```

Sets the antenna id format to 'global form' and the antenna id to the value of the argument. The global form the antenna id is an object identifier as defined by ASN.1, represented as a sequence of integers.

```
void Set_AntennaIdGFString( const char* id);
```

Sets the antenna id format to 'global form' and the antenna id to the value of the argument. If the argument is badly formatted, the parameter is reset to its initial state, i.e., 'not set'.

Arguments

id an object identifier formatted as a dot separated list of numbers

```
void Set_DataLinkContinuity( int numFrames );
```

Sets the parameter data link continuity to the value of the argument.

```
void Set_FrameQuality( RAF_FrameQuality quality );
```

Sets the parameter frame quality to the value of the argument.

```
void Set_PrivateAnnotation( const SLE_Octet* pannotation,
                           size_t size );
```

Copies size bytes from the argument pannotation to the parameter private annotation.

Arguments

pannotation pointer to the private annotation
length the length of the annotation in bytes

```
void Put_PrivateAnnotation( SLE_Octet* pannotation, size_t size );
```

Stores the argument pannotation to the parameter private annotation.

CCSDS RECOMMENDED PRACTICE: API FOR THE SLE RAF SERVICE

Arguments

pannotation pointer to the private annotation
 length the length of the annotation in bytes

```
void Set_Data( const SLE_Octet* pdata, size_t size );
```

Copies size bytes from the argument `pdata` to the parameter 'data'.

Arguments

pdata pointer to the data
 length the length of the data in bytes

```
void Put_Data( SLE_Octet* pdata, size_t size );
```

Stores the argument `pdata` to the parameter 'data'.

Arguments

pdata pointer to the data
 length the length of the data in bytes

Initial Values of Operation Parameters after Creation

| Parameter | Created directly | Created by Service Instance |
|----------------------|------------------|-----------------------------|
| earth receive time | NULL | NULL |
| antenna id | NULL | NULL |
| antenna id format | 'invalid' | 'invalid' |
| data link continuity | -2 | -2 |
| frame quality | 'invalid' | 'invalid' |
| private annotation | NULL | NULL |
| data | NULL | NULL |

Checking of Invocation Parameters

| Parameter | Required condition |
|----------------------|---|
| earth receive time | must not be NULL |
| antenna id | must not be NULL |
| data link continuity | must be > -2 |
| frame quality | must not be 'invalid' |
| private annotation | if used, the size must be in the range of 1 to 128 octets |
| data | must not be NULL |

A3.3 RAF SYNC NOTIFY OPERATION

Name IRAF_SyncNotify
GUID {2F5AEB22-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown - ISLE_Operation
File IRAF_SyncNotify.H

The interface provides access to the parameters of the unconfirmed operation RAF-SYNC-NOTIFY.

Synopsis

```

#include <RAF_Types.h>
#include <ISLE_Operation.H>
interface ISLE_Time;

#define IID_IRAF_SyncNotify_DEF { 0x2f5aeb22, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SyncNotify : ISLE_Operation
{
    virtual RAF_NotificationType
        Get_NotificationType() const = 0;
    virtual const ISLE_Time*
        Get_LossOfLockTime() const = 0;
    virtual RAF_LockStatus
        Get_CarrierDemodLock() const = 0;
    virtual RAF_LockStatus
        Get_SubCarrierDemodLock() const = 0;
    virtual RAF_LockStatus
        Get_SymbolSyncLock() const = 0;
    virtual RAF_ProductionStatus
        Get_ProductionStatus() const = 0;
    virtual void
        Set_LossOfFrameSync( const ISLE_Time& time,
                            RAF_LockStatus symbolSyncLock,
                            RAF_LockStatus subCarrierDemodLock,
                            RAF_LockStatus carrierDemodLock ) = 0;
    virtual void
        Set_ProductionStatusChange( RAF_ProductionStatus status ) = 0;
    virtual void
        Set_DataDiscarded() = 0;
    virtual void
        Set_EndOfData() = 0;
};
  
```

Methods

RAF_NotificationType Get_NotificationType() const;

Returns the type of the notification.

```
const ISLE_Time* Get_LossOfLockTime() const;
```

Returns the time at which the frame synchronizer lost lock.

Precondition: notification type is ‘loss of frame synchronization’.

```
RAF_LockStatus Get_CarrierDemodLock() const;
```

Returns the lock status of the carrier demodulation process.

Precondition: notification type is ‘loss of frame synchronization’.

```
RAF_LockStatus Get_SubCarrierDemodLock() const;
```

Returns the lock status of the sub-carrier demodulation process.

Precondition: notification type is ‘loss of frame synchronization’.

```
RAF_LockStatus Get_SymbolSyncLock() const;
```

Returns the lock status of the symbol synchronization process.

Precondition: notification type is ‘loss of frame synchronization’.

```
RAF_ProductionStatus Get_ProductionStatus() const;
```

Returns the production status.

Precondition: notification type is ‘production status change’.

```
void Set_LossOfFrameSync( const ISLE_Time& time,
                          RAF_LockStatus symbolSyncLock,
                          RAF_LockStatus subCarrierDemodLock,
                          RAF_LockStatus carrierDemodLock );
```

Sets the notification type to ‘loss of frame synchronization’ and the notification values as specified by the arguments.

Arguments

| | |
|---------------------|---|
| time | the time at which the frame synchronizer lost lock |
| symbolSyncLock | the lock status of the symbol synchronization process |
| subCarrierDemodLock | the lock status of the sub-carrier demodulation process |
| carrierDemodLock | the lock status of the carrier demodulation process |

```
void Set_ProductionStatusChange( RAF_ProductionStatus status );
```

Sets the notification type to 'production status change' and the notification value as defined by the argument.

```
void Set_DataDiscarded();
```

Sets the notification type to 'data discarded due to excessive backlog'.

```
void Set_EndOfData();
```

Sets the notification type to 'end of data'.

Initial Values of Operation Parameters after Creation

| Parameter | Created directly | Created by Service Instance |
|-------------------------|------------------|-----------------------------|
| notification-type | 'invalid' | 'invalid' |
| loss of lock time | NULL | NULL |
| symbol-sync-lock-status | 'invalid' | 'invalid' |
| subcarrier-lock-status | 'invalid' | 'invalid' |
| carrier-lock-status | 'invalid' | 'invalid' |
| production-status | 'invalid' | 'invalid' |

Checking of Invocation Parameters

| Parameter | Required condition |
|-------------------------|---|
| notification-type | must not be 'invalid' |
| loss of lock time | if notification type is 'loss of frame synchronization' must not be NULL |
| symbol-sync-lock-status | if notification type is 'loss of frame synchronization' must not be 'invalid' or 'not in use' |
| subcarrier-lock-status | if notification type is 'loss of frame synchronization' must not be 'invalid' |
| carrier-lock-status | if notification type is 'loss of frame synchronization' must not be 'invalid' or 'not in use' |
| production-status | if notification type is 'production status change' must not be 'invalid' |

A3.4 RAF STATUS REPORT OPERATION

Name IRAF_StatusReport
GUID {2F5AEB23-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown - ISLE_Operation
File IRAF_StatusReport.H

The interface provides access to the parameters of the unconfirmed operation RAF-STATUS-REPORT.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_Operation.H>

#define IID_IRAF_StatusReport_DEF { 0x2f5aeb23, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_StatusReport : ISLE_Operation
{
    virtual unsigned long
        Get_NumErrorFreeFrames() const = 0;
    virtual unsigned long
        Get_NumFrames() const = 0;
    virtual RAF_LockStatus
        Get_FrameSyncLock() const = 0;
    virtual RAF_LockStatus
        Get_CarrierDemodLock() const = 0;
    virtual RAF_LockStatus
        Get_SubCarrierDemodLock() const = 0;
    virtual RAF_LockStatus
        Get_SymbolSyncLock() const = 0;
    virtual RAF_ProductionStatus
        Get_ProductionStatus() const = 0;
    virtual void
        Set_NumErrorFreeFrames( unsigned long count ) = 0;
    virtual void
        Set_NumFrames( unsigned long count ) = 0;
    virtual void
        Set_FrameSyncLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_CarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_SubCarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_SymbolSyncLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_ProductionStatus( RAF_ProductionStatus status ) = 0;
};
```

Methods

unsigned long Get_NumErrorFreeFrames() const;

Returns the number of error free frames delivered.

```
unsigned long Get_NumFrames() const;
```

Returns the total number of frames delivered.

```
RAF_LockStatus Get_FrameSyncLock() const;
```

Returns the lock status of the frame synchronization process.

```
RAF_LockStatus Get_CarrierDemodLock() const;
```

Returns the lock status of the carrier demodulation process.

```
RAF_LockStatus Get_SubCarrierDemodLock() const;
```

Returns the lock status of the sub-carrier demodulation process.

```
RAF_LockStatus Get_SymbolSyncLock() const;
```

Returns the lock status of the symbol synchronization process.

```
RAF_ProductionStatus Get_ProductionStatus() const;
```

Returns the production status.

```
void Set_NumErrorFreeFrames( unsigned long count );
```

Sets the number of error free frames delivered as defined by the argument.

```
void Set_NumFrames( unsigned long count );
```

Sets the total number of frames delivered as defined by the argument.

```
void Set_FrameSyncLock( RAF_LockStatus status );
```

Sets the frame synchronizer lock status as defined by the argument.

```
void Set_CarrierDemodLock( RAF_LockStatus status );
```

Sets the carrier demodulator lock status as defined by the argument.

```
void Set_SubCarrierDemodLock( RAF_LockStatus status );
```

Sets the sub-carrier demodulator lock status as defined by the argument.

CCSDS RECOMMENDED PRACTICE: API FOR THE SLE RAF SERVICE

```
void Set_SymbolSyncLock( RAF_LockStatus status );
```

Sets the symbol synchronizer lock status as defined by the argument.

```
void Set_ProductionStatus( RAF_ProductionStatus status );
```

Sets the production status as defined by the argument.

Initial Values of Operation Parameters after Creation

| Parameter | Created directly |
|---------------------------------------|------------------|
| number-of-error-free-frames-delivered | 0 |
| number-of-frames-delivered | 0 |
| frame-sync-lock-status | 'invalid' |
| symbol-sync-lock-status | 'invalid' |
| subcarrier-lock-status | 'invalid' |
| carrier-lock-status | 'invalid' |
| production-status | 'invalid' |

NOTE – The interface ISLE_SIOpFactory does not support creation of status report operation objects, as this operation is handled by the service instance internally.

Checking of Invocation Parameters

| Parameter | Required condition |
|-------------------------|---------------------------------------|
| frame-sync-lock-status | must not be 'invalid' or 'not in use' |
| symbol-sync-lock-status | must not be 'invalid' or 'not in use' |
| subcarrier-lock-status | must not be 'invalid' |
| carrier-lock-status | must not be 'invalid' or 'not in use' |
| production-status | must not be 'invalid' |

A3.5 RAF GET PARAMETER OPERATION

Name IRAF_GetParameter
GUID {2F5AEB24-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown - ISLE_Operation - ISLE_ConfirmedOperation
File IRAF_GetParameter.H

The interface provides access to the parameters of the confirmed operation RAF-GET-PARAMETER.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_ConfirmedOperation.H>

#define IID_IRAF_GetParameter_DEF { 0x2f5aeb24, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_GetParameter : ISLE_ConfirmedOperation
{
    virtual RAF_ParameterName
        Get_RequestedParameter() const = 0;
    virtual RAF_ParameterName
        Get_ReturnedParameter() const = 0;
    virtual RAF_DeliveryMode
        Get_DeliveryMode() const = 0;
    virtual RAF_ParFrameQuality
        Get_RequestedFrameQuality() const = 0;
    virtual unsigned short
        Get_LatencyLimit() const = 0;
    virtual unsigned long
        Get_TransferBufferSize() const = 0;
    virtual unsigned long
        Get_ReportingCycle() const = 0;
    virtual unsigned long
        Get_ReturnTimeoutPeriod() const = 0;
    virtual RAF_GetParameterDiagnostic
        Get_GetParameterDiagnostic() const = 0;
    virtual void
        Set_RequestedParameter( RAF_ParameterName name ) = 0;
    virtual void
        Set_DeliveryMode( RAF_DeliveryMode mode ) = 0;
    virtual void
        Set_RequestedFrameQuality( RAF_ParFrameQuality quality ) = 0;
    virtual void
        Set_LatencyLimit( unsigned short limit ) = 0;
    virtual void
        Set_TransferBufferSize( unsigned long size ) = 0;
    virtual void
        Set_ReportingCycle( unsigned long cycle ) = 0;
    virtual void
        Set_ReturnTimeoutPeriod( unsigned long period ) = 0;
    virtual void
        Set_GetParameterDiagnostic( RAF_GetParameterDiagnostic
            diagnostic ) = 0;
};
```

Methods

RAF_ParameterName Get_RequestedParameter() const;

Returns the identification of the parameter whose value shall be returned.

RAF_ParameterName Get_ReturnedParameter() const;

Returns the identification of the parameter whose value is reported.

RAF_DeliveryMode Get_DeliveryMode() const;

Returns the delivery mode of the service instance.

Precondition: the returned parameter is `delivery-mode`.

RAF_ParFrameQuality Get_RequestedFrameQuality() const;

Returns the requested frame quality as set by the RAF-START operation.

Precondition: the returned parameter is `requested-frame-quality`.

unsigned short Get_LatencyLimit() const;

Returns the latency limit defined by service management. If the delivery mode is 'offline', returns zero.

Precondition: the returned parameter is `latency-limit`.

unsigned long Get_TransferBufferSize() const;

Returns the size of the transfer buffer as the maximum number of RAF-TRANSFER-DATA invocations and RAF-SYNC-NOTIFY invocations that can be stored in the buffer.

Precondition: the returned parameter is `transfer-buffer-size`.

unsigned long Get_ReportingCycle() const;

Returns the reporting cycle requested by the user if periodic reporting is active. If reporting is not active, returns zero.

Precondition: the returned parameter is `reporting-cycle`.

unsigned long Get_ReturnTimeoutPeriod() const;

Returns the return timeout period used by the provider.

Precondition: the returned parameter is `return-timeout-period`.

```
RAF_GetParameterDiagnostic Get_GetParameterDiagnostic() const;
```

Returns the diagnostic code.

Precondition: the result is negative, and the diagnostic type is set to ‘specific’.

```
void Set_RequestedParameter( RAF_ParameterName name );
```

Sets the parameter for which the provider shall report the value.

```
void Set_DeliveryMode( RAF_DeliveryMode mode );
```

Sets the returned parameter name to `delivery-mode` and the value as defined by the argument.

```
void Set_RequestedFrameQuality( RAF_ParFrameQuality quality );
```

Sets the returned parameter name to `requested-frame-quality` and the value as defined by the argument.

```
void Set_LatencyLimit( unsigned short limit );
```

Sets the returned parameter name to `latency-limit` and the value as defined by the argument.

```
void Set_TransferBufferSize( unsigned long size );
```

Sets the returned parameter name to `transfer-buffer-size` and the value as defined by the argument.

```
void Set_ReportingCycle( unsigned long cycle );
```

Sets the returned parameter name to `reporting-cycle` and the value as defined by the argument.

```
void Set_ReturnTimeoutPeriod( unsigned long period );
```

Sets the returned parameter name to `return-timeout-period` and the value as defined by the argument.

```
void Set_GetParameterDiagnostic( RAF_GetParameterDiagnostic  
                                diagnostic );
```

Sets the result to ‘negative’, the diagnostic type to ‘specific’, and stores the value of the diagnostic code passed by the argument.

Initial Values of Operation Parameters after Creation

| Parameter | Created directly | Created by Service Instance |
|--------------------------|------------------|-----------------------------|
| requested parameter | 'invalid' | 'invalid' |
| returned parameter | 'invalid' | 'invalid' |
| delivery-mode | 'invalid' | 'invalid' |
| requested-frame-quality | 'invalid' | 'invalid' |
| latency-limit | 0 | 0 |
| transfer-buffer-size | 0 | 0 |
| reporting-cycle | 0 | 0 |
| return-timeout-period | 0 | 0 |
| GET PARAMETER diagnostic | 'invalid' | 'invalid' |

Checking of Invocation Parameters

| Parameter | Required condition |
|---------------------|-----------------------|
| requested parameter | must not be 'invalid' |

Checking of Return Parameters

| Parameter | Required condition |
|--------------------------|---|
| returned parameter | must be the same as 'requested parameter' |
| delivery-mode | If the returned parameter is 'delivery mode' must not be 'invalid' |
| transfer-buffer-size | If the returned parameter is 'transfer buffer size' must not be 0 |
| return-timeout-period | If the returned parameter is 'return timeout period' must not be 0 |
| GET PARAMETER diagnostic | must not be 'invalid' if the result is 'negative' and the diagnostic type is 'specific' |

The interface ensures consistency between the returned parameter name and the parameter value, as the client cannot set the returned parameter name. Therefore, this consistency need not be checked on the provider side. The checks defined above only need to be performed when the return is received by the service user.

A4 RAF SERVICE INSTANCE INTERFACES

A4.1 SERVICE INSTANCE CONFIGURATION

Name IRAF_SIAAdmin
GUID {2F5AEB25-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown
File IRAF_SIAAdmin.H

The interface provides write and read access to the RAF-specific service instance configuration-parameters. All configuration parameters must be set as part of service instance configuration. When the method `ConfigCompleted()` is called on the interface `ISLE_SIAAdmin`, the service element checks that all required parameters have been set and returns an error when the configuration is not complete.

Configuration parameters must not be set after successful return of the method `ConfigCompleted()`. The effect of invoking these methods at a later stage is undefined.

As a convenience for the application, the interface provides read access to the configuration parameters, except for parameters used to initialize the status report. If retrieval methods are called before configuration, the value returned is undefined.

Synopsis

```
#include <RAF_Types.h>
#include <SLE_SCM.H>

#define IID_IRAF_SIAAdmin_DEF { 0x2f5aeb25, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SIAAdmin : IUnknown
{
    virtual void
        Set_DeliveryMode( RAF_DeliveryMode mode ) = 0;
    virtual void
        Set_LatencyLimit( unsigned short limit ) = 0;
    virtual void
        Set_TransferBufferSize( unsigned long size ) = 0;
    virtual void
        Set_InitialProductionStatus( RAF_ProductionStatus status ) = 0;
    virtual void
        Set_InitialFrameSyncLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_InitialCarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_InitialSubCarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_InitialSymbolSyncLock( RAF_LockStatus status ) = 0;
    virtual RAF_DeliveryMode
        Get_DeliveryMode() const = 0;
    virtual unsigned short
        Get_LatencyLimit() const = 0;
    virtual unsigned long
        Get_TransferBufferSize() const = 0;
};
```

Methods

```
void Set_DeliveryMode( RAF_DeliveryMode mode );
```

Sets the delivery mode of the service instance.

```
void Set_LatencyLimit( unsigned short limit );
```

Sets the latency limit in seconds for transmission of the transfer buffer. If the delivery mode is 'offline', the parameter need not be set.

```
void Set_TransferBufferSize( unsigned long size );
```

Sets the maximum number of RAF-TRANSFER-DATA invocations and RAF-SYNC-NOTIFY invocations that shall be stored in one transfer buffer PDU.

```
void Set_InitialProductionStatus( RAF_ProductionStatus status );
```

Sets the value of the production status at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialFrameSyncLock( RAF_LockStatus status );
```

Sets the lock status of the frame synchronization process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialCarrierDemodLock( RAF_LockStatus status );
```

Sets the lock status of the carrier demodulation process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialSubCarrierDemodLock( RAF_LockStatus status );
```

Sets the lock status of the sub-carrier demodulation process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialSymbolSyncLock( RAF_LockStatus status );
```

Sets the lock status of the symbol synchronization process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
RAF_DeliveryMode Get_DeliveryMode() const;
```

Returns the value of the parameter `delivery-mode`.

```
unsigned short Get_LatencyLimit() const;
```

Returns the value of the parameter `latency-limit`.

```
unsigned long Get_TransferBufferSize() const;
```

Returns the value of the parameter `transfer-buffer-size`.

A4.2 UPDATE OF SERVICE INSTANCE PARAMETERS

| | |
|---------------------|--|
| Name | IRAF_SIUpdate |
| GUID | {2F5AEB26-7C28-11d3-9F15-00104B4F22C0} |
| Inheritance: | IUnknown |
| File | IRAF_SIUpdate.H |

The interface provides methods to update parameters that shall be reported to the service user via the operation STATUS-REPORT. In order to keep this information up to date the appropriate methods of this interface must be called whenever the information changes, independent of the state of the service instance.

The interface provides read access to the parameters set via this interface and to parameters accumulated or derived by the API according to the specifications in 3.1. The API sets the parameters to the initial values specified at the end of this section when the service instance is configured. Parameter values retrieved before configuration are undefined.

In the delivery mode ‘offline’, status reporting is not supported. Therefore configuration parameters used to initialize the status report need not be supplied and the status information need not be updated. If the initial values and updates are not supplied, the retrieval methods return the values defined at the end of this section. Values accumulated by the service element are kept up to date for all delivery modes, including the mode ‘offline’.

Retrievable parameters include the `requested-frame-quality`. This parameter is not included in the status report but can be read by the service user via the operation RAF-GET-PARAMETER.

Synopsis

```
#include <RAF_Types.h>
#include <SLE_SCM.H>

#define IID_IRAF_SIUpdate_DEF { 0x2f5aeb26, 0x7c28, 0x11d3, \
    { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SIUpdate : IUnknown
{
    virtual void
        Set_ProductionStatus( RAF_ProductionStatus status ) = 0;
    virtual void
        Set_FrameSyncLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_CarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_SubCarrierDemodLock( RAF_LockStatus status ) = 0;
    virtual void
        Set_SymbolSyncLock( RAF_LockStatus status ) = 0;
    virtual RAF_ProductionStatus
        Get_ProductionStatus() const = 0;
    virtual RAF_LockStatus
        Get_FrameSyncLock() const = 0;
    virtual RAF_LockStatus
```

```

    Get_CarrierDemodLock() const = 0;
virtual RAF_LockStatus
    Get_SubCarrierDemodLock() const = 0;
virtual RAF_LockStatus
    Get_SymbolSyncLock() const = 0;
virtual unsigned long
    Get_NumErrorFreeFrames() const = 0;
virtual unsigned long
    Get_NumFrames() const = 0;
virtual RAF_ParFrameQuality
    Get_RequestedFrameQuality() const = 0;
};

```

Methods

```
void Set_ProductionStatus( RAF_ProductionStatus status );
```

The method must be called whenever the production status changes to set the new value.

```
void Set_FrameSyncLock( RAF_LockStatus status );
```

The method must be called whenever the lock status of the frame synchronization process changes to set the new value.

```
void Set_CarrierDemodLock( RAF_LockStatus status );
```

The method must be called whenever the lock status of the carrier demodulation process changes to set the new value.

```
void Set_SubCarrierDemodLock( RAF_LockStatus status );
```

The method must be called whenever the lock status of the sub-carrier demodulation process changes to set the new value.

```
void Set_SymbolSyncLock( RAF_LockStatus status );
```

The method must be called whenever the lock status of the symbol synchronization process changes to set the new value.

```
RAF_ProductionStatus Get_ProductionStatus() const;
```

Returns the value of the production status.

```
RAF_LockStatus Get_FrameSyncLock() const;
```

Returns the lock status of the frame synchronization process.

```
RAF_LockStatus Get_CarrierDemodLock() const;
```

Returns the lock status of the carrier demodulation process.

```
RAF_LockStatus Get_SubCarrierDemodLock() const;
```

Returns the lock status of the sub-carrier demodulation process.

```
RAF_LockStatus Get_SymbolSyncLock() const;
```

Returns the lock status of the symbol synchronization process.

```
unsigned long Get_NumErrorFreeFrames() const;
```

Returns the number of error free frames delivered by the service instance. In the delivery mode 'timely online' this number can be smaller than the number of error free frames passed to the service element because data might have been discarded because of excessive backlog.

```
unsigned long Get_NumFrames() const;
```

Returns the total number of frames delivered by the service instance. In the delivery mode 'timely online' this number can be smaller than the number of frames passed to the service element because data might have been discarded because of excessive backlog.

```
RAF_ParFrameQuality Get_RequestedFrameQuality() const;
```

Returns the frame quality requested by the service user. If the state of the service instance is not 'active' the method returns 'undefined'.

Initial Parameter Values

| Parameter | Value |
|-------------------------|--|
| production-status | initial production status set via the interface IRAF_SIAAdmin, in the delivery mode 'offline' set to 'invalid' if not set via IRAF_SIAAdmin |
| frame-sync-lock-status | initial frame synchronizer lock set via the interface IRAF_SIAAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAAdmin |
| symbol-sync-lock-status | initial symbol synchronizer lock set via the interface IRAF_SIAAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAAdmin |
| subcarrier-lock-status | initial sub-carrier demodulator lock set via the interface IRAF_SIAAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAAdmin |

| Parameter | Value |
|-----------------------------|--|
| carrier-lock-status | initial carrier demodulator lock set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAdmin |
| number-of-error-free-frames | 0 |
| total-number-of-frames | 0 |
| requested-frame-quality | 'undefined' |

ANNEX B**ACRONYMS****(INFORMATIVE)**

This annex expands the acronyms used throughout this Recommended Practice.

| | |
|-------|--|
| API | Application Program Interface |
| CCSDS | Consultative Committee for Space Data Systems |
| GUID | Globally Unique Identifier |
| ID | Identifier |
| IEC | International Electrotechnical Commission |
| ISO | International Organization for Standardization |
| OMG | Object Management Group |
| PDU | Protocol Data Unit |
| RAF | Return All Frames |
| SI | Service Instance |
| SLE | Space Link Extension |
| UML | Unified Modeling Language |

ANNEX C

INFORMATIVE REFERENCES

(INFORMATIVE)

- [C1] *Organization and Processes for the Consultative Committee for Space Data Systems*. Issue 4. CCSDS Record (Yellow Book), CCSDS A02.1-Y-4. Washington, D.C.: CCSDS, April 2014.
- [C2] *Space Link Extension—Return All Frames Service Specification*. Issue 1.7. Draft Recommendation for Space Data System Standards (Draft Red Book), CCSDS 911.1-R-1.7. n.p.: n.p., September 1999.
- [C3] *Space Link Extension—Return All Frames Service Specification*. Issue 2-S. Recommendation for Space Data System Standards (Historical), CCSDS 911.1-B-2-S. Washington, D.C.: CCSDS, (December 2004) January 2010.
- [C4] *Cross Support Concept—Part 1: Space Link Extension Services*. Issue 3. Report Concerning Space Data System Standards (Green Book), CCSDS 910.3-G-3. Washington, D.C.: CCSDS, March 2006.
- [C5] *Space Link Extension—Internet Protocol for Transfer Services*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 913.1-B-2. Washington, D.C.: CCSDS, September 2015.
- [C6] *Space Link Extension—Application Program Interface for Transfer Services—Summary of Concept and Rationale*. Issue 1. Report Concerning Space Data System Standards (Green Book), CCSDS 914.1-G-1. Washington, D.C.: CCSDS, January 2006.
- [C7] *Space Link Extension—Application Program Interface for Transfer Services—Application Programmer's Guide*. Issue 2. Report Concerning Space Data System Standards (Green Book), CCSDS 914.2-G-2. Washington, D.C.: CCSDS, October 2008.
- [C8] *The COM/DCOM Reference*. COM/DCOM Product Documentation, AX-01. San Francisco: The Open Group, 1999.
- [C9] *Unified Modeling Language (UML)*. Version 2.4.1. Needham, Massachusetts: Object Management Group, August 2011.

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email subscriptions@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services

Tel: +44 345 086 9001

Email (orders): orders@bsigroup.com

Email (enquiries): cservices@bsigroup.com

Subscriptions

Tel: +44 345 086 9001

Email: subscriptions@bsigroup.com

Knowledge Centre

Tel: +44 20 8996 7004

Email: knowledgecentre@bsigroup.com

Copyright & Licensing

Tel: +44 20 8996 7070

Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK