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Space data and information transfer systems — Space link extension — Application program interface for return operational control fields service

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National foreword

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

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INTERNATIONAL STANDARD

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Space data and information transfer systems — Space link extension — Application program interface for return operational control fields service

Systèmes de transfert des informations et données spatiales — Extension de liaisons spatiales — Interface du programme d'application pour service des champs de contrôle de retour opérationnel

Reference number
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Foreword

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ISO 18444 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 915.5-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 18444:2013), which has been technically revised.

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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**.

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DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 915.2-M-1	Space Link Extension—Application Program Interface for Return Channel Frames Service, Recommended Practice, Issue 1	October 2008	Original issue, superseded
CCSDS 915.5-M-2	Space Link Extension—Application Program Interface for Return Operational Control Fields Service, Recommended Practice, Issue 2	September 2015	Current issue: – 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.

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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 Operational Control Fields (ROCF) service defined in reference [2].

1.2 SCOPE

This specification defines extensions to the SLE API in terms of:

a) the ROCF-specific functionality provided by API components;

b) the ROCF-specific interfaces provided by API components; and

c) the externally visible behavior associated with the ROCF 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 specification defines only interfaces and behavior that must be provided by implementations supporting the Return Operational Control Fields service in addition to the specification in reference [3].

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1.3 APPLICABILITY

The Application Program Interface specified in this document supports two generations of Return Operational Control Fields service, namely:

a) Generation 2 identified by the version number 1 in the BIND operation, as specified by reference [C8];

b) Generation 3 identified by the version number 4 in the BIND operation, as specified by reference [2].

NOTES

1 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.

2 Support for Generation 1 is not valid in this book because the ROCF initial issue was written as part of Generation 2 of the RAF, RCF and CLTU specific version 1 recommendations.

Support for Generation 2 of the service is included for backward compatibility purposes for a limited time and may not be continued in future versions of this specification.

Provisions within this Recommended Practice that are specific for a specific generation are marked as:

– [G2:] for provisions specific to Generation 2;

– [G3:] for provisions specific to Generation 3.

Provisions that apply to all generations are not marked.

1.4 RATIONALE

This Recommended Practice specifies the mapping of the ROCF 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.

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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:

- section 1 provides purpose and scope of this specification, identifies conventions, and lists definitions and references used throughout the document;
- section 2 provides an overview of the ROCF service and describes the API model extension including support for the ROCF service defined in reference [2];
- section 3 contains detailed specifications for the API components and for applications using the API;
- annex A provides a formal specification of the API interfaces and data types specific to the ROCF service;
- annex B lists all acronyms used within this document;
- 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 SLE services 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.

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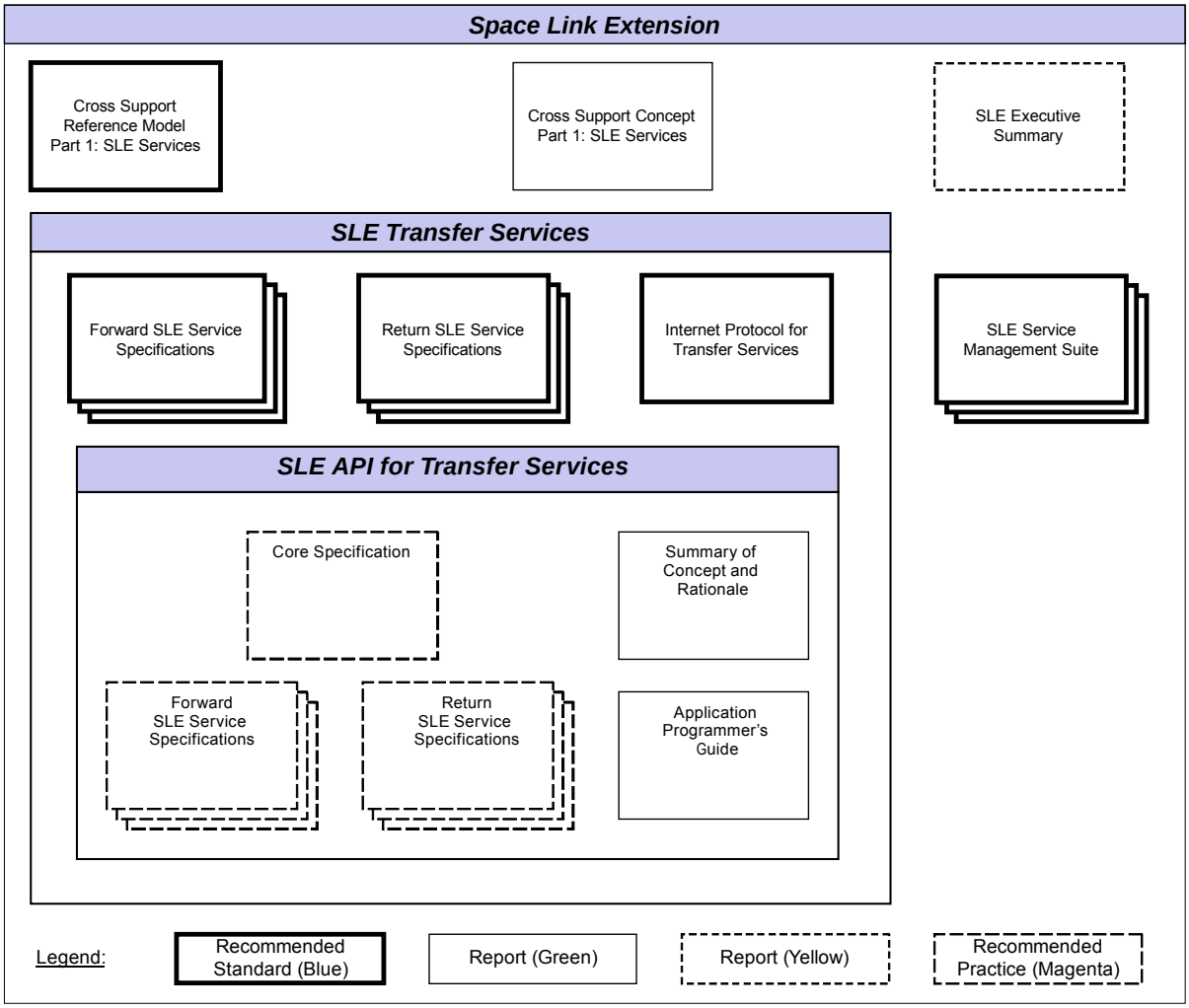

Figure 1-1: SLE Services and SLE API Documentation

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.

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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 Operational Control Fields service (ROCF 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.

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1.6.1.2 Definitions from ROCF 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) global VCID;

f) invocation;

g) latency limit;

h) lock status;

i) notification;

j) offline processing latency;

k) parameter;

l) performance;

m) permitted global VCID set;

n) port identifier;

o) production status;

p) return;

q) service instance provision period;

r) transfer buffer;

s) unconfirmed operation;

t) virtual channel.

1.6.1.3 Definitions from ASN.1 Specification

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

a) Object Identifier;

b) Octet String.

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1.6.1.4 Definitions from UML Specification

This Recommended Practice makes use of the following terms defined in reference [C7]:

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 Programming 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;

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– Background;

– Rationale;

– Discussion.

1.6.3 CONVENTIONS

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

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

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

The ROCF-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 Operational Control Fields Service Specification*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 911.5-B-2. 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.

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[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.

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2 OVERVIEW

2.1 INTRODUCTION

This section describes the extension of the SLE API model in reference [3] for support of the ROCF 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 ROCF-specific protocol data units.

2.2 PACKAGE ROCF SERVICE INSTANCES

2.2.1 GENERAL

The ROCF extensions to the component API Service Element are defined by the package ROCF 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 ROCF service.

The package adds two service instance classes:

a) ROCF SI User, supporting the service user role; and

b) ROCF 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 ROCF operations.

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

The class ROCF SI Provider adds two new interfaces:

a) `IROCF_SIAdmin` by which the application can set ROCF-specific configuration parameters; and

b) `IROCF_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].

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

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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 ROCF SI USER

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

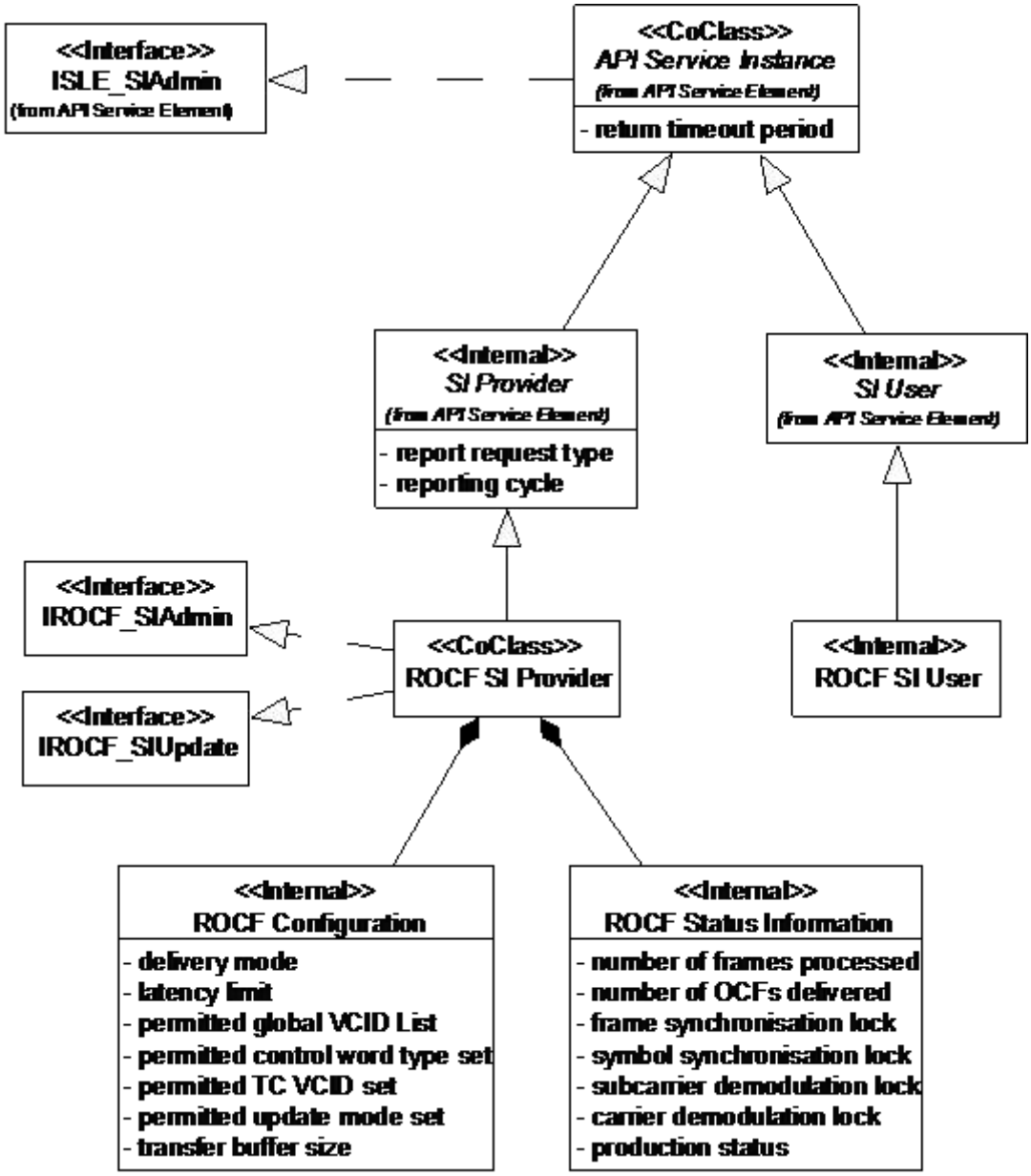

Figure 2-1: ROCF Service Instances

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2.2.3 COMPONENT CLASS ROCF SI PROVIDER

2.2.3.1 General

The class defines a ROCF service instance supporting the service provider role. It exports the interfaces `IROCF_SIAdmin` for configuration of the service instance after creation and `IROCF_SIUpdate` 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 `IROCF_SIAdmin` to set the ROCF-specific configuration parameters defined by the class ROCF 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_SIAdmin`) have been set, the method `ISLE_SIAdmin::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 `IROCF_SIAdmin` provides read access to the configuration parameters.

2.2.3.2.2 Update of Dynamic Status Parameters

The class implements the interface `IROCF_SIUpdate`. The methods of this interface update status parameters defined by the class ROCF 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 ROCF Status Information from ROCF 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 `IROCF_SIUpdate` provides read access to all status parameters.

2.2.3.2.3 Handling of the ROCF–GET-PARAMETER Operation

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

2.2.3.2.4 Status Reporting

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

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2.2.3.2.5 Processing of ROCF Protocol Data Units

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

2.2.4 INTERNAL CLASS ROCF CONFIGURATION

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

Table 2-1: ROCF Configuration Parameters

Parameter	Used for
`delivery-mode`	handling of the transfer buffer (enables / disables discarding of data) checking of PDUs ROCF–GET–PARAMETER returns
`latency-limit`	handling of the transfer buffer in the timely online and complete online delivery modes ROCF–GET–PARAMETER returns
`permitted-global-VCID-list`	ROCF–GET–PARAMETER returns checking of ROCF-START invocations
`permitted-control-word-type-set`	ROCF–GET–PARAMETER returns checking of ROCF-START invocations
`permitted-TC-VCID-set`	ROCF–GET–PARAMETER returns checking of ROCF-START invocations
`permitted-update-mode-set`	ROCF–GET–PARAMETER returns checking of ROCF-START invocations
`transfer-buffer-size`	handling of the transfer buffer ROCF–GET–PARAMETER returns

2.2.5 INTERNAL CLASS ROCF 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.

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Table 2-2: ROCF Status Information

Parameter	Update	Used for
number-of-frames-processed	count of telemetry frames processed for OCF extraction set by a method of IROCF_SIUpdate	status reports
number-of-ocfs-delivered	count of ROCF–TRANSFER–DATA invocations transmitted	status reports
frame-sync-lock-status	set by a method of IROCF_SIUpdate	status reports
symbol-sync-lock-status	set by a method of IROCF_SIUpdate	status reports
subcarrier-lock-status	set by a method of IROCF_SIUpdate	status reports
carrier-lock-status	set by a method of IROCF_SIUpdate	status reports
production-status	set by a method of IROCF_SIUpdate	status reports
requested-global-VCID	extracted from ROCF-START-return with a positive result	GET-PARAMETER
requested-control-word-type	extracted from ROCF-START-return with a positive result	GET-PARAMETER
requested-TC-VCID	extracted from ROCF-START-return with a positive result	GET-PARAMETER
requested-update-mode	extracted from ROCF-START-return with a positive result	GET-PARAMETER

2.3 PACKAGE ROCF OPERATIONS

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

a) ROCF–START;

b) ROCF–TRANSFER–DATA;

c) ROCF–SYNC–NOTIFY;

d) ROCF–STATUS–REPORT; and

e) ROCF–GET–PARAMETER.

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

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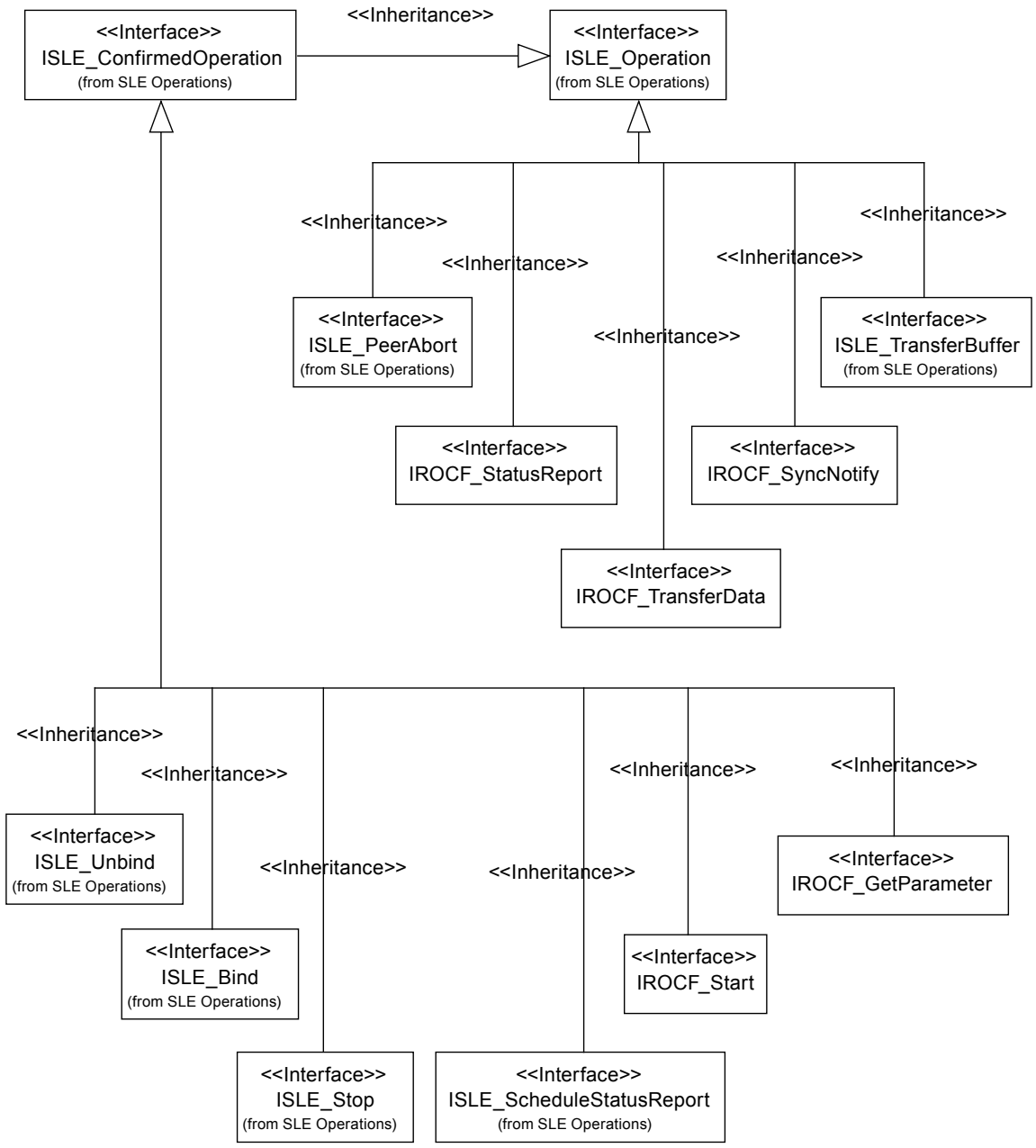

Figure 2-2: ROCF Operation Object Interfaces

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

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