
**Space link extension — Cross support
transfer service — Specification
framework**

STANDARDSISO.COM : Click to view the full PDF of ISO 23103:2020



STANDARDSISO.COM : Click to view the full PDF of ISO 23103:2020



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: 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 (see 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 (see 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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 921.1-B-1, April 2017) and drafted in accordance with its editorial rules. It was assigned to Technical Committee ISO/TC 20, *Space vehicles*, Subcommittee SC 13, *Space data and information transfer systems* and adopted under the "fast-track procedure".

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

CONTENTS

<u>Section</u>	<u>Page</u>
1 INTRODUCTION	1-1
1.1 PURPOSE	1-1
1.2 SCOPE	1-1
1.3 APPLICABILITY	1-1
1.4 RATIONALE	1-2
1.5 DOCUMENT STRUCTURE	1-2
1.6 DEFINITIONS, NOMENCLATURE AND CONVENTIONS	1-5
1.7 REFERENCES	1-19
2 DESCRIPTION OF CROSS SUPPORT SERVICES	2-1
2.1 OVERVIEW	2-1
2.2 CROSS SUPPORT REFERENCE MODEL	2-3
2.3 SERVICE MANAGEMENT	2-4
2.4 ELEMENTS OF THE CSTS SPECIFICATION FRAMEWORK	2-5
2.5 PRINCIPLES OF USING THE CSTS SPECIFICATION FRAMEWORK	2-9
2.6 PROTOCOL DESCRIPTION	2-11
3 COMMON OPERATIONS	3-1
3.1 OVERVIEW	3-1
3.2 GENERAL CONSIDERATIONS	3-1
3.3 STANDARD OPERATION HEADER	3-6
3.4 BIND (CONFIRMED)	3-9
3.5 UNBIND (CONFIRMED)	3-14
3.6 PEER-ABORT (UNCONFIRMED)	3-15
3.7 START (CONFIRMED)	3-17
3.8 STOP (CONFIRMED)	3-19
3.9 TRANSFER-DATA (UNCONFIRMED)	3-20
3.10 PROCESS-DATA (UNCONFIRMED / CONFIRMED)	3-22
3.11 NOTIFY (UNCONFIRMED)	3-24
3.12 GET (CONFIRMED)	3-26
3.13 EXECUTE-DIRECTIVE (ACKNOWLEDGED)	3-31
4 PROCEDURES	4-1
4.1 OVERVIEW	4-1
4.2 COMMON PROCEDURES BEHAVIOR	4-1
4.3 ASSOCIATION CONTROL	4-3
4.4 UNBUFFERED DATA DELIVERY	4-10

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

CONTENTS (continued)

<u>Section</u>	<u>Page</u>
4.5 BUFFERED DATA DELIVERY	4-15
4.6 DATA PROCESSING	4-39
4.7 BUFFERED DATA PROCESSING	4-54
4.8 SEQUENCE-CONTROLLED DATA PROCESSING	4-66
4.9 INFORMATION QUERY	4-83
4.10 CYCLIC REPORT	4-87
4.11 NOTIFICATION	4-98
4.12 THROW EVENT	4-109
ANNEX A IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA (NORMATIVE)	A-1
ANNEX B PRODUCTION STATUS (NORMATIVE)	B-1
ANNEX C QUALIFIED PARAMETERS (NORMATIVE)	C-1
ANNEX D OBJECT IDENTIFIERS DEFINITION (NORMATIVE)	D-1
ANNEX E COMPOSITION OF PARAMETER, EVENT, AND DIRECTIVE NAMES AND PARAMETER AND EVENT LISTS (NORMATIVE) ...	E-1
ANNEX F DATA TYPES DEFINITION (NORMATIVE)	F-1
ANNEX G SERVICE STATE TABLES (NORMATIVE)	G-1
ANNEX H SECURITY, SANA, AND PATENT CONSIDERATIONS (INFORMATIVE)	H-1
ANNEX I INFORMATIVE REFERENCES (INFORMATIVE)	I-1
ANNEX J INDEX TO DEFINITIONS (INFORMATIVE)	J-1
ANNEX K ACRONYMS (INFORMATIVE)	K-1
ANNEX L OBJECT IDENTIFIERS (INFORMATIVE)	L-1
ANNEX M PUBLISHED IDENTIFIERS FOR FUNCTIONAL RESOURCES REGISTERED UNDER THE CROSSSUPPORTFUNCTIONALITIES NODE (INFORMATIVE)	M-1

Figure

1-1 Cross Support Service Documentation	1-4
2-1 CSTS Specification Framework Concept	2-2
2-2 Service and Procedure States (Stateful Prime Procedure)	2-13
2-3 Service and Procedure States (Stateless Prime Procedure)	2-14
2-4 Communications Realization of a Cross Support Transfer Service	2-17
4-1 Services Using a Buffered Data Delivery Procedure	4-18
4-2 Real-Time and Complete Buffered Data Delivery Service Instances and Supporting Buffering Mechanisms	4-19
A-1 Production Status Diagram	B-1
C-1 CSTS and Cross Support Resources Root Object Identifier Tree	D-2
C-2 'procedures' Subtree	D-6

CONTENTS (continued)

<u>Figure</u>	<u>Page</u>
C-3 ‘fwProceduresFunctionalities’ Subtree.....	D-8
C-4 ‘services’ Subtree.....	D-9
C-5 ‘service procedures’ Subtree.....	D-10
C-6 ‘crossSupportFunctionalities’ Subtree.....	D-12
C-7 ‘agenciesFunctionalities’ Subtree.....	D-14
L-1 Cross Support Services Part of the CCSDS Object Identifiers Tree	L-1
L-2 CSS Object Identifiers Tree.....	L-1
L-3 CSTS Object Identifiers Tree	L-2
L-4 CSTS Specification Framework Object Identifiers Tree.....	L-3
L-5 CSTS Services Object Identifiers Tree.....	L-4
L-6 CSTS Published Identifiers—Object Identifiers Tree	L-6
M-1 Example Cross Support Functional Resources.....	M-2
M-2 Subcarrier Related Parameters of the Rtn401SpaceLinkCarrierRecpt Functional Resource	M-3

Table

2-1 Common Operations Defined by the CSTS Specification Framework	2-6
2-2 Common Procedures Defined by the CSTS Specification Framework.....	2-8
2-3 Use of Operations by Common Procedures.....	2-9
3-1 Standard Confirmed Operation Header Parameters	3-6
3-2 Standard Unconfirmed Operation Header Parameters	3-6
3-3 BIND Operation Parameters.....	3-10
3-4 UNBIND Operation Parameters.....	3-14
3-5 PEER-ABORT Operation Parameters.....	3-15
3-6 START Operation Parameters.....	3-18
3-7 STOP Operation Parameters.....	3-19
3-8 TRANSFER-DATA Operation Parameters.....	3-20
3-9 PROCESS-DATA Operation Parameters.....	3-22
3-10 NOTIFY Operation Parameters.....	3-24
3-11 GET Operation Parameters.....	3-29
3-12 EXECUTE-DIRECTIVE Operation Parameters.....	3-32
4-1 Association Control Procedure Required Operations.....	4-7
4-2 Association Control Procedure Configuration Parameters.....	4-7
4-3 Association Control Procedure State Table.....	4-8
4-4 Procedure State Table Incoming Event Description References.....	4-9
4-5 Procedure State Table Predicate Descriptions.....	4-9
4-6 Procedure State Table Simple Action References	4-9
4-7 Procedure State Table Compound Action Definitions	4-9
4-8 Unbuffered Data Delivery Procedure Required Operations.....	4-12

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

CONTENTS (continued)

<u>Table</u>	<u>Page</u>
4-9 Unbuffered Data Delivery Procedure State Table	4-13
4-10 Procedure State Table Incoming Event Description References	4-13
4-11 Procedure State Table Predicate Descriptions	4-13
4-12 Procedure State Table Boolean Flags	4-14
4-13 Procedure State Table Simple Action References	4-14
4-14 Buffered Data Delivery Procedure Required Operations	4-25
4-15 START Extension Parameters	4-25
4-16 Buffered Data Delivery Procedure Configuration Parameters	4-31
4-17 Buffered Data Delivery Procedure State Table	4-32
4-18 Procedure State Table Incoming Event Description References	4-34
4-19 Procedure State Table Predicate Descriptions	4-34
4-20 Procedure State Table Boolean Flags	4-34
4-21 Procedure State Table Simple Action References	4-35
4-22 Procedure State Table Compound Action Definitions	4-35
4-23 Data Processing Procedure Required Operations	4-45
4-24 PROCESS-DATA Extension Parameter	4-45
4-25 NOTIFY Extension Parameters	4-46
4-26 Data Processing Procedure Configuration Parameters	4-50
4-27 Data Processing Procedure State Table	4-51
4-28 Procedure State Table Incoming Event Description References	4-52
4-29 Procedure State Table Predicate Descriptions	4-52
4-30 Procedure State Table Boolean Flags	4-53
4-31 Procedure State Table Simple Action References	4-53
4-32 Procedure State Table Compound Action Definitions	4-53
4-33 Buffered Data Processing Procedure Required Operations	4-60
4-34 Buffered Data Processing Procedure Configuration Parameters	4-61
4-35 Buffered Data Processing Procedure State Table	4-62
4-36 Procedure State Table Incoming Event Description References	4-64
4-37 Procedure State Table Predicate Descriptions	4-64
4-38 Procedure State Table Boolean Flags	4-65
4-39 Procedure State Table Simple Action References	4-65
4-40 Procedure State Table Compound Action Definitions	4-65
4-41 Sequence-Controlled Data Processing Procedure Required Operations	4-72
4-42 START Extension Parameters	4-72
4-43 PROCESS-DATA Invocation Extension Parameters	4-73
4-44 PROCESS-DATA Return Extension Parameters	4-73
4-45 Sequence-Controlled Data Processing Procedure Configuration Parameters	4-79
4-46 Sequence-Controlled Data Processing Procedure State Table	4-80
4-47 Procedure State Table Incoming Event Description References	4-81
4-48 Procedure State Table Predicate Descriptions	4-82
4-49 Procedure State Table Simple Action References	4-82

CONTENTS (continued)

<u>Table</u>	<u>Page</u>
4-50 Procedure State Table Compound Action Definitions	4-82
4-51 Information Query Procedure Required Operations	4-85
4-52 Information Query Procedure Configuration Parameters	4-85
4-53 Information Query Procedure State Table	4-86
4-54 Procedure State Table Incoming Event Description References	4-86
4-55 Procedure State Table Predicate Descriptions	4-86
4-56 Procedure State Table Simple Action References	4-86
4-57 Cyclic Report Procedure Required Operations	4-92
4-58 START Extension Parameters	4-93
4-59 Cyclic Report Procedure Configuration Parameters	4-96
4-60 Cyclic Report Procedure State Table	4-96
4-61 Procedure State Table Incoming Event Description References	4-97
4-62 Procedure State Table Predicate Descriptions	4-97
4-63 Procedure State Table Simple Action References	4-97
4-64 Procedure State Table Compound Action Definitions	4-97
4-65 Notification Procedure Required Operations	4-103
4-66 START Extension Parameters	4-103
4-67 Notification Procedure Configuration Parameters	4-107
4-68 Notification Procedure State Table	4-107
4-69 Procedure State Table Event Description References	4-108
4-70 Procedure State Table Predicate Descriptions	4-108
4-71 Procedure State Table Simple Action References	4-108
4-72 Procedure State Table Compound Action Definitions	4-108
4-73 Throw Event Procedure Required Operations	4-111
4-74 Throw Event Procedure Configuration Parameters	4-113
4-75 Throw Event Procedure State Table	4-113
4-76 Procedure State Table Incoming Event Description References	4-114
4-77 Procedure State Table Predicate Definitions	4-114
4-78 Procedure State Table Simple Action References	4-114
A-1 Production Status Semantic	B-2
A-2 Production Status Transitions	B-3
F-1 State Table for CSTSes with a Stateless Prime Procedure Instance	G-2
F-2 State Table for CSTSes with a Stateless Prime Procedure Instance: Event Description References	G-2
F-3 State Table for CSTSes with a Stateless Prime Procedure Instance: Predicate Descriptions	G-2
F-4 State Table for CSTSes with a Stateless Prime Procedure Instance: Compound Action Definitions	G-3
F-5 State Table for CSTSes with a Stateful Prime Procedure Instance	G-4

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

CONTENTS (continued)

<u>Table</u>	<u>Page</u>
F-6 State Table for CSTSes with a Stateful Prime Procedure Instance: Event Description References.....	G-5
F-7 State Table for CSTSes with a Stateful Prime Procedure Instance: Predicate Descriptions	G-5
F-8 State Table for CSTSes with a Stateful Prime Procedure Instance: Compound Action Definitions.....	G-5
G-1 Identification of PICS	A-3
G-2 Identification of Implementation Under Test	A-4
G-3 Identification of Supplier	A-4
G-4 Identification of Specification	A-4
G-5 Required Procedures	A-5
G-6 Required PDUs	A-6
G-7 BIND Invocation Parameters.....	A-7
G-8 BIND Return Parameters	A-8
G-9 PEER-ABORT Invocation Parameters.....	A-9
G-10 UNBIND Invocation Parameters	A-9
G-11 UNBIND Return Parameters	A-10
G-12 EXECUTE-DIRECTIVE Invocation Parameters.....	A-11
G-13 EXECUTE-DIRECTIVE Acknowledgement Parameters.....	A-13
G-14 EXECUTE-DIRECTIVE Return Parameters	A-14
G-15 GET Invocation Parameters.....	A-16
G-16 GET Return Parameters	A-17
G-17 PROCESS-DATA Invocation Parameters.....	A-19
G-18 PROCESS-DATA Return Parameters	A-21
G-19 START Invocation Parameters.....	A-23
G-20 START Return Parameters	A-25
G-21 STOP Invocation Parameters.....	A-27
G-22 STOP Return Parameters	A-28
G-23 NOTIFY Invocation Parameters.....	A-29
G-24 TRANSFER-DATA Invocation Parameters.....	A-31
M-1 Specification of the Subcarrier Level Estimate Parameter	M-4
M-2 Specification of the Subcarrier Lock Status Parameter	M-5

1 INTRODUCTION

1.1 PURPOSE

The purpose of this Recommended Standard is to define the various logical components, also known within this Recommended Standard as procedures that are required for specifying Cross Support Transfer Services (CSTs).

1.2 SCOPE

1.2.1 This Recommended Standard defines, in an abstract manner, a CSTS in terms of:

- a) the procedures necessary to provide the service;
- b) the states of the service;
- c) the behavior of each procedure;
- d) the states of the procedures;
- e) the operations necessary to constitute the procedures; and
- f) the parameters associated with each operation.

1.2.2 It does not specify:

- a) individual application services, implementations, or products;
- b) the implementation of entities or interfaces within real systems;
- c) the methods or technologies required to acquire data;
- d) the methods or technologies required to provide a suitable environment for communications; or
- e) the management activities required to schedule and configure services.

1.3 APPLICABILITY

1.3.1 APPLICABILITY OF THIS RECOMMENDED STANDARD

This Recommended Standard provides a basis for the specification and development of Cross Support Services that are intended to be used for developing real systems that implement such services.

Implementation of a service based on the CSTS procedures defined in this Recommended Standard in a real system additionally requires the availability of a communications service to convey invocations and responses of the CSTS operations between the service user and the service provider.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

This Recommended Standard requires that such a communications service provides a reliable protocol, i.e., that it ensures that invocations and responses of operations are transferred:

- a) in sequence;
- b) completely and with integrity;
- c) without duplication;
- d) with flow control that notifies the application layer in the event of congestion or backpressure; and
- e) with notification to the application layer in the event that communications between the service user and the service provider are disrupted, possibly resulting in a loss of data.

It is the specific intent of this Recommended Standard to define the CSTS independently of any particular communications services, protocols, technologies, or formatting of the data content.

1.3.2 LIMITS OF APPLICABILITY

This Recommended Standard specifies the CSTS procedures that may be used for the definition of Cross Support Transfer Services. It does not intend to specify a Cross Support Transfer Service.

1.4 RATIONALE

The goal of this Recommended Standard is to create a standard for interoperability between various Agencies' tracking stations or ground data handling systems and the consumers or producers of spacecraft data and related monitor and/or control information.

1.5 DOCUMENT STRUCTURE

1.5.1 ORGANIZATION OF THIS DOCUMENT

This document is organized as follows:

- a) section 1 presents the purpose, scope, applicability, and rationale of this Recommended Standard and lists the definitions, conventions, and references;
- b) section 2 provides an overview of the CSTS Specification Framework;
- c) section 3 specifies the common operations to be used by Cross Support Transfer Services;
- d) section 4 specifies the procedures to be used by the Cross Support Transfer Services;
- e) annex A contains the proforma of the Protocol Implementation Conformance Statement;

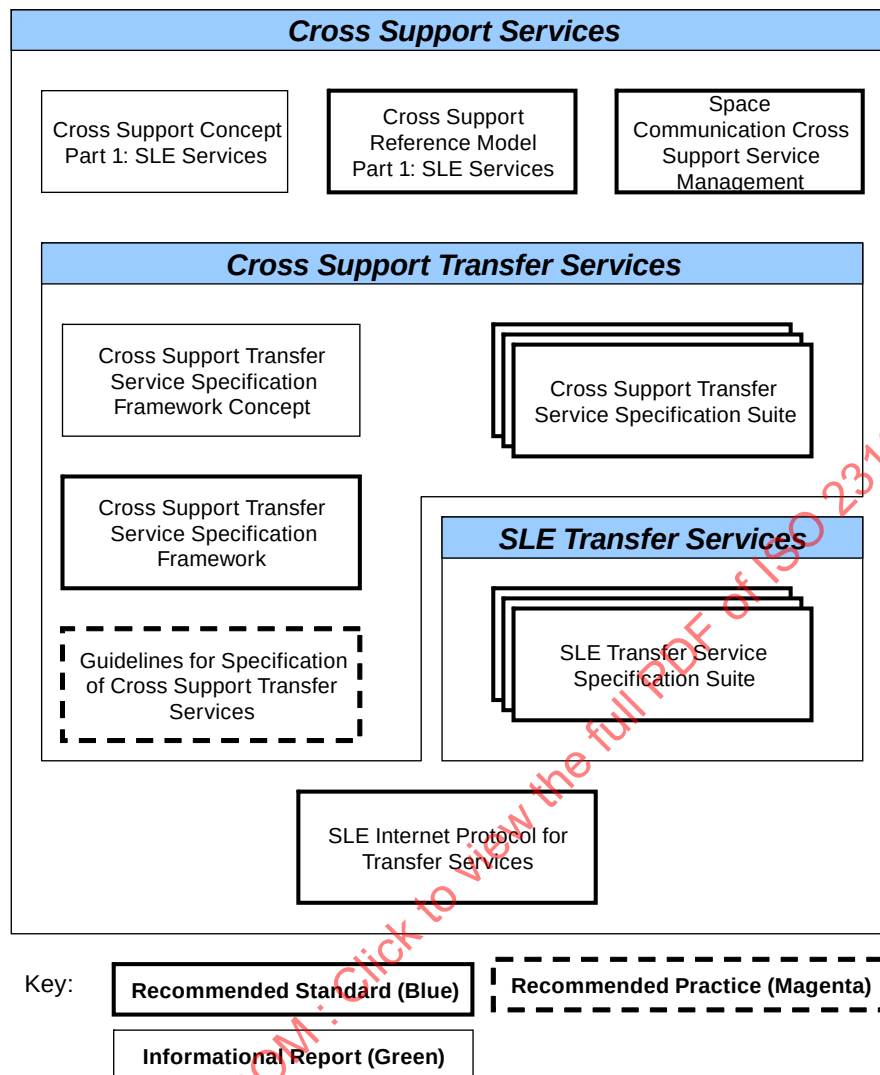
CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- f) annex B provides a formal specification of the production status;
- g) annex C provides a formal specification of what a qualified parameter is;
- h) annex D provides a formal specification of the Object Identifiers and the management of their allocation;
- i) annex E defines the composition of Functional Resource Names, Parameter Names, Event Names, Parameter Lists, and Event Lists using Published Identifiers of the appropriate types;
- j) annex F provides a formal specification of data types for Protocol Data Units (PDUs) for common operations using Abstract Syntax Notation One (ASN.1);
- k) annex G provides a description of the service provider states;
- l) annex H contains considerations related to security, SANA, and patents;
- m) annex I provides a list of informative references;
- n) annex J lists selected terms used in this Recommended Standard and identifies where they are defined;
- o) annex K lists acronyms used in this document;
- p) annex L provides an informative list of Object Identifiers used by this Recommended Standard;
- q) annex M illustrates by means of examples the concept of Published Identifiers.

1.5.2 CROSS SUPPORT TRANSFER SERVICES DOCUMENTATION

The basic organization of the Cross Support Services documentation and the relationship to CSTS documentation is shown in figure 1-1.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

**Figure 1-1: Cross Support Service Documentation**

The Cross Support Services documents that are related to Cross Support Transfer Services are:

- Cross Support Concept—Part 1: Space Link Extension Services* (reference [I2]): A report introducing the concepts of cross support and the SLE services. Many of the concepts for the SLE transfer services have been adopted for the CSTSes (see h) below).
- Cross Support Reference Model—Part 1: Space Link Extension Services* (reference [1]): A Recommended Standard that defines the framework and terminology for the specification of SLE services. Much of the framework and terminology of this reference model has been adopted or adapted for CSTSes (see 1.6.1.3 and 2.2).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- c) *Space Communication Cross Support Service Management suite* (references [I4], [I6] and [I7]. Future data format Recommended Standards will specify the Service Management Information Entities that are used to configure and schedule CSTSes.
- d) *The SLE Transfer Services suite*: The SLE Transfer Services are a suite of Cross Support Services that are used to transfer specific telecommand and telemetry protocol data units. The SLE Transfer Services are closely related to the CSTS suite in that they collectively define the set of operations that are the basis for the CSTS Specification Framework. However, because of history (the SLE Transfer Services were already specified and implemented prior to development of the CSTS Specification Framework) the SLE Transfer Services are separated from CSTSes.
- e) *Space Link Extension—Internet Protocol for Transfer Services* (reference [2]): A Recommended Standard that defines a protocol for transfer of PDUs defined in the Cross Support Transfer Services. This Recommended Standard was originally developed to support SLE transfer services (hence the title), but it is also applicable to use by Cross Support Transfer Services.

The documents specific to Cross Support Transfer Services are:

- f) *Cross Support Transfer Services Specification Framework* (this Recommended Standard): A Recommended Standard that defines the specification of the Cross Support Transfer Service procedures;
- g) *Guideline for Specification of Cross Support Transfer Services* (reference [I3]): A Recommended Practice that defines the guidelines for construction of a Cross Support Transfer Service based on the CSTS Specification Framework;
- h) *Cross Support Transfer Services Specification Framework Concept* (reference [I5]): A Report that provides tutorial material on the objectives and concepts of the CSTS Specification Framework;
- i) *Cross Support Transfer Services Suite*: The set of specifications for actual CSTSes built from the procedures in the CSTS Specification Framework and in accordance with the CSTS Guidelines.

1.6 DEFINITIONS, NOMENCLATURE AND CONVENTIONS

1.6.1 DEFINITIONS

1.6.1.1 Definitions from Open Systems Interconnection (OSI) Basic Reference Model

This Recommended Standard makes use of a number of terms defined in reference [3]. The use of those terms in this Recommended Standard shall be understood in a generic sense, i.e., in the sense that those terms are generally applicable to technologies that provide for the exchange of information between real systems. Those terms are:

- a) abstract syntax;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- b) application entity;
- c) application layer;
- d) flow control;
- e) real system.

1.6.1.2 Definitions from Abstract Syntax Notation One

This Recommended Standard makes use of the following terms defined in reference [4]:

- a) Abstract Syntax Notation One (ASN.1);
- b) Object Identifier;
- c) (data) type;
- d) (data) value.

NOTE – In annex F of this Recommended Standard, ASN.1 is used for specifying the abstract syntax of service operation invocations and responses.

1.6.1.3 Definitions from Cross Support Reference Model

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

- a) binding;
- b) initiator;
- c) invoker;
- d) operation;
- e) performer;
- f) physical channel;
- g) responder;
- h) service agreement;
- i) service provider;
- j) service user;
- k) space link.

1.6.1.4 Definitions from CCSDS SANA Registry Management Policy

This Recommended Standard makes use of the following terms defined in reference [6]:

- a) OID Registry;
- b) owned by Agencies;
- c) owned by xxx Area;
- d) Review Authority;
- e) Service Site and Aperture Registry;
- f) Spacecraft Registry.

1.6.1.5 Definitions from SANA Role, Responsibilities, Policies, and Procedures

This Recommended Standard makes use of the following terms defined in reference [7]:

- a) delegation;
- b) registration rules;
- c) registry;
- d) SANA Steering Group.

1.6.1.6 Additional Definitions

1.6.1.6.1 acknowledgement: A confirmation that the invocation sent by the invoker was accepted by the performer and will now be acted upon.

- a) An acknowledgement with a negative result is also called a negative acknowledgement.
- b) An acknowledgement with a positive result is also called a positive acknowledgement.

1.6.1.6.2 association: A cooperative relationship between a service-providing application entity and a service-using application entity. An association is formed by exchanging service protocol data units using an underlying communications service.

1.6.1.6.3 communications service: A capability that enables a CSTS-providing application entity and a CSTS-using application entity to exchange information.

1.6.1.6.4 confirmed operation: An operation that requires the performer to return a report of the operation outcome to the invoker. Confirmed operations are further classified as two-phase operations and three-phase operations.

1.6.1.6.5 Cross Support Complex: A set of resources that are operated by a single management authority to provide Cross Support Services to a space flight mission.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.1.6.6 Cross Support Complex Management: The authority that negotiates the provision of service packages with Cross Support Utilization Management and controls and monitors the production and provision of the Cross Support Transfer Service instances by the Functional Resources belonging to the Cross Support Complex.

1.6.1.6.7 Cross Support Service: A set of capabilities that an object that belongs to one Space Agency provides to objects that belong to other Space Agencies by means of one or more ports, in support of spacecraft operations. A Cross Support Service can also be used within a given Space Agency.

1.6.1.6.8 Cross Support Transfer Service (CSTS): A subclass of Cross Support Service that provides reliable, access-controlled transfer of spaceflight mission-related data between ground element entities, realized through the invocation and performance of defined operations in accordance with defined procedures. A CSTS is qualified by the kind of data it transfers (e.g., telemetry frames, tracking data). A CSTS may optionally have capabilities to coordinate and observe the behavior of the production with which this service is associated.

1.6.1.6.9 Cross Support Transfer Service instance: An instance of a specific Cross Support Transfer Service type by means of which a Cross Support Complex provides the capability to the service user to transfer the service-type specific spaceflight mission-related data.

1.6.1.6.10 Cross Support Service production: Performing of the data acquisition process and/or the data transformation as necessary for the given type of Cross Support Transfer Service.

1.6.1.6.11 Cross Support Utilization Management: The abstraction of the entities within a real ground system that on behalf of the cross supported mission interacts with the Cross Support Complex Management to arrange for the required Cross Support Services.

1.6.1.6.12 Cross Support Service provision: Exposing the operations necessary so that the service user can obtain the service. Provision involves the interface between the service user and the service provider.

1.6.1.6.13 data acquisition process: The means by which a Cross Support Complex provides the capability to a service provider to access data required for service provisioning or to access information coming from service production (e.g., physical channel of the space link).

1.6.1.6.14 derivation: A mechanism that allows extending (see 1.6.1.6.20) or refining (see 1.6.1.6.44) an operation or the behavior of a procedure.

NOTE – Derivation can also be applied to a Cross Support Transfer Service.

1.6.1.6.15 Directive Identifier: In the context of a CSTS, the unique identifier of a directive defined for service provision or service production. A Directive Identifier is defined as a Published Identifier (see D6).

1.6.1.6.16 Directive Name: A data structure consisting of a Directive Identifier that represents an individual directive type, and a Functional Resource Name that represents the Functional Resource with which the specific instance of that directive type is associated.

1.6.1.6.17 Event Identifier: In the context of a CSTS, the unique identifier of an event defined for service provision or service production. An Event Identifier is defined as a Published Identifier (see D6).

1.6.1.6.18 Event Label: (See E8 for the detailed definition.)

1.6.1.6.19 Event Name: (See E5 for the detailed definition.)

1.6.1.6.20 extension: The act of extending operations or procedures. Operations are extended by a) adding new parameters to the invocation or response message or b) extending the range of values for already existing parameters or c) changing an unconfirmed operation into a confirmed operation. Procedures are extended by a) adding new operations or b) extending the used operations.

1.6.1.6.21 Framework: A set of generic behaviors (called common procedures) and the constituent common operations used to simplify the specification of systems providing or using CSTSes.

1.6.1.6.22 Functional Resource Instance: An instance of a Functional Resource Type.

1.6.1.6.23 Functional Resource Instance Number: An integer index used to identify an instance of a Functional Resource Type.

1.6.1.6.24 Functional Resource Name: The unique identifier of an instance of a Functional Resource. A Functional Resource Name is made of a Functional Resource Type and a Functional Resource Instance Number.

1.6.1.6.25 Functional Resource Type: A logical function or related set of functions that characterizes a unique instance of service provider or production capability. A Functional Resource Type is defined as a Published Identifier (see D6).

1.6.1.6.26 invocation: The making of a request by an entity (the invoker) to another entity (the performer) to carry out the invoked operation.

1.6.1.6.27 Label List: A data structure that specifies the name of a list of Parameter Labels or Event Labels, indicates if the given list is the default list, and contains all Parameter Labels or Event Labels represented by that Label List name.

1.6.1.6.28 Label List Set: The set of Label Lists accessible by the user of the given service instance.

1.6.1.6.29 object: A functional entity that interacts with other objects. Objects are of different types, which determine their function and behavior. Objects are characterized by their interfaces, which are called ports. One object may provide multiple ports.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.1.6.30 operation: A task that the invoker requests the performer to execute. Depending on the type of operation, the performer may or may not report the result of the operation to the invoker. Service user and service provider interact by invoking and performing operations.

1.6.1.6.31 parameter: In the context of an operation, data that may accompany the operation's invocation, acknowledgement, or return.

NOTE – The term parameter is also used to refer to mission-dependent configuration information used in the production or provision of the service.

1.6.1.6.32 Parameter Identifier: In the context of a CSTS, the unique identifier of a parameter type defined for service provision or service production. A Parameter Identifier is defined as a Published Identifier (see D6).

1.6.1.6.33 Parameter Label: (See E7 for the detailed definition.)

1.6.1.6.34 Parameter Name: (See E4 for the detailed definition.)

1.6.1.6.35 performance: In the context of an operation, the carrying out of the operation by an object (the performer).

1.6.1.6.36 port identifier: Identifier of a source or a destination in a communications system.

NOTE – For purposes of the communications mapping, the endpoints of a CSTS association are identified by port identifiers, namely, an 'initiator port identifier' and a 'responder port identifier'. The port identifiers represent all the technology-specific addressing information needed to establish communications between service user and service provider and to route CSTS PDUs between them.

1.6.1.6.37 procedure: A specified series of actions performed using operations which have to be executed in order to implement a specified behavior.

1.6.1.6.38 procedure configuration parameter: A configuration parameter for a procedure type. If a service permits multiple instances of a procedure type, each such procedure instance will have its own instances of (and values for) the procedure configuration parameters for that procedure type. Unless explicitly specified otherwise in the Framework definition of a procedure type, the method(s) by which the values of the procedure configuration parameters are set is (are) delegated to the service using the procedure or to a derived procedure which may delegate setting of procedure configuration to service management (see 1.6.1.6.49 and 2.3). Some procedure configuration parameters may be dynamically modifiable (see 1.6.3.2.6). Dynamic modification of procedure configuration parameter values is performed by the user of the service that uses that procedure. Unless explicitly specified otherwise in the Framework definition of a procedure type, the method(s) by which the values of dynamically modifiable procedure configuration parameters are modified is (are) delegated to the service using the procedure or to a derived procedure.

NOTE – The method a service may use to set the value of dynamically modifiable procedure configuration parameters is the THROW-EVENT procedure (see 4.12). A derived procedure may comprise the EXECUTE-DIRECTIVE operation (see 3.13) as the method to set dynamically modifiable procedure configuration parameter values.

1.6.1.6.39 production status: The aggregate status of the production processes that generate or process the data that is transferred by the transfer service instance.

1.6.1.6.40 protocol abort: A communications failure event.

NOTE – In case of communications disruption, the underlying communications service will report a communications failure event to the application. Occurrence of the communications failure event is referred to as a 'protocol abort'.

1.6.1.6.41 Published Identifier: A unique identifier that allows identification of a spacecraft, a facility where a CSTS provider is located, a Functional Resource Type, procedure type, a parameter, a directive, or an event. Published Identifiers are allocated by the Space Assigned Numbers Authority (SANA) and registered in standard SANA registries for use in CCSDS services and protocols, including but not limited to CSTSes.

1.6.1.6.42 real-time data: Data that can be accessed by the service user as soon as it is collected or generated by the service provider.

1.6.1.6.43 recorded data: Data that has been collected and stored by the service provider for access by the service user at some later time.

1.6.1.6.44 refinement: The act of refining operations or procedures. Operations are refined by constraining the values of parameters or by detailing the parameter semantics. Procedures are refined by modifying, e.g., narrowing, their semantics or defining their behavior or states in more detail.

1.6.1.6.45 registered parameter: A parameter that has been assigned a Published Identifier that is registered with SANA as specified in more detail in annex E.

1.6.1.6.46 response: A report, from the performer to the invoker:

- a) of the acceptance of the invocation sent by the invoker; such response is referred to as acknowledgement; or
- b) of the outcome of the performance of the invoked operation; such report is referred to as return.

1.6.1.6.47 return: A report, from the performer to the invoker, of the outcome of the performance of the operation.

- a) A return with a negative result is also called a negative return.
- b) A return with a positive result is also called a positive return.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.1.6.48 service instance provision period: The time during which a service is scheduled to be provided by this instance.

1.6.1.6.49 service management parameter: A configuration parameter of a CSTS for which the initial value is set by Service Management methods, e.g., through a Utilization Request (see reference [I6]). Some CSTS configuration parameters are explicitly defined to be service management parameters by this Recommended Standard. In addition, a service using a procedure or a derived procedure may specify some or all of the procedure configuration parameters (see 1.6.3.2.6) of that (derived) procedure to be service management parameters. For each procedure configuration parameter that the service using the procedure/derived procedure specifies as being a service management parameter, Service Management will set one value for that procedure configuration parameter, which will apply to every instance of that (derived) procedure.

1.6.1.6.50 service package: The set of Cross Support Transfer Service instances, which may be of different service types, together with the specification of the characteristics of the production of those Cross Support Transfer Service instances that are provided by one Complex to one or more service users as agreed between Complex Management and Utilization Management.

1.6.1.6.51 started procedure: A procedure placed in the 'active' substate by a successful START operation.

NOTE – 'started' applies to a stateful CSTS procedure that has START and STOP operations. A started procedure is placed in the 'active' substate by a successful START operation and remains active until the procedure is (a) placed in the 'inactive' substate by a successful STOP operation, (b) terminated in response to a protocol error, or (c) terminated by the Association Control procedure.

1.6.1.6.52 stateful procedure: A procedure with two substates: 'inactive' and 'active'.

1.6.1.6.53 stateless procedure: A procedure without substates.

1.6.1.6.54 three-phase operation: An operation that requires the performer to return to the invoker an initial acknowledgement of the acceptance of the invocation in addition to the report of the execution of the operation.

1.6.1.6.55 two-phase operation: An operation that requires the performer to return to the invoker the report of the execution of the operation.

1.6.1.6.56 unconfirmed operation: An operation for which the performer does not return a report of its outcome to the invoker.

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

1.6.3.1 Specification of Operations

1.6.3.1.1 General

Section 3 of this Recommended Standard specifies the common operations that can be used by CSTSes. The specification of each operation is divided into subsections as described in 1.6.3.1.2 and 1.6.3.1.3.

1.6.3.1.2 Behavior Subsection

The Behavior subsection provides a brief description of the operation. Additionally, it indicates whether the operation may be invoked by the service user, service provider, or both; and whether there are any constraints on when the operation may be invoked.

NOTE – Whether the operation is confirmed, unconfirmed, or acknowledged is specified in the title of the section specifying the operation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.3.1.3 Invocation, Response, and Parameters Subsection

The Invocation, Response, and Parameters subsection describes the parameters associated with each operation, including their semantics. A table accompanying the description of each operation lists all parameters associated with the operation and, for the invocation, the acknowledgement (if applicable) and the return, whether the parameter is always present, always absent, or conditionally present.

For parameters that are conditionally present, the parameter description specifies the conditions for the presence or absence of the parameter. The condition is generally based on the value of another parameter in the same invocation, acknowledgement, or return, for example, in the return of an operation, the **diagnostic** parameter is present if and only if the value of the **result** parameter is 'negative'. For a conditional parameter in a return, the condition may be based on the value of a parameter in the corresponding invocation.

In the table, the following convention is used to indicate whether a parameter is always present, always absent, or conditionally present:

- a) M Mandatory, i.e., always present;
- b) C Conditionally present;
- c) Blank Always absent.

NOTE – Even though a parameter is characterized as always present, its description may specify that its value may be left unspecified. Given that in ASN.1 a parameter value not set to a specific value is mapped to the NULL type (see annex F), this by convention in this document is expressed as this parameter having the value 'null'.

1.6.3.2 Specification of Procedures**1.6.3.2.1 General**

Section 4 of this Recommended Standard specifies the procedures that can be used by CSTSes. The specification of each procedure is divided into subsections as described in 1.6.3.2.2 through 1.6.3.2.6.

Each procedure section follows a common template covering a descriptive and a prescriptive part.

1.6.3.2.2 Version Number Subsection

The version number of the procedure is identified in the Version Number subsection and is used by the service using that procedure.

1.6.3.2.3 Discussion Subsection

The descriptive part covers the purpose and the concept of the procedure. This part provides the reader with an overview of the procedure.

1.6.3.2.4 Behavior Subsection

The prescriptive part introduces the sequence of activities that describes the behavior of the procedure, e.g., starting, running, and ending the activities. The operations required by the procedure are listed, and for each of them the procedure identifies those operations that are extended and/or refined by the procedure. For those operations that require extension or refinement, the details are provided. For those operations that do not require extension or refinement, the operations are not repeated as they fully conform to the common definition of the common operations (see section 3) or to the specification of the procedure from which the described procedure is derived (e.g., the Cyclic Report procedure is derived from the Unbuffered Data Delivery procedure).

The prescriptive part ends with the service provider state transition table applicable to the procedure.

1.6.3.2.5 Required Operations Subsection

This Required Operations subsection identifies the operations used by the procedure.

1.6.3.2.6 Configuration Parameters Subsection

This Configuration Parameters subsection lists the parameters that need to be configured in the context of this procedure.

This subsection also identifies those parameters that may be accessed (read) by the service user of any service that includes a procedure that contains a GET operation. For each configuration parameter, this subsection provides cross references to the use of the parameter in the specification of the procedure and also identifies the Parameter Identifier to be used in reporting the value of the parameter (see 1.6.1.6.34).

Furthermore, this subsection specifies which, if any, of the configuration parameter values may be dynamically modified while the service that is executing the procedure is bound. If one or more configuration parameters are dynamically modifiable, the subsection identifies the event that is used to notify (by means of the NOTIFY operation) when such a modification has occurred.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.3.2.7 Procedure State Table Subsection

Each stateful procedure is complemented with a state transition table describing the behavior of the service provider implementing the procedure. The state tables follow the following rules:

- a) The state tables specify operation interactions and state transitions for the procedures on the service provider side in its role as either invoker or performer.
- b) The leftmost column simply numbers the rows of the table.
- c) The second column of the state table lists all incoming events. Where these events correspond to the arrival of an incoming PDU, the ASN.1 type defined for this PDU in annex F is indicated in parentheses (()).
- d) Where an event is internal to the service provider, its description is put in single quotation marks (' ').
- e) The following columns (one column per state) on the right side of the table specify the behavior the service provider will exhibit, which depends on the current state and the incoming event. In some cases, the behavior additionally depends on Boolean conditions, also referred to as predicates. Such conditions are put in double quotation marks (" "). The predicates are defined in a table following the procedure state table. Predicates that are simple Boolean variables set only by that state machine itself are referred to as Boolean flags. The dependency on a predicate is presented in form of an IF <condition> THEN <action> [[ELSEIF <condition> THEN <action>] ELSE <action>] ENDIF clause.
- f) If the action given in the table is simply to send a specific PDU, that is indicated by the appearance of the name of ASN.1 type of the PDU to be sent in parentheses (()). If that PDU is a return or an acknowledgement, the name may be preceded by the plus symbol ('+') to indicate that result is 'positive' or by the negative symbol ('-') to indicate that result is 'negative'. Where several actions are to be taken (referred to as a 'compound action'), the name of the compound action is put in curly braces ({ }). The individual actions making up each compound action are identified in a table following the procedure state table. Where a simple action is to be taken, the name of the action is put in single quotes (' ').
- g) 'Not applicable' is stated where the given event can only occur in the given state because of an implementation error on the service provider side.
- h) Where the consequences of an incoming event are not visible to the service user because the service provider does not send any PDU in reaction to the given event, the action is put in square brackets ([]).
- i) State transitions are indicated by an arrow and the number of the state that will be entered; for example, '→ 1' indicates the transition to state 1.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- j) The actions to be taken and the state transition are considered to be one atomic action. The sequence in which the actions shown in the table are executed is irrelevant except that the sending of PDUs shall be performed in the sequence stated in the table.
- k) Whenever the service user invokes a confirmed operation with `invoke-id` set to `<n>`, it starts an associated return `<n>` timer. Should this timer expire before the return `<n>` is received, the service user invokes PEER-ABORT.
- l) Whenever a procedure is derived from another procedure (also called parent procedure), the following applies:
 - 1) the derived procedure's state table contains the same incoming events as the parent procedure and may have additional ones;
 - 2) whenever the behavior in a given state and for an incoming event is fully identical to that of the parent procedure, its description is limited to a reference to the parent procedure's state table;
 - 3) whenever the behavior in a given state and for an incoming event is not fully identical to that of the parent procedure,
 - the behavior copied from the parent procedure is written in italic typeface; and
 - the behavior specific to the derived procedure is written in plain text.

1.6.3.3 Typographic Conventions

1.6.3.3.1 Operation Names

Names of service operations appear in uppercase.

1.6.3.3.2 Procedure Names

The names of procedures appear with initial capital letters (e.g., Buffered Data Delivery).

1.6.3.3.3 Parameter Names

In the main text, names of parameters of service operations generally appear in lowercase and are typeset in a fixed-width font (e.g., `responder-port-identifier`). The same convention is applied to parameters that are not service operation parameters, but are elements of a complex type parameter that is a service operation parameter. In annex F, the corresponding name is formed by omitting any hyphens contained in the name and using mixed-case (e.g., `responderPortIdentifier`).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

1.6.3.3.4 Value Names

The values of many parameters discussed in this Recommended Standard are represented by names. In the main text, those names are shown in quotation marks (e.g., ‘no such service instance’). The corresponding name in annex F is formed by omitting any hyphens or white space contained in the name and using mixed-case (e.g., `noSuchServiceInstance`). The actual value associated with the name is constrained by the type of the parameter taking on that value. Parameter types are specified in annex F of this Recommended Standard.

NOTE – The name of a value does not imply anything about its type. For example, the value ‘no such service instance’ has the appearance of a character string but might be assigned to a parameter whose type is ‘integer’.

1.6.3.3.5 State Names

This Recommended Standard specifies the states of service providers. States may be referred to by number (e.g., state 2) or by name. State names are always shown in single quotation marks (e.g., ‘active’).

1.6.3.3.6 PDU Names

The names of PDUs appear in mixed-case (e.g., `BindInvocation`).

1.6.3.3.7 Data Type Definitions

Data type definitions are presented in annex F in the form of a set of ASN.1 modules. Regardless of the conventions used elsewhere in this Recommended Standard, the text of the ASN.1 modules is typeset entirely in a fixed-width font.

1.6.3.3.8 Normative Mechanism and Data Structure Names

The names of normative mechanisms and data structures appear with initial capital letters (e.g., Cross Support Transfer Service, Functional Resource Name, Published Identifier). Such mechanisms and data structures have defined roles in the functioning of operations and procedures.

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 I.

- [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—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.
- [3] *Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model*. 2nd ed. International Standard, ISO/IEC 7498-1:1994. Geneva: ISO, 1994.
- [4] *Information Technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation*. 4th ed. International Standard, ISO/IEC 8824-1:2008. Geneva: ISO, 2008.
- [5] *Time Code Formats*. Issue 4. Recommendation for Space Data System Standards (Blue Book), CCSDS 301.0-B-4. Washington, D.C.: CCSDS, November 2010.
- [6] *CCSDS SANA Registry Management Policy*. Issue 1. CCSDS Record (Yellow Book), CCSDS 313.1-Y-1. Washington, D.C.: CCSDS, May 2016.
- [7] *Space Assigned Numbers Authority (SANA)—Role, Responsibilities, Policies, and Procedures*. Issue 2. CCSDS Record (Yellow Book), CCSDS 313.0-Y-2. Washington, D.C.: CCSDS, May 2016.

2 DESCRIPTION OF CROSS SUPPORT SERVICES

2.1 OVERVIEW

Cross Support Transfer Services (CSTSeS) provide for reliable, access-controlled transfer of spaceflight mission related data between ground element entities. A Cross Support Service is characterized by the kind of data it transfers (e.g., telemetry data, tracking data, service production monitoring data), and therefore different CSTSeS need to respond to specific requirements that may demand specific solutions. On the other hand, all CSTSeS defined by CCSDS apply the same basic communications patterns in order to simplify specification, implementation, and operation of these services. The basic approach applied to CSTSeS is that they are realized through invocation and performance of operations in accordance with well-defined procedures.

This Recommended Standard provides a Specification Framework for CSTSeS with the objective to:

- a) maximize the commonality between CCSDS CSTSeS;
- b) simplify specification of new CCSDS CSTSeS; and
- c) enable the design and implementation of reusable software components with the potential of simplifying the implementation of CSTSeS.

NOTE – While this specification strives for enabling the design and implementation of reusable software components, it does not intend to provide a specification for such components.

This Recommended Standard defines basic building blocks from which services can be constructed. The companion Recommended Practice, *Guidelines for Specifications of Cross Support Transfer Services* (reference [I3]), defines the rules to be used for the specification of CSTSeS.

Building blocks defined by the CSTS Specification Framework include:

- a) data types for information exchanged between service user and service provider;
- b) common operations that are invoked by one entity and performed by the other entity and as such implement the basic elements of interaction between service user and service provider; and
- c) common procedures which define the behavior and protocol for the invocation and performance of a set of operations to achieve a well-defined objective.

A CSTS may be defined by combining a set of procedures specified in the CSTS Specification Framework in a manner that best suits the objective of the service.

To be generally applicable, parameters, operations, and procedures defined by the CSTS Specification Framework are sufficiently abstract that they may or may not be directly usable

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

for real services. For cases where the building blocks are not directly usable, new operations or procedures can be derived from those defined in the CSTS Specification Framework.

Taking the concept of generic definitions one step further, this Recommended Standard supports the concept of abstract services (see reference [15]) that specify the common operations and behavior of CSTSes but are not directly implementable because service-specific specifications are still missing. Real CSTSes can be derived from such abstract services.

NOTE – An example of an abstract service could be a CSTS Return Link Service from which real services such as CSTS RAF, CSTS RCF, and CSTS ROCF could be derived. These CSTSes would be equivalent to SLE RAF, SLE RCF, and SLE ROCF.

The relationships between the elements of the CSTS Specification Framework and example CSTSes based on the Framework are illustrated in figure 2-1.

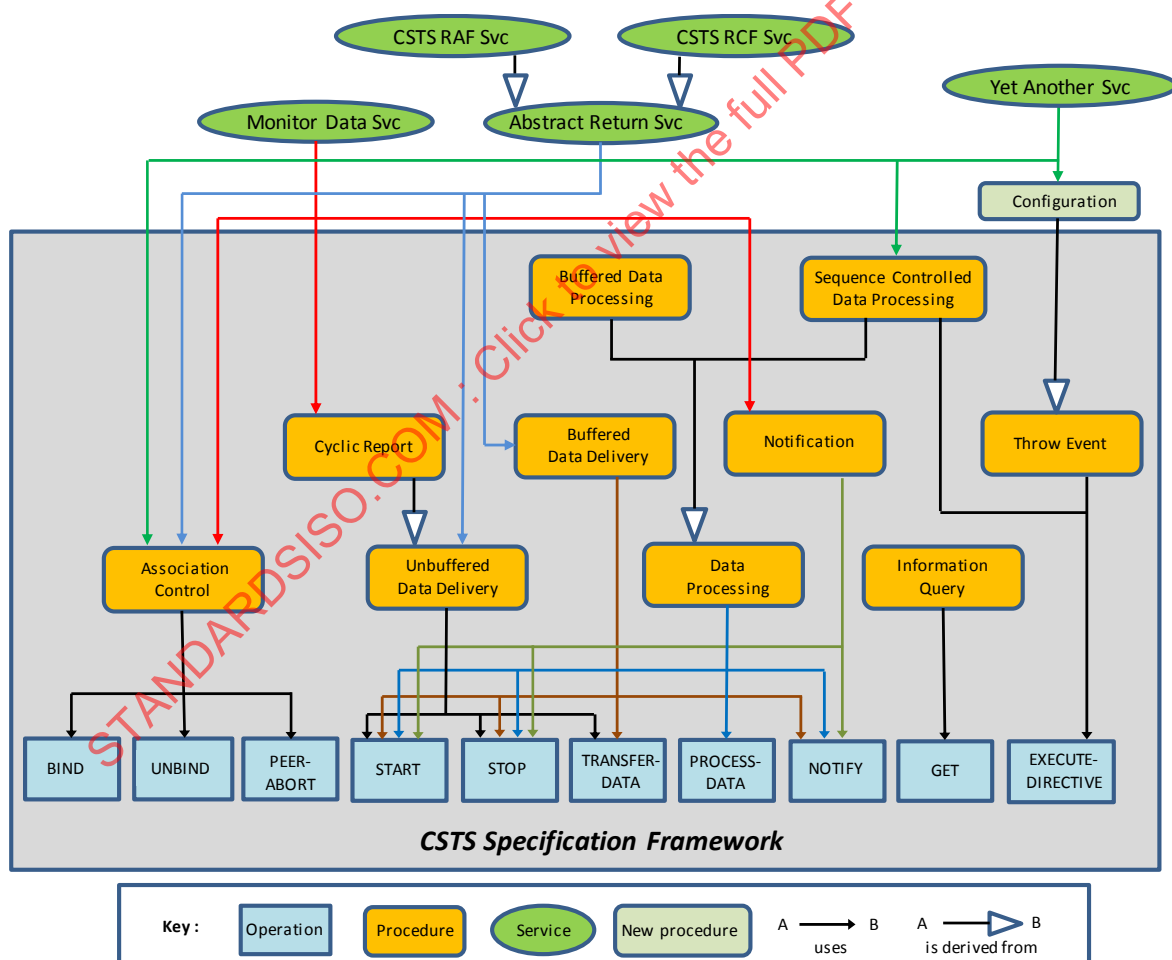


Figure 2-1: CSTS Specification Framework Concept

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

2.2 CROSS SUPPORT REFERENCE MODEL

2.2.1 INTRODUCTION

CCSDS Cross Support Transfer Services are defined within a framework that is a logical extension of the Cross Support Reference Model (reference [1]) that was originally defined for Space Link Extension (SLE) services. The following subsections summarize concepts from the reference model that are supported by the CSTS Specification Framework and to which later sections in this Recommended Standard refer. Formal definitions of terms are provided in 1.6.

Before a Cross Support Transfer Service can be used, an association needs to be established between service user and service provider by binding the ports associated with the specific CSTS. To that end, the initiator issues the request to bind to the responder. If the responder can complete the binding, the required association is established and service user and service provider can invoke and perform the operations of the given CSTS type. Depending on the type of operation, the performer may or may not report the result of the operation to the invoker.

2.2.2 SERVICE PRODUCTION AND PROVISION

2.2.2.1 General

The Cross Support Reference Model (reference [1]) distinguishes between service production and service provision.

Cross Support Service production refers to the common processes performed by a Cross Support Complex associated with the provision of one or more Cross Support Services.

A Cross Support Complex is said to **provide** a service when it makes available to the service user the capability to obtain the service via one or more of its ports. Provision involves the interface between the service user and the service provider, and is characterized by the type(s) of data transferred and the quality of service with which they are transferred (e.g., completely, reliably, etc.).

The CSTS Specification Framework deals primarily with service provision. Service production is generally very specific for specific services or a class of services, and therefore the CSTS Specification Framework makes only very general assumptions on service production.

2.2.2.2 Service Production Status

The status of production resources is reported by means of the **resource-status** parameter of each of the associated Functional Resources except those Functional Resources that represent CSTS instances. The latter each have a **production-status** parameter. The CSTS specifies how the **production-status** value shall be determined based on the CSTS instance as such and on the **resource-status** parameters of the Functional

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Resource Instances involved in the service production. This Recommended Standard defines the permissible values of `production-status` and the transitions between these values in abstract terms (see annex B); these values may be refined by service specifications based on the CSTS Specification Framework. Service specifications may also define substates for one or more of the `production-status` values where appropriate.

Production status changes may be notified to the service user via any procedure that includes the NOTIFY operation (3.11), e.g., the Notification procedure (see 4.11). As for any other parameter, the current value of the `production-status` parameter may be obtained using (a) the Cyclic Report procedure defined in 4.10, if that is supported by the service, or (b) the GET operation, if any procedure of the service (including the Information Query procedure) uses the GET operation.

The `production-status` values and the permissible transitions, and the effects of these `production-status` values on common operations are defined in annex B.

2.3 SERVICE MANAGEMENT

For all CSTSes, service management determines the number and schedule of service instances to be provided, the resources required to enable those service instances, and the initial configuration of all service instances and their supporting resources. Configuration parameters that have their initial values set through Service Management are called service management parameters (see 1.6.1.6.49). Cross Support Service Management is the subject of separate CCSDS Recommended Standards (see references [I6] and [I7]).

Service management parameters may refer to service provision or to service production. Explicit specification of service management parameters in this Recommended Standard is confined to a small set of service provision parameters, including

- a) identities of the service initiator (i.e., the service user) and the service responder (i.e., the service provider);
- b) identity of the port at which the service is made available;
- c) the service instance provision period.

For some procedures this Recommended Standard identifies procedure configuration parameters that are known to the service user and the service provider but the definition of how their values are determined is delegated to the service specification. The service specification may specify these values, or designate them to be service management parameters. Reference [I3] provides guidelines on how service management parameters shall be handled in derived service specifications.

For service management parameters that correspond to procedure configuration parameters, Service Management will configure all instances of a given procedure type being associated with a given service instance equally.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Some procedure configuration parameters of individual procedure instances may be updated dynamically at any time while the service instance executing the procedure instances is bound. The dynamic modification of such procedure configuration parameters is outside the scope of Service Management and must be carried out within the CSTS instance itself, e.g., through a Throw Event procedure that is part of that service. The particular method(s) by which dynamic modifications of procedure configuration parameters are performed is left to the definition of the services that use such dynamically modifiable procedure configurations.

2.4 ELEMENTS OF THE CSTS SPECIFICATION FRAMEWORK

2.4.1 COMMON OPERATIONS

An operation is a task that the invoker requests the performer to execute and as such presents the basic interaction pattern between the service user and the service provider. The invocation of an operation may include parameters that specify further details of the task to be performed.

Operations are further classified by the number of interactions required to complete the operation:

- a) An **unconfirmed operation** is invoked by the invoker and performed by the performer, but there is no report on the outcome of the operation.
- b) For a **confirmed operation** the performer provides a report (the '**return**') to the invoker on success or failure of the operation. Operation returns comprise an indication of success (**result** has the value 'positive') or failure (**result** has the value 'negative') and, in case of failure, a **diagnostic** that further specifies the reason for the failure. Confirmed operations are further classified as:
 - 1) **two-phase operations**, for which the performer returns a single report to the invoker;
 - 2) **three-phase operations**, for which the performer provides an initial response in the form of an **acknowledgement** when receiving the invocation and subsequently issues the return when the operation has completed. This type of operation is typically used for operations where the task to be performed requires non-negligible time to complete. The acknowledgement confirms that the invocation has been received and understood and that the general preconditions for the operation are fulfilled.

NOTE – In labeling confirmed operations, the designation (CONFIRMED) identifies a two-phase confirmed operation, and (ACKNOWLEDGED) identifies a three-phase confirmed operation.

Confirmed operations are further classified as **blocking** or **non-blocking** with respect to the procedure that uses the operation. When a blocking operation has been invoked, no further operation of the same procedure instance can be invoked before the return to the invocation

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

has been received. Non-blocking operations do not impose any constraints with respect to invocation of further operations.

The CSTS Specification Framework defines standard operation headers for unconfirmed and confirmed operations and a set of common operations for use within CSTS. To be of general use, the operations of the CSTS Specification Framework are rather abstract and might not all be directly usable within a procedure used by a specific CSTS. However, all operations used in a procedure of a CSTS that conforms to this Recommended Standard are derived directly or indirectly from the operations specified herein applying the rules described in 2.5.

The common operations defined by the CSTS Specification Framework are listed in table 2-1. Section 3 of this Recommended Standard provides the detailed specification of these operations.

Table 2-1: Common Operations Defined by the CSTS Specification Framework

Operation	Invoked By	Purpose	Confirmed	
			Ack.	Ret
BIND	service user	Establishment of an association with the peer.	No	Yes
UNBIND	service user	Release of an association previously established by a BIND operation.	No	Yes
PEER-ABORT	service user or service provider	Notification to the peer that the local application detected an error that requires the association to be terminated.	No	No
START	service user	Request that the service provider start performing activities associated with the procedure using the operation.	No	Yes
STOP	service user	Request that the service provider stop performing activities associated with the procedure using the operation.	No	Yes
TRANSFER-DATA	service provider	Transfer of a data unit to the service user.	No	No
PROCESS-DATA	service user	Request that the service provider process the data received.	No	No/ Yes (see NOTE)
NOTIFY	service provider	Sending of a notification of an event to a service user.	No	No
GET	service user	Ascertainment of the value of (a) service parameter(s).	No	Yes
EXECUTE-DIRECTIVE	service user	Request that the service provider perform a predefined action.	Yes	Yes

NOTE – For the PROCESS-DATA operation, both an unconfirmed and a confirmed variant exist. It is at the discretion of the procedure using this operation to specify if the unconfirmed or confirmed variant is used.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

2.4.2 COMMON PROCEDURES

Procedures define the protocol and the expected behavior for the invocation and performance of a set of operations to achieve a well-defined objective. A CSTS may be specified by assembling a given set of procedures to handle specific aspects of the service.

For instance, a service that forwards telemetry received on the space link can be broken down into a number of procedures that handle association establishment and release, actual transfer of telemetry data units, status reporting, and querying of the service configuration parameters. All of these procedures except for telemetry data transfer can also be used for a service that supports reception and radiation of telecommands, where only a subset of the parameters in the reports differs.

The specification of a procedure includes:

- a) a description of the objective of the procedure including all assumptions that are made with respect to the type of data to be transferred and the service production process (descriptive);
- b) a definition of the behavior of this procedure (prescriptive);
- c) a definition of the operations that constitute this procedure (prescriptive);
- d) a description of behavior expected of the service provider and the service user supported by a service provider side state matrix, where applicable (prescriptive).

As far as the protocol is concerned, procedures can be stateful or stateless. A stateful procedure supports the states 'inactive' and 'active' with transitions between these states triggered by well-defined operation invocations or responses. Typically the transition from 'inactive' to 'active' is triggered by a START invocation and the transition from 'active' to 'inactive' is triggered by a STOP return. However, other transitions may exist. For instance, procedures using three-phase operations might transition from 'inactive' to 'active' with the operation invocation and back to 'inactive' with the final return.

NOTE – The Association Control procedure is an exception to the above rules. The Association Control procedure does not belong to any class (stateful or stateless) and is required to manage the association.

A CSTS will typically use more than one procedure in addition to the Association Control procedure and may require more than one procedure of the same type to be active at the same time, e.g., to transfer different data streams concurrently. Therefore this Recommended Standard distinguishes between the **procedure type** and the **procedure instance**. The procedure type corresponds to the specification of the procedure or the supporting program that implements the procedure specification. A procedure of a given type can be instantiated once or several times as part of the instantiation of the service using this procedure. Different instances of the procedure are distinguished by a 'procedure instance identifier' that is assigned by service management when creating the service package and included in all operation invocation and response headers.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – Further information on how a service uses predefined procedures is provided in 2.5. Normative rules for this purpose are specified in reference [I3].

The CSTS Specification Framework defines a set of common procedures that cover typical tasks of a CSTS. In order to be commonly usable, the procedure definition and in particular the purpose and semantics specification are reasonably abstract, such that the specifications as provided by this Recommended Standard may sometimes not be directly usable. For those cases, reference [I3] specifies methods to derive more specific procedures from these common procedures.

Table 2-2 identifies the common procedures included in this CSTS Specification Framework and table 2-3 shows the operations that are used by these procedures. Section 4 of this Recommended Standard provides the detailed specification of these procedures.

Table 2-2: Common Procedures Defined by the CSTS Specification Framework

Procedure	Purpose	Class
Association Control	Establishment and release of an association between a service user and a service provider.	N/A
Unbuffered Data Delivery	Best effort transfer of bulk data, structured into data units, sent from the service provider to the service user in real-time delivery mode.	SF
Buffered Data Delivery	In-sequence transfer of bulk data, structured into data units, sent from the service provider to the service user. In real-time mode, low latency is given priority over data completeness. In complete mode, data completeness is given priority over low latency.	SF
Data Processing	Processing of individual data units in the sequence as sent by the service user to the service provider and reporting of processing progress.	SF
Buffered Data Processing	Processing of data units contained in buffers in the sequence as sent by the service user to the service provider and reporting of processing progress. Processing may be in complete mode at the expense of latency or in timely mode at the expense of data loss.	SF
Sequence-Controlled Data Processing	Processing with full flow control of individual data units in the sequence as sent by the service user to the service provider and reporting of processing progress.	SF
Information Query	Query by the service user of the value of one or more parameters related to the service provider or service production behavior.	SL
Cyclic Report	Periodic reporting of parameter values from the service provider to the service user.	SF
Notification	Notification of the service user by the service provider of events of interest to the service user.	SF
Throw Event	Signaling to the service provider the occurrence of an event requiring a configuration change action and report of the result of the action back to the service user.	SF
NOTE – 'SF' and 'SL' indicate 'stateful' and 'stateless', respectively.		

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 2-3: Use of Operations by Common Procedures

	Association Control	Unbuffered Data Delivery	Buffered Data Delivery	Data Processing	Buffered Data Processing	Sequence-controlled Data Processing	Information Query	Cyclic Report	Notification	Throw Event
BIND	B									
UNBIND	B									
PEER-ABORT	NB									
START		B	B	B	B	B		B	B	
STOP		B	B	B	B	B		B	B	
TRANSFER-DATA		NB	NB					NB		
PROCESS-DATA				NB	NB	NB				
GET							NB			
NOTIFY			NB	NB	NB	NB			NB	
EXECUTE-DIRECTIVE						NB				NB
NOTE – 'B' and 'NB' indicate that the operation is 'Blocking' or 'Non-Blocking', respectively.										

2.5 PRINCIPLES OF USING THE CSTS SPECIFICATION FRAMEWORK**2.5.1 OVERVIEW**

The CSTS Specification Framework provides a set of reusable building blocks for the specification of CSTSes and defines general rules by which such building blocks can be extended and refined to match the specific requirements of a CSTS.

The specification of a CSTS can be constructed by composition of procedures that either are fully predefined within the CSTS Specification Framework or are derived from those defined in the Framework. Specification of a completely new service-specific procedure using common operations or operations derived from the common operations is permissible but is not recommended.

The rules for derivation of operations and procedures have been rigorously applied to the specification of the CSTS Specification Framework itself:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) The common procedures specified in section 4 present the most abstract and general version; several procedures defined within the CSTS Specification Framework derive extended operations, which may be further derived by services using these procedures.
- b) Some of the procedures defined within the CSTS Specification Framework are derived from more basic procedures also defined in the Framework. For instance, the Cyclic Report procedure is derived from the Unbuffered Data Delivery procedure.

The derivation rules can be further applied to operations and procedures that have been derived from the operations and procedures defined within the CSTS Specification Framework. It is envisaged that such operations and procedures might eventually be included in the Framework if they prove to be useful for more than one service type.

The normative specification of the rules for derivation of operations and procedures and for composition of services can be found in reference [I3]. The following subsections provide a brief summary.

2.5.2 DERIVATION OF OPERATIONS AND PROCEDURES

Derivation of operations and procedures from the building blocks defined in the CSTS Specification Framework encompasses two dimensions:

- a) extension, by which new data or behavior are added to a specification; and
- b) refinement, by which the range of values may be constrained or the semantics of parameters may be specialized.

Operations may be extended in the following ways:

- a) New parameters may be added (syntax and semantics specification) to an operation invocation or response; unless explicitly specified otherwise, all operations defined in the CSTS Specification Framework can be extended in this way.
- b) In some cases additional values may be defined for an existing parameter (e.g., additional diagnostics or additional types of notification).
- c) In some cases, the format and content of a parameter may have to be specified by the service using the corresponding operation. This is necessary because, for some operations, there are parameters whose structure is unspecified.

Operations may be refined by narrowing the value range of a parameter or by specializing the meaning of a parameter. For instance, the **generation-time** parameter of the TRANSFER-DATA operation in the Buffered Data Delivery procedure may be refined for a procedure dealing with transfer of telemetry by stating that the **generation-time** is the Earth Receive Time of the telemetry frame being transferred.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Procedures may be extended in the following ways:

- a) extension of the operations used by a procedure as described above;
- b) addition of operations defined in the CSTS Specification Framework or derived from operations defined in the Framework.

Procedures may be refined by narrowing the specification of the semantics associated with the procedure or by adding more detail to the behavior description or the state table. The refinement of a procedure does not imply the definition of a new procedure.

As an example, a Telemetry Delivery procedure could be derived from the Buffered Data Delivery procedure by extension and refinement of the operations START and TRANSFER DATA and by refinement of the semantics associated with the data to be transferred and the parameters of the operations. The extension of a procedure implies the definition of a new procedure (derived procedure).

2.5.3 SPECIFICATION OF SERVICES BY COMPOSITION OF PROCEDURES

A CSTS can be specified by composition of procedures defined in the CSTS Specification Framework, derived from procedures in the Framework or derived from an existing CSTS.

Every service includes the Association Control procedure (see 4.3). Only a single instance of the Association Control procedure exists throughout the lifetime of a transfer service instance.

In addition to the Association Control procedure a service may comprise any number of further procedure types and may use one or more instances of each procedure type. However, one single procedure instance is designated the **prime procedure** of the service. All other procedure instances are referred to as secondary procedures.

NOTE – The prime procedure (instance) can be of the same type as one or more secondary procedure instances.

The prime procedure (instance) of a service should reflect the primary purpose of the service. In practical terms it determines the state of the service and as such determines the orderly association release as detailed in 2.6.

2.6 PROTOCOL DESCRIPTION

2.6.1 STATES OF THE SERVICE PROVIDER

The service user and service provider of a Cross Support Transfer Service can interact as soon as the associated service ports are bound by establishment of an association between the service user and the service provider. Binding is achieved by the Association Control procedure that is included in every CSTS.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Once the service instance is bound other procedures used by the service can be operated according to their specific protocol.

NOTE – This Recommended Standard does not specify any interdependencies between the procedures that constitute a service. However, the service specification may specify dependencies that must be observed, e.g., with respect to the sequence in which procedures are started.

When the service instance is bound the service state is further determined by the state of the prime procedure (instance). If the prime procedure is stateful the state 'bound' has two substates, 'ready' and 'active'. When the prime procedure is 'inactive', the service instance is in the state 'bound.ready', and when the prime procedure is 'active', the service instance is in the state 'bound.active'. If the prime procedure is stateless then the service state 'bound' has no substates.

A service instance having a stateful prime procedure can be unbound by the service user in an orderly manner only while in the state 'bound.ready', i.e., while the prime procedure is 'inactive'. Service instances with a stateless prime procedure can be unbound at any time. Finally a service instance may be aborted by either entity at any time by invoking the PEER-ABORT operation.

Any stateful secondary procedure has a state machine of its own but has no effect on the overall service instance state. This implies that the UNBIND operation can be invoked while one or more stateful secondary procedures are in the state 'active'. Therefore, for a stateful secondary procedure, unbinding has the same effect as PEER-ABORT.

Any stateless secondary procedure is unaffected by the overall service instance state. The operations of any stateless secondary procedure instance may be invoked whenever the service instance is in the 'bound.ready' or 'bound.active' state if the prime procedure of that service is stateful or the service instance is in the 'bound' state if the prime procedure of that service is stateless.

The overall relationship of the states of the service instance, the prime procedure, and secondary procedures is illustrated in figures 2-2 and 2-3 for a stateful and a stateless prime procedure, respectively.

NOTE – The diagrams in figures 2-2 and 2-3 do not present state diagrams in a formal sense, as they present different state machines in a synoptic view. The corresponding normative statements can be found in annex G.

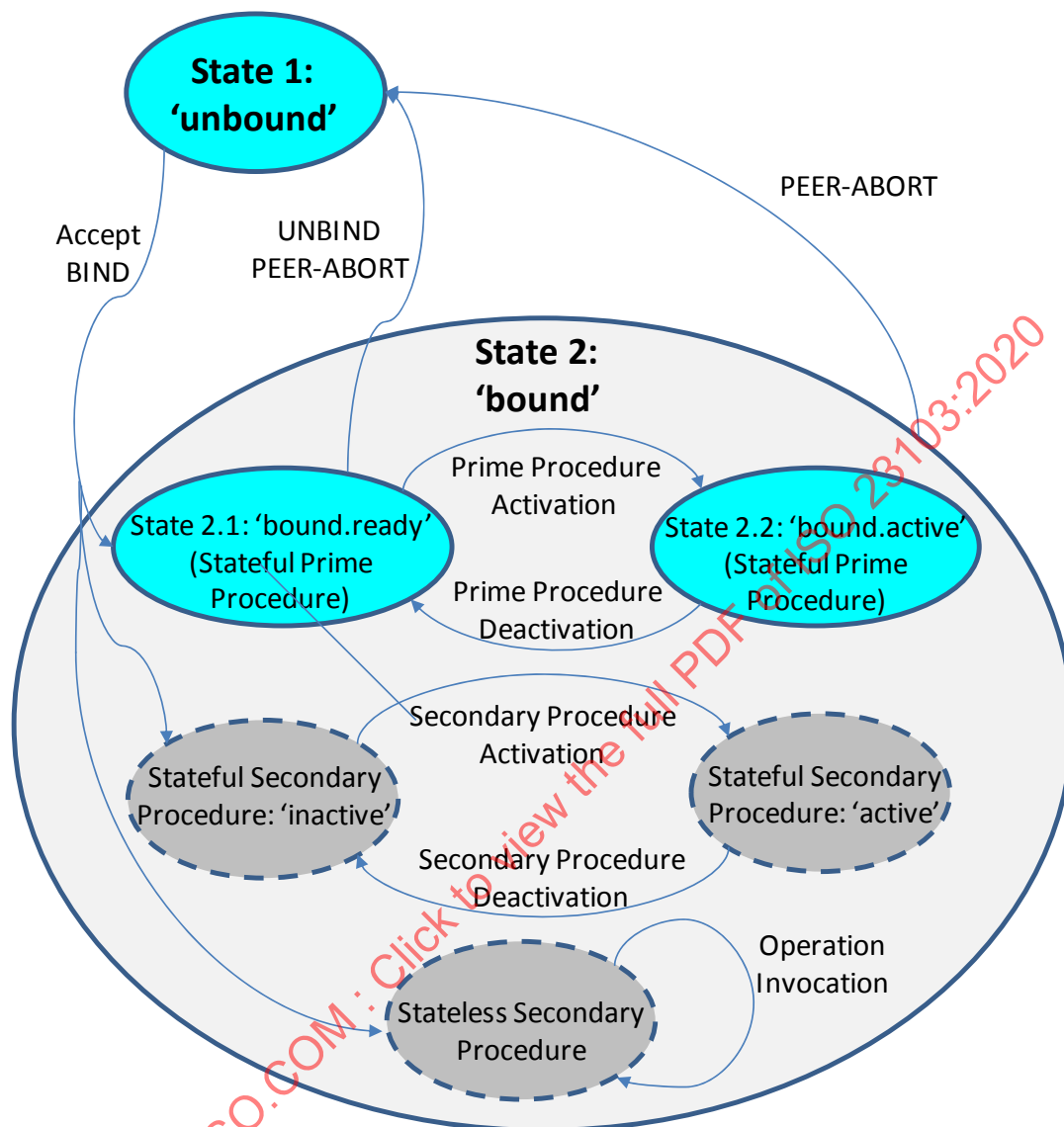


Figure 2-2: Service and Procedure States (Stateful Prime Procedure)

NOTE – The activation and deactivation of stateful procedures is further specified in 4.2.4.

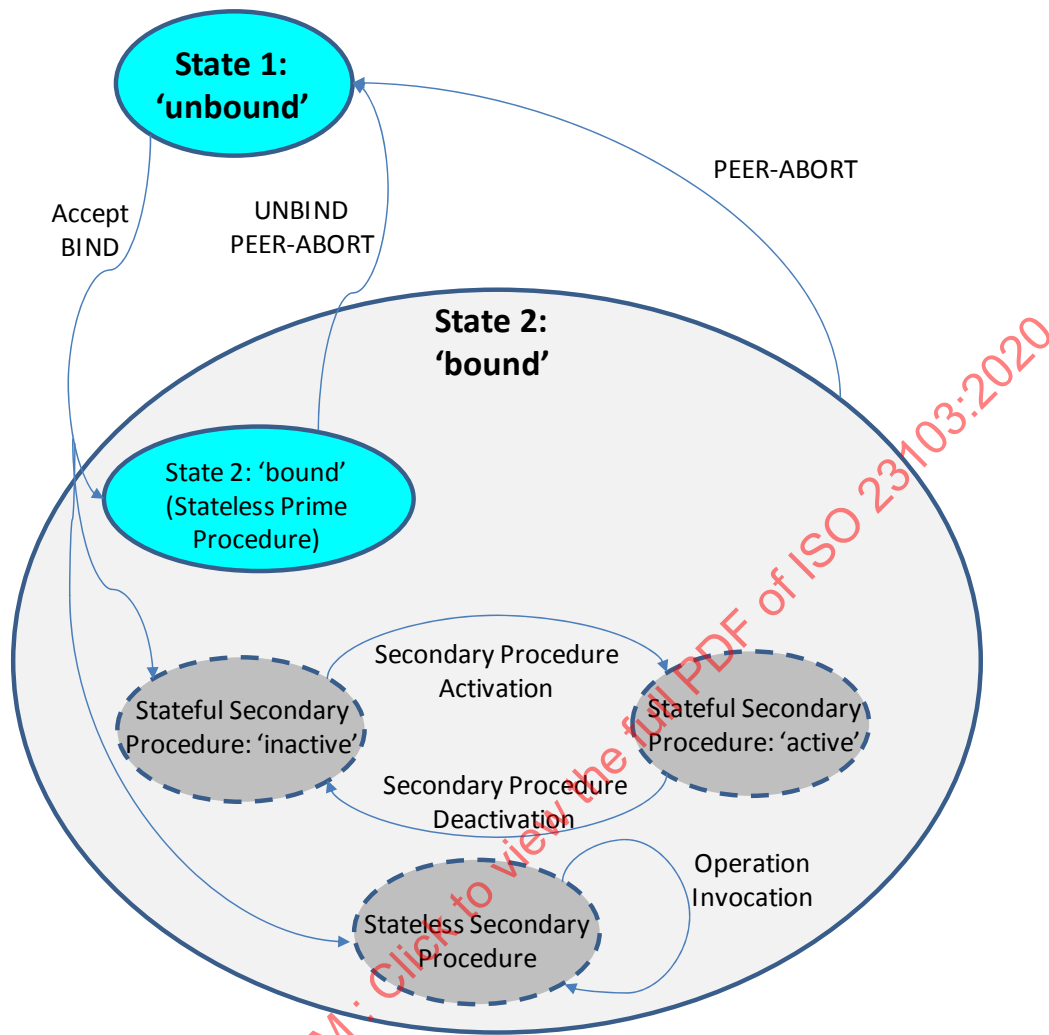


Figure 2-3: Service and Procedure States (Stateless Prime Procedure)

2.6.2 ASSOCIATION MANAGEMENT

Establishment and release of an association between the service user and the service provider is handled by the Association Control procedure specified in 4.3. All other procedures rely on the presence of such association and therefore establishment and release of the association must be coordinated between the procedure instances within a service instance.

An association is established by means of the BIND operation (see 3.4) which is always invoked by the service user. Before the BIND operation is completed, i.e., the BIND return is issued by the service provider, no further operation can be invoked. The only exception to this rule is the PEER-ABORT operation, which can be invoked by the service user if the BIND return is not received in good time. Once the association is established, other procedures used by the service can be operated according to their defined protocol.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

During the lifetime of the association, the prime procedure (instance) of the service instance and the Association Control procedure instance must cooperate to determine the applicable substate of the state 'bound' and the transitions between these states (see 2.6.1).

An association is released normally when an UNBIND operation is invoked by the service user and accepted by the service provider (the responder). An association may be aborted by either the service user or the service provider by means of the PEER-ABORT operation. An association may also be aborted because of a failure in the underlying communications system. Such failures are signaled to the local application entity by the 'protocol abort' event described in 4.3.3.1.9.5.

Conceptually, invocations of the operations UNBIND and PEER-ABORT will be received by the Association Control procedure, which will

- a) verify the validity of the event according to the defined protocol and react accordingly;
- b) inform all other procedures of the event;
- c) respond to the event as defined by the protocol, e.g., by issuing an UNBIND return;
- d) terminate the underlying communications connection, if applicable.

If a procedure needs to abort the association, e.g., because of a protocol error, it forwards this request to the Association Control procedure, which will invoke the PEER-ABORT operation and will inform all other procedures.

All procedures are expected to close down and release all resources associated with the service instance when they are notified of the termination event.

When an association is released or aborted, no further operations can be exchanged between the service user and the service provider. The systems may re-establish an association via a new BIND operation if that is consistent with the service instance provision period. However, status information from the prior association is not preserved unless specified differently by the service specification.

2.6.3 TECHNOLOGY SPECIFIC ASPECTS

This Recommended Standard defines building blocks for the specification of CSTSes. Provision of a CSTS in a real system also requires a specification of how the service is mapped to a communications service such that all invocations and responses of the service operations can be conveyed between the service user and the service provider. In order not to restrict the applicability of service specifications based on this Recommended Standard to a specific communications technology, as few assumptions as possible have been made about the characteristics of the underlying communications service (see 1.3.1).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – While this Recommended Standard makes only a few assumptions on the underlying communications service, reference [2] specifies a communications service that is assumed to be used by default for CSTSes.

Elements of the CSTS interface between the service user and the service provider are specified in this Recommended Standard in terms of the operations that the service implements. These operations are realized by mapping the service operation invocations, acknowledgements, and returns to protocol data units that can be conveyed by means of the underlying communications service. This Recommended Standard conceptualizes such mapping in two parts:

- a) operation invocations, acknowledgements, and returns are mapped to CSTS PDUs defined in annex F;
- b) CSTS PDUs are conveyed by means of an underlying communications service.

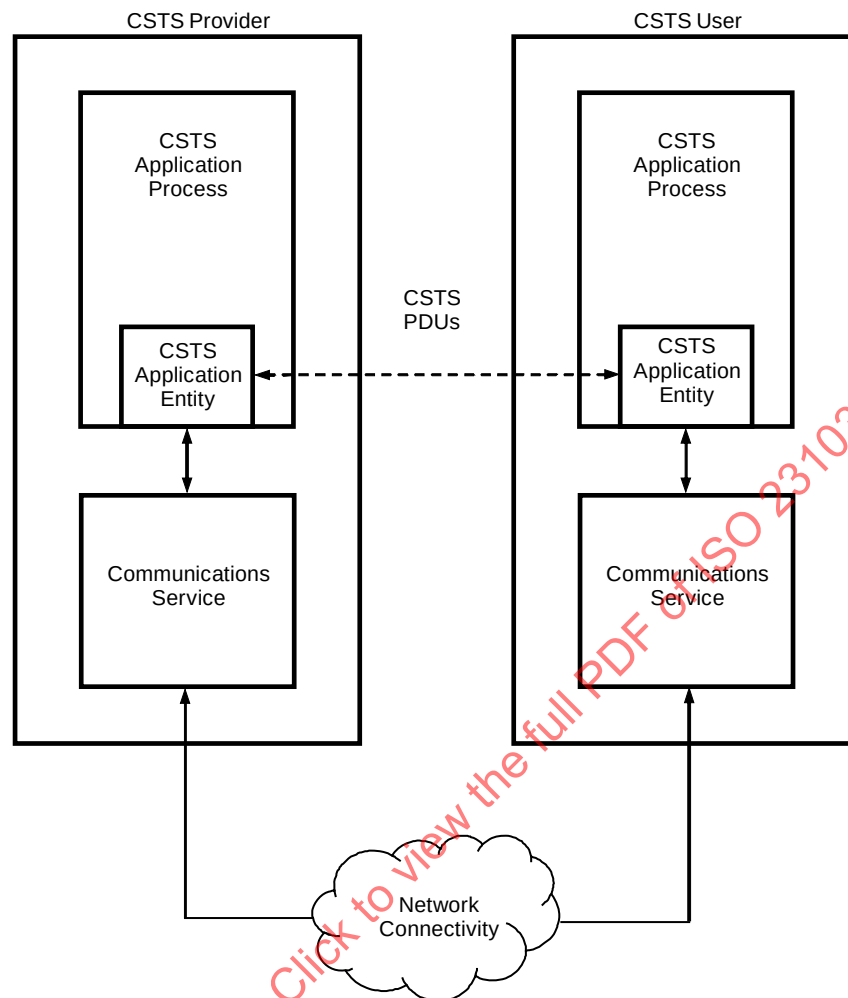
Typically one CSTS PDU corresponds to the invocation, acknowledgement, or return of an operation. There is one exception in which multiple TRANSFER-DATA or PROCESS-DATA invocations are deliberately buffered and subsequently mapped to a single CSTS PDU (see 4.5.2.2.2.2 and 4.7.3.2.1). From the point of view of the service provider or service user application, the interaction between the service user and service provider is in terms of operations, but from the point of view of the application entities that implement the CSTS protocol, what is exchanged are CSTS PDUs.

The mapping of CSTS PDUs to an underlying communications service is intentionally outside the scope of this Recommended Standard. In order to achieve interoperability, the service user and service provider must conform not only to the service specification based on this Recommended Standard but also to an agreed-upon specification of the mapping of the service to the underlying communications service. The specification of a mapping of the service onto a particular communications service must address such points as:

- a) selection of communications network(s) to ensure connectivity;
- b) compatible configuration of protocol stacks (e.g., timeout values);
- c) specification of port identifiers, and their translation onto the communications technology;
- d) specification of security-related information.

Figure 2-4 illustrates a communications realization of a CSTS that results from such a mapping. The specification of a suitable mapping for CSTS to the Transmission Control Protocol (TCP) and the Abstract Syntax Notation One (ASN.1) is provided in reference [2].

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

**Figure 2-4: Communications Realization of a Cross Support Transfer Service**

3 COMMON OPERATIONS

3.1 OVERVIEW

This section specifies the operations that are used by the procedures defined in this Recommended Standard. Subsection 3.2 and 3.3 specify behaviors that are generally applicable to all operations. Subsections 3.4 through 3.13 specify individual operations that are used by the procedures defined in this Recommended Standard.

3.2 GENERAL CONSIDERATIONS

3.2.1 COMMON OPERATION BEHAVIOR

3.2.1.1 All invokers of confirmed operations shall implement a timer for the acknowledgement in case of three-phase operations or the return in case of two-phase operations. In case the timer expires, the service user may issue a **PEER-ABORT**.

3.2.1.2 On reception of the acknowledgement in case of three-phase operations or the return in case of two-phase operations, the invoker of the corresponding confirmed operations shall stop the timer.

3.2.1.3 All acknowledgements and returns shall include a **result** parameter that indicates whether the outcome of the operation was successful (**result** has the value 'positive') or unsuccessful (**result** has the value 'negative').

3.2.1.4 If **result** reported in an acknowledgement is 'negative', no return shall be generated.

3.2.1.5 If **result** reported in an acknowledgement or return is 'negative', the acknowledgement or return shall also include a **diagnostic** parameter, the value of which is descriptive of the reason for the negative result.

3.2.1.6 For certain values of the **diagnostic** parameter it shall be complemented by:

- a) a **visible** string which value shall start with the diagnostic name identified in this Recommended Standard or in the service definition using this Recommended Standard;
- b) additional diagnostic information whenever required by this Recommended Standard.

NOTES

- 1 Possible values of the **diagnostic** parameter are listed in the specification of each operation.
- 2 The **visible** string **diagnostic** is for troubleshooting purpose in order to allow implementers to add information to the **diagnostic** and to accommodate service-type or implementation-specific information. The value of the string, apart from the

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

diagnostic name, shall be chosen by the implementers or defined in the CSTS specification.

- 3 The presence or absence of a visible string complementing the **diagnostic** value is specified in annex F.

3.2.1.7 The **diagnostic** parameter value may be extended by derived operations, procedures and services to support dedicated diagnostics.

3.2.1.8 Unless otherwise specified, all operation invocations, acknowledgements, and returns defined in this Recommended Standard can be extended.

NOTE – The extension capability is not explicitly mentioned in the rest of the document and is to be considered implicit for all operations.

3.2.2 PARAMETER TYPES

The types of all parameters shall conform to the abstract syntax specified in annex F.

NOTES

- 1 Some parameter types in annex F are chosen such that an extension is possible. For example, the **diagnostic** parameter can be extended so that a service can define its own diagnostics.
- 2 The syntax specified in annex F ensures the possibility of extension by defining fields that can be, whenever required, defined externally to the proposed syntax (e.g., operations extension).

3.2.3 PARAMETER CHECKING AND PDU VALIDATION

3.2.3.1 Validity checks shall be performed on the values of parameters associated with an operation.

NOTE – Rules governing the validity of parameter values are included in the specification of individual operations. General reasons for regarding a parameter value as invalid are specified in the following paragraphs.

3.2.3.2 A parameter value shall be treated as invalid if it is outside the range or not in the set of values permitted by the operation using the given parameter.

NOTE – A conforming implementation is capable of supporting the full range or set of values as specified in annex F and applicable to the service using this Recommended Standard.

3.2.3.3 A parameter value shall be treated as invalid if it is in conflict with the value of another parameter in the same invocation.

NOTE – For example, the value of the `start-time` parameter in the invocation of an operation is invalid if it is later than the value of the `stop-time` parameter.

3.2.3.4 If a parameter value is not valid, the operation shall not be performed and, for confirmed operations, a report of the negative result shall be returned to the invoker.

3.2.3.5 While this Recommended Standard does not prescribe the sequence of checks for the parameters, the implementer shall document the implemented sequence.

3.2.3.6 A PDU shall be considered invalid if:

- a) it contains an unrecognized operation type or a parameter of the wrong type; or
- b) it is otherwise not decodable; or
- c) the procedure identifier is not one of the specified service procedures identifiers.

3.2.3.7 In the case of an invalid PDU, the service provider shall abort the association using a PEER-ABORT with the corresponding `diagnostic` value (see 3.6.2.2.1).

NOTE – The invalid PDU case is not addressed elsewhere in this Recommended Standard.

3.2.4 AUTHENTICATION

NOTE – Requirements for security depend on the application and the system environment (e.g., whether closed or public networks are used or if access is only from physically restricted areas). In many environments, security may be provided by the communications service, transparently to the application. This Recommended Standard does not preclude the use of security features that are provided by the communications service or the local environment, nor does it assume the availability of such features.

3.2.4.1 The service shall provide the following options with respect to the level of authentication of invocations and responses of operations:

- a) ‘all’: all invocations, acknowledgments, and returns, except the invocation of PEER-ABORT, shall be authenticated;
- b) ‘bind’: only the BIND invocation and return shall be authenticated;
- c) ‘none’: neither invocations nor responses shall be authenticated.

3.2.4.2 Complex Management and Utilization Management shall agree on the level of authentication to be required for a given service instance and shall configure service user and service provider accordingly.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.2.4.3 Complex Management and Utilization Management shall agree on the algorithm used to generate and check credentials parameters and shall make this algorithm known to the service user and service provider together with associated parameters such as passwords or keys as necessary for the selected algorithm.

NOTES

- 1 The specification of the algorithms themselves is outside the scope of this Recommended Standard. However, the SLE Internet Protocol for Transfer Services (ISP-1, reference [2]), which is the default underlying communication protocol for CSTSes, specifies a particular algorithm for the generation of credentials. Any implementation that uses ISP-1 will use the credentials algorithm specified therein.
- 2 The **initiator-identifier** and **responder-identifier** parameters of the BIND operation identify the service user and service provider and therefore the applicable authentication level and algorithm necessary to generate and check credentials.

3.2.4.4 For operations for which authentication is required by the terms of the agreement between Complex Management and Utilization Management:

- a) invocations shall include an **invoker-credentials** parameter to permit the performer to authenticate the invocation;
- b) responses shall include a **performer-credentials** parameter to permit the invoker to authenticate the response.

3.2.4.5 For operations for which authentication is not required, the **invoker-credentials** and **performer-credentials** parameters should be set to the value 'unused' to signify that the invocation or response does not carry credentials.

3.2.4.5.1 An incoming invocation, return, or acknowledgment shall be ignored if the credentials parameter cannot be authenticated when, by management arrangement, credentials are required.

3.2.4.5.2 If an invocation is ignored, the operation shall not be performed, and a report of the outcome shall not be returned to the invoker.

3.2.4.5.3 If a return is ignored, it shall be as if no report of the outcome of the operation has been received.

3.2.5 INVOKE IDENTIFIER

3.2.5.1 To support applications that may need to invoke several operations concurrently, the parameter `invoke-id` is specified for all operations.

NOTES

- 1 The `invoke-id` parameter allows the invoker to correlate a particular response to the invocation that prompted it.
- 2 Confirmed operations may be blocking or non-blocking. The choice is to be specified in the procedure definition. Unconfirmed operations are always non-blocking.

3.2.5.2 The value of the `invoke-id` parameter shall be an invoker-supplied arbitrary integer value that shall be returned, unchanged, by the performer.

3.2.5.3 In case the value of the `invoke-id` parameter is the same as the `invoke-id` of another operation that is still being performed within the context of the same service instance, the service provider shall issue a PEER-ABORT.

3.2.5.4 To ensure that the service behaves in a predictable manner, the effects of operations shall be as though the operations were performed in the order in which they were invoked.

3.2.6 BLOCKING AND NON-BLOCKING OPERATIONS

3.2.6.1 Invocation of an operation for the same procedure instance when a blocking operation response is outstanding constitutes a protocol error and shall lead to the service provider issuing a PEER-ABORT.

3.2.6.2 After invoking a non-blocking operation, invocation of another operation for the same procedure instance without waiting for the response from the first invocation is allowed.

3.2.6.3 After invoking a blocking operation, the initiator may invoke a PEER-ABORT if the response is not received in good time (see 3.2.1.1).

3.2.6.4 Compliance with this Recommended Standard does not require the performer to process invocations concurrently; however, the performer must accept invocations from a non-blocking invoker and buffer and serialize them by local means not visible externally.

3.2.7 TIME

The time reference for all parameters containing a time value shall be based on Coordinated Universal Time (UTC).

NOTE – The type of all time parameters is specified in annex F.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.3 STANDARD OPERATION HEADER**3.3.1 BEHAVIOR**

3.3.1.1 All operation invocations, except the PEER-ABORT invocation, shall be defined with a common header containing the parameters specified in 3.3.2.

3.3.1.2 All operation responses shall be defined with a common header containing the parameters specified in 3.3.2.

3.3.1.3 A confirmed operation may be defined with a return only or with an acknowledgement and a return.

NOTE – While the acknowledgement and return PDUs may use the same syntax, the invoker of the operation can differentiate the acknowledgement and return PDUs by reading the tag at the beginning of the PDU (see annex F).

3.3.2 INVOCATION, ACKNOWLEDGEMENT AND RETURN PARAMETERS**3.3.2.1 General**

Table 3-1 identifies the parameters that appear in the invocation, acknowledgement, and return of the Standard Confirmed Operation Header. Table 3-2 identifies the parameters that appear in the invocation of the Standard Unconfirmed Operation Header. The following subsections specify each of these parameters.

Table 3-1: Standard Confirmed Operation Header Parameters

Parameters	Invocation	Acknowledgement	Return
invoker-credentials	M		
performer-credentials		M	M
invoke-id	M	M	M
procedure-instance-identifier	M		
result		M	M
diagnostic		C	C

Table 3-2: Standard Unconfirmed Operation Header Parameters

Parameter	Invocation
invoker-credentials	M
invoke-id	M
procedure-instance-identifier	M

3.3.2.2 invoker-credentials

The `invoker-credentials` parameter shall provide information that enables the performer to authenticate the invocation (see 3.2.4). If authentication is not required, the `invoker-credentials` parameter shall be set to 'unused'.

3.3.2.3 performer-credentials

The `performer-credentials` parameter shall provide information that enables the invoker to authenticate the response from the performance of the invoked operation (see 3.2.4). If authentication is not required, the `performer-credentials` parameter shall be set to 'unused'.

3.3.2.4 invoke-id

3.3.2.4.1 The value of the `invoke-id` parameter shall be an invoker-supplied arbitrary integer value (see 3.2.5).

NOTE – The presence of the `invoke-id` in the standard unconfirmed operation header is required to maintain commonality with the confirmed operation.

3.3.2.4.2 The performer shall insert unchanged the invoker-supplied value of the `invoke-id` parameter in each corresponding operation response.

3.3.2.5 procedure-instance-identifier

3.3.2.5.1 The `procedure-instance-identifier` shall consist of:

- a) the `procedure-type` (e.g., Buffered Data Delivery);
- b) the `procedure-role`:
 - 1) the role of the Association Control procedure is always association control; as there is only one instance of the Association Control procedure, the `procedure-role` parameter is set to the 'associationControl' value;
 - 2) the role of any other procedure is either prime procedure instance or secondary procedure instance;
- c) there is only a single instance of any prime procedure; consequently, the `procedure-instance-number` parameter in this case is set to the 'primeProcedure' value;
- d) for secondary procedures, the `procedure-instance-number` parameter is present.

3.3.2.5.2 The `procedure-type` shall uniquely identify the type of the procedure.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.3.2.5.3 The value of the `procedure-instance-identifier` shall be the same for all operations used in the context of that procedure instance.

3.3.2.5.4 The procedure instance number in the `procedure-instance-identifier` of secondary procedures shall be set to an incrementing number starting with 1. The value of `procedure-instance-identifier` shall represent the count of the instances of the given secondary procedure type within one service instance.

NOTE – If there is more than one instance of the prime procedure type, only one instance is considered the prime procedure, the other instances are considered secondary procedures.

EXAMPLE – A service has three instances of the procedure type ‘x’ and three instances of the procedure type ‘y’. One of the three procedure instances of ‘x’ is prime:

- a) prime procedure ‘x’ instance number: not applicable;
- b) secondary procedure ‘x’ instance numbers: 1 and 2;
- c) secondary procedure ‘y’ instance numbers: 1, 2, and 3.

3.3.2.6 result

3.3.2.6.1 Definition

3.3.2.6.1.1 The `result` parameter of an operation acknowledgment shall specify the result of the related invocation and shall contain one of the following values:

- a) ‘positive’—the invocation has been accepted by the performer;
- b) ‘negative’—the invocation has not been accepted by the performer.

3.3.2.6.1.2 The `result` parameter of an operation return shall specify the result of an invocation and shall contain one of the following values:

- a) ‘positive’—the operation has been performed by the performer;
- b) ‘negative’—the operation has not been performed by the performer.

3.3.2.6.2 ‘positive’

All procedures shall have the possibility to extend positive responses with additional parameters, the names, types, and values of which shall depend on the procedure using that operation.

3.3.2.6.3 'negative'

If `result` is 'negative', a `diagnostic` parameter shall be present in the response.

3.3.2.7 `diagnostic`

3.3.2.7.1 If present (see 3.3.2.6.3), the `diagnostic` parameter value shall be one of the following:

- a) 'invalid parameter value'—the value of one of the parameters provided is invalid (i.e., is not within the specified range); the `diagnostic` shall be complemented with the name of the invalid parameter (see 3.2.3.2);
- b) 'conflicting values'—the value of one of the parameters is in conflict with the value of another parameter in the invocation (see 3.2.3.3);
- c) 'unsupported option'—one or more of the options required by the invocation is not supported;
- d) 'other reason'—the reason for rejection of the operation will have to be found by other means.

3.3.2.7.2 All procedures shall have the possibility to extend 'negative' with additional parameters, the names, types, and values of which shall depend on the procedure using that operation; in particular, additional values of the `diagnostic` parameter may be defined.

3.4 BIND (CONFIRMED)

3.4.1 BEHAVIOR

3.4.1.1 The service user shall invoke the BIND operation to establish an association with a service provider.

3.4.1.2 The service provider shall return a report of the outcome of the performance of the BIND operation to the service user, unless the BIND invocation is ignored because of invalid credentials (see 3.2.4).

3.4.2 INVOCATION AND RETURN PARAMETERS

3.4.2.1 General

The parameters of the BIND operation shall be present in the invocation and return as specified in table 3-3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 3-3: BIND Operation Parameters

Parameters	Invocation	Return
<i>Standard Operation Header (confirmed)</i>	M	M
initiator-identifier	M	
responder-identifier		M
responder-port-identifier	M	
service-type	M	
version-number	M	
service-instance-identifier	M	

3.4.2.2 Operation Parameters Definitions**3.4.2.2.1 Standard Confirmed Operation Header**

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.4.2.2.2 initiator-identifier

3.4.2.2.2.1 The *initiator-identifier* parameter shall identify the authority on whose behalf the application entity is initiating an association.

3.4.2.2.2.2 The *initiator-identifier* parameter shall be a service management parameter.

3.4.2.2.3 responder-identifier

3.4.2.2.3.1 The *responder-identifier* parameter shall identify the authority on whose behalf the responding application is acting.

3.4.2.2.3.2 The *responder-identifier* parameter shall be a service management parameter.

3.4.2.2.4 responder-port-identifier

3.4.2.2.4.1 The *responder-port-identifier* parameter shall specify the port identifier of the responding application entity with which the initiator seeks to establish an association.

NOTE – The *responder-port-identifier* parameter also permits the use of particular kinds of gateways where because of different communications technologies at the peer entities establishing a direct end-to-end communications channel is not possible or where such direct end-to-end channel is not desired for

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

security reasons. The **responder-port-identifier** parameter is used by such gateways to complete the association with the responding application entity, but it is not intended to be used by the responding application entity itself. Beyond this statement, the behavior of such gateways is outside the scope of this Recommended Standard.

3.4.2.2.4.2 The responding application entity shall ignore the value of the **responder-port-identifier** parameter for purposes of determining the validity of the invocation.

3.4.2.2.4.3 The **responder-port-identifier** parameter shall be a service management parameter.

NOTES

- 1 The value of the **responder-port-identifier** parameter is a logical name that can be translated into the technology-specific addressing information required to establish a connection with the responder using the agreed-upon communications service. The CSTS application entity on the service user side needs to know this parameter so that it is properly populated for use by the port-designation mechanism of the underlying communications service. On the service provider side, the application entity completely ignores this parameter. However, it needs to be known on the provider side for the configuration of the underlying communications service.
- 2 Complex Management and Utilization Management must have previously agreed on the **responder-port-identifier** and its translation that is applicable to a particular instance of service. The parameter value can conveniently be used beyond the port-designation mechanism as a pointer to a set of configuration parameters of the underlying communications service such as the size of transmit and receive buffers.
- 3 The **responder-port-identifier** parameter is included in the BIND invocation select the communications port on the responder side or to support its possible use by particular kinds of gateways. The responding application entity ignores its value.
- 4 In case the association between user and provider is established via a gateway and the value of the **responder-port-identifier** parameter is incorrectly set, the gateway will not be able to relay the BIND invocation to the target responding application entity. Likewise, if because of an incorrectly set **responder-port-identifier** parameter the target application entity is not listening on the correct communications port for an incoming BIND invocation, The BIND invocation will not be noticed and the application entity will not issue a BIND return. The lack of a return for the BIND operation will trigger the 'return timeout' event on the user side. As specified in 3.6.2.2, the user will abort the association by invoking the PEER-ABORT operation with the **diagnostic** parameter set to 'return timeout'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.4.2.2.5 service-type

The **service-type** parameter shall uniquely identify the type of service that will be provided if the BIND operation succeeds.

3.4.2.2.6 version-number

The **version-number** parameter shall identify the version number of the service specification that is to govern this association if the BIND operation succeeds.

3.4.2.2.7 service-instance-identifier

3.4.2.2.7.1 The **service-instance-identifier** parameter shall uniquely identify this service instance within the scope of the service-providing Complex.

3.4.2.2.7.2 The **service-instance-identifier** shall consist of the following sequence:

- a) an identifier of the spacecraft being supported by the given CSTS instance;
- b) an identifier of the facility where the CSTS provider is located;
- c) an identifier of the CSTS type;
- d) the service instance number.

3.4.2.2.7.3 The ordering of the elements constituting the **service-instance-identifier** shall be significant. The order shall be: spacecraft identifier first, followed by the facility identifier, followed by the transfer service type and ending with the service instance number.

3.4.2.2.7.4 The elements of the **service-instance-identifier** being identifiers (spacecraft, facility, CSTS type) shall be defined as Object Identifiers while the service instance number shall be a positive integer.

3.4.2.2.7.5 The spacecraft supported by the given CSTS instance shall be specified by means of the spacecraft Object Identifier assigned in the CCSDS Spacecraft Registry (see H2.5).

3.4.2.2.7.6 The 'facility' where the CSTS provider is located shall be specified by means of an Object Identifier assigned in the CCSDS Service Site and Aperture Registry (see H2.5).

3.4.2.2.7.7 The CSTS type shall be identified by means of the Object Identifier assigned to the service type as specified in D5.

3.4.2.2.7.8 The **service-instance-identifier** parameter shall be a service management parameter.

NOTES

- 1 For all Object Identifiers being elements of the **service-instance-identifier** parameter, SANA maintains registries where these Object Identifiers can be looked up.
- 2 For the convenience of human users, these registries may specify names in the form of strings associated with the various Object Identifiers. However, these strings are not part of the BIND invocation PDU. They are used in the following example only to illustrate the elements of the **service-instance-identifier** parameter.

EXAMPLE:

- Spacecraft Name: 'XenoSat'
- Facility Identifier: 'DSNDSS5'
- CSTS type: 'MD CSTS'
- Service Instance Number: 1

3.4.2.2.7.9 The service instance number shall be identical to the Functional Resource Instance Number of the Functional Resource Name assigned to the service instance.

NOTE – The concatenation of the CSTS type and the service instance number are semantically equivalent to the Functional Resource Name of the service instance.

3.4.2.2.8 BIND Invocation Syntax

The type **BindInvocation**, as defined in F4.5, shall define the syntax of the BIND invocation PDU and its parameters.

3.4.2.2.9 BIND Return Syntax

The type **BindReturn**, as defined in F4.5, shall define the syntax of the BIND return PDU and its parameters.

3.4.2.3 diagnostic Parameter Extension Value Definitions

3.4.2.3.1 If a negative BIND return is sent, one of the diagnostics specified in 3.3.2.7 or one of the following diagnostics shall be used:

- a) 'access denied'—the value of the **initiator-identifier** parameter is not recognized by the service provider (the value does not identify an authorized service user of any service instance known to the service provider);
- b) 'service type not supported'—the value of the **service-type** parameter of the BIND invocation does not identify a service type supported by the service provider;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- c) 'version not supported'—the service type version is not supported;
- d) 'no such service instance'—the requested service instance is unknown to the service provider;
- e) 'already bound'—the service instance is already bound via a different association;
- f) 'service instance not accessible to this initiator'—the service user identified by the `initiator-identifier` parameter of the BIND invocation does not match the authorized initiator for the service instance identified by the `service-instance-identifier` parameter;
- g) 'inconsistent service type'—the value of the `service-type` parameter of the BIND invocation is not a valid one, or the value of the `service-type` parameter does not match the service type of the service instance identified by the `service-instance-identifier` parameter;
- h) 'out of service'—`production-status` is 'halted' (see annex B).

3.4.2.3.2 The type `AssocBindDiagnosticExt` (see F4.5) shall define the syntax of the extended diagnostics listed in this section.

3.5 UNBIND (CONFIRMED)

3.5.1 BEHAVIOR

3.5.1.1 The service user shall invoke the UNBIND operation to release an established association with a service provider.

3.5.1.2 In case the service provider cannot accept the UNBIND invocation (i.e., 'duplicate invoke-id'), it shall abort the association by invoking PEER-ABORT.

3.5.1.3 Otherwise, the service provider shall return a positive report of the outcome of the performance of the UNBIND operation to the service user.

3.5.2 INVOCATION AND RETURN PARAMETERS

3.5.2.1 General

The parameters of the UNBIND operation shall be present in the invocation and return as specified in table 3-4.

Table 3-4: UNBIND Operation Parameters

Parameters	Invocation	Return
<i>Standard Operation Header (confirmed)</i>	<i>M</i>	<i>M</i>

3.5.2.2 Operation Parameters Definitions

3.5.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3) without extension.

3.5.2.2.2 UNBIND Invocation Syntax

The type `UnbindInvocation`, as defined in F4.5, shall specify the syntax of the UNBIND invocation PDU and its parameters.

3.5.2.2.3 UNBIND Return Syntax

The type `UnbindReturn`, as defined in F4.5, shall specify the syntax of the UNBIND return PDU and its parameters.

3.6 PEER-ABORT (UNCONFIRMED)

3.6.1 BEHAVIOR

3.6.1.1 The service user or service provider shall invoke the PEER-ABORT operation to terminate unconditionally an association between a service user and a service provider.

3.6.1.2 The PEER-ABORT operation shall not be extended.

3.6.1.3 On reception of a PEER-ABORT the service user or the service provider shall flush all queued data.

3.6.2 INVOCATION PARAMETERS

3.6.2.1 The parameters of the PEER-ABORT operation shall be present in the invocation as specified in table 3-5.

Table 3-5: PEER-ABORT Operation Parameters

Parameters	Invocation
diagnostic	M

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.6.2.2 Operation Parameters Definitions**3.6.2.2.1 diagnostic**

3.6.2.2.1.1 The **diagnostic** parameter shall specify why the PEER-ABORT is being invoked.

3.6.2.2.1.2 The value of the **diagnostic** parameter shall be one of the following:

- a) 'access denied'—a service provider with an identity as presented in the **responder-identifier** parameter of the BIND return is not known to the service user;
- b) 'unexpected responder ID'—the value of the **responder-identifier** parameter in the BIND return does not match the identity of the authorized service provider for this service instance as specified by service management;
- c) 'operational requirement'—the local system had to terminate the association to accommodate some other operational need;
- d) 'protocol error'—the local application detected an error in the sequencing of service operations;
- e) 'communications failure'—the communications service on the other side of a gateway was disrupted;

NOTE – The 'communications failure' diagnostic is included in the PEER-ABORT invocation to support its possible use by particular kinds of gateways. It is used by such gateways to report on a communications failure with the peer application entity. It is not intended to be used by the peer application entity itself. Beyond this statement, the behavior of such gateways is outside the scope of this Recommended Standard.

- f) 'encoding error'—the local application detected an error in the encoding of one or more operation parameters or did not recognize the operation or the data is badly formatted (e.g., one of the service instance identifier fields is missing);
- g) 'response timeout'—the local application detected that the acknowledgement from a three-phase operation or the return from a two-phase operation was not received within a specified time limit;
- h) 'end of service instance provision period'—the service provider detected that the service instance provision period has ended and the service user has not invoked the UNBIND operation;
- i) 'unsolicited invoke-id'—the local application received a response with an **invoke-id** that does not match the **invoke-id** of any of the operations for which a response is pending;

- j) 'duplicate invoke ID'—the value of the `invoke-id` parameter is the same as the `invoke-id` value of another operation still being performed;
- k) 'invalid procedure instance identifier'—the `procedure-instance-identifier` of the received operation contains an unknown procedure type or the procedure role does not match the expected one or the `procedure-instance-identifier` contains an unknown procedure instance;
- l) 'unrecognized operation or parameter type'—the operation type of the received operation does not match any of the defined types or one of the parameter types does not match any of the defined types;
- m) 'other reason'—the local application detected an unspecified error during the processing of one or more operations.

3.6.2.2.1.3 A procedure or a service shall have the capability to specify further diagnostic values within the constraints specified in F4.5.

3.6.2.2.2 PEER-ABORT Invocation Syntax

The type `PeerAbortInvocation`, as defined in F4.5, shall specify the syntax of the PEER-ABORT invocation PDU and its parameters.

3.7 START (CONFIRMED)

3.7.1 BEHAVIOR

3.7.1.1 The service user shall invoke the START operation to request that the service provider begin the activities associated with the procedure using the operation.

3.7.1.2 The activity to be started shall be defined by the procedure using the START operation.

3.7.1.3 The service provider shall return a report of the outcome of the performance of the START operation to the service user.

3.7.1.4 After a successful START, the service provider shall:

- a) transition the procedure to the state 'active';
- b) perform the activities associated with the procedure using the operation.

3.7.1.5 After an unsuccessful START, the service provider shall remain in procedure state 'inactive'.

3.7.2 INVOCATION AND RETURN PARAMETERS

3.7.2.1 General

The parameters of the START operation shall be present in the invocation and return as specified in table 3-6.

Table 3-6: START Operation Parameters

Parameters	Invocation	Return
<i>Standard Operation Header (confirmed)</i>	<i>M</i>	<i>M</i>

3.7.2.2 Operation Parameters Definitions

3.7.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.7.2.2.2 START Invocation Syntax

The type `StartInvocation`, as defined in F4.4, shall specify the syntax of the START invocation PDU and its parameters.

3.7.2.2.3 START Return Syntax

The type `StartReturn`, as defined in F4.4, shall specify the syntax of the START return PDU and its parameters.

3.7.2.3 diagnostic Parameter Extension Value Definitions

3.7.2.3.1 If a negative START return is sent, one of the diagnostics specified in 3.3.2.7, or one of the following diagnostics shall be used:

- ‘unable to comply’—the service provider is unable to activate the procedure at this time because of a fault affecting the service;
- ‘out of service’—the service provider has been taken out of service for an indefinite period by management action; i.e., `production-status` is ‘halted’.

3.7.2.3.2 The type `StartDiagnosticExt`, as specified in F4.4, shall define the syntax of the extended diagnostics listed in this section.

3.8 STOP (CONFIRMED)

3.8.1 BEHAVIOR

3.8.1.1 The service user shall invoke the STOP operation to request that the service provider stop the activities associated with the procedure using the operation.

3.8.1.2 The activity to be stopped shall be defined by the procedure using the STOP operation.

NOTE – Within the constraints of the service instance provision period, the service user may re-enable the activity by again invoking the START operation.

3.8.1.3 The service provider shall provide a report of the outcome of the performance of the STOP operation to the service user.

3.8.1.4 After a successful STOP, the service provider shall:

- a) stop performing its activities;
- b) transition the procedure to the state 'inactive'.

3.8.1.5 After an unsuccessful STOP, the service provider shall:

- a) continue performing its activities;
- b) remain in procedure state 'active'.

3.8.2 INVOCATION, RETURN, AND PARAMETERS

3.8.2.1 General

The parameters of the STOP operation shall be present in the invocation and return as specified in table 3-7.

Table 3-7: STOP Operation Parameters

Parameters	Invocation	Return
Standard Operation Header (confirmed)	M	M

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.8.2.2 Operation Parameters Definitions**3.8.2.2.1 Standard Confirmed Operation Header**

This operation shall use the Standard Confirmed Operation Header (see 3.3) without extension.

3.8.2.2.2 STOP Invocation Syntax

The type `StopInvocation`, as defined in F4.4, shall specify the syntax of the STOP invocation PDU and its parameters.

3.8.2.2.3 STOP Return Syntax

The type `StopReturn`, as defined in F4.4, shall specify the syntax of the STOP return PDU and its parameters.

3.9 TRANSFER-DATA (UNCONFIRMED)**3.9.1 BEHAVIOR**

The service provider shall invoke the TRANSFER-DATA operation to deliver data units to the service user.

3.9.2 INVOCATION AND PARAMETERS**3.9.2.1 General**

The parameters of the TRANSFER-DATA operation shall be present in the invocation as specified in table 3-8.

Table 3-8: TRANSFER-DATA Operation Parameters

Parameters	Invocation
<i>Standard Operation Header (unconfirmed)</i>	M
generation-time	M
sequence-counter	M
data	M

3.9.2.2 Operation Parameters Definitions

3.9.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Unconfirmed Operation Header (see 3.3) without extension.

3.9.2.2.2 **generation-time**

The **generation-time** parameter shall contain the UTC time at which the data unit was generated.

NOTE – The meaning of data generation can be understood only in the context of the service defining the data to be transferred.

3.9.2.2.3 **sequence-counter**

3.9.2.2.3.1 For each instance of a procedure that uses the TRANSFER-DATA operation, the service provider shall set the **sequence-counter** parameter of the first data unit due for transmission to 0 after acceptance of the START operation for that procedure instance.

3.9.2.2.3.2 For each instance of a procedure that uses the TRANSFER-DATA operation, the **sequence-counter** parameter shall be incremented with each data unit after the first one that the service provider transmits to the service user using that procedure instance.

NOTE – The purpose of the **sequence-counter** is to give the service user a mechanism for checking the continuity of the data transmitted by the service provider.

3.9.2.2.3.3 When the maximum value of the counter is reached the **sequence-counter** parameter shall be reset to 0.

3.9.2.2.4 **data**

3.9.2.2.4.1 The value of the **data** parameter is the data unit generated.

3.9.2.2.4.2 The **data** parameter shall be either of the type octet string or the type shall be specified as an extension.

3.9.2.2.4.3 A procedure using this operation shall:

- a) refine (i.e., specify) the format and the semantics of the octet string in the **data** parameter; or
- b) extend the operation by defining the structure and the semantics of the extension field in the **data** parameter.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.9.2.2.5 TRANSFER-DATA Invocation Syntax

The type `TransferDataInvocation`, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA invocation PDU and its parameters.

3.10 PROCESS-DATA (UNCONFIRMED / CONFIRMED)**3.10.1 BEHAVIOR**

The service user shall invoke the PROCESS-DATA operation to transfer data to the service provider for further processing.

3.10.2 INVOCATION, RETURN, AND PARAMETERS**3.10.2.1 General**

The parameters of the PROCESS-DATA operation shall be present in the invocation as specified in table 3-9, where a procedure using this operation shall specify if the unconfirmed variant or the confirmed variant is applied.

Table 3-9: PROCESS-DATA Operation Parameters

Parameters	Invocation	Return (optional)
<i>Standard Operation Header (unconfirmed or confirmed)</i>	M	M
data-unit-id	M	
data	M	

3.10.2.2 Operation Parameters Definitions**3.10.2.2.1 Standard Unconfirmed Operation Header**

If the procedure using this operation opts for the unconfirmed variant of the PROCESS-DATA operation, the operation shall use the Standard Unconfirmed Operation Header (see 3.3).

3.10.2.2.2 Standard Confirmed Operation Header

If the procedure using this operation opts for the confirmed variant of the PROCESS-DATA operation, the operation shall use the Standard Confirmed Operation Header (see 3.3).

3.10.2.2.3 data-unit-id

The **data-unit-id** parameter value, defined to be of the type unsigned integer, can be freely chosen by the service user. The service provider shall copy this parameter into the respective notifications reporting on the outcome of the processing of the data unit.

NOTE – Notifications can only be unambiguously associated with a specific data unit if the service user ensures that the **data-unit-id** parameter values of all data units already sent to the service provider, but of which processing did not yet complete or abort, are unique. One simple way for achieving uniqueness of the **data-unit-id** values is using a counter that is incremented by one for each data unit sent to the service provider.

3.10.2.2.4 data

3.10.2.2.4.1 The **data** parameter shall contain the data to be transferred from the service user to the service provider and subsequently processed by the service provider.

3.10.2.2.4.2 The **data** parameter shall be either of the type octet string or the type shall be specified as an extension.

3.10.2.2.4.3 A procedure using this operation shall:

- a) refine (i.e., specify) the format and the semantics of the octet string in the **data** parameter; or
- b) extend the operation by defining the structure and the semantics of the extension field in the **data** parameter.

3.10.2.2.5 PROCESS-DATA Invocation Syntax

The type **ProcessDataInvocation**, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA invocation PDU and its parameters.

3.10.2.2.6 PROCESS-DATA Return Syntax

The type **ProcessDataReturn**, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA return PDU and its parameters. It only applies if the procedure using the PROCESS-DATA operation has opted for the confirmed variant of this operation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.11 NOTIFY (UNCONFIRMED)**3.11.1 BEHAVIOR**

The service provider shall invoke the NOTIFY operation to notify the service user of the occurrence of an event of interest to the service user.

NOTE – Notification of events may be of value to the service user in understanding specific service provider behavior, such as an interruption in data delivery.

3.11.2 INVOCATION AND PARAMETERS**3.11.2.1 General**

The parameters of the NOTIFY operation shall be present in the invocation as specified in table 3-10.

Table 3-10: NOTIFY Operation Parameters

Parameters	Invocation
<i>Standard Operation Header (unconfirmed)</i>	M
event-time	M
event-name	M
event-value	M

3.11.2.2 Operation Parameters Definitions**3.11.2.2.1 Standard Confirmed Operation Header**

This operation shall use the Standard Unconfirmed Operation Header (see 3.3) without extension.

3.11.2.2.2 event-time

The event-time parameter shall contain the UTC time at which the event occurred.

3.11.2.2.3 event-name

3.11.2.2.3.1 The event-name is in the form of an Event Name as defined in E5; it consists of the Event Identifier defined for the event being notified and either the Functional Resource Name of the Functional Resource Instance triggering the event or the procedure instance identifier of the procedure that issues the notification.

3.11.2.2.3.2 For service production related events, this operation shall define the following published events:

- a) 'production status change' (**event-name**)—the status of service production has changed (see annex B). The associated **event-value** shall report the `svcProductionStatus` given since the 'production status change' event triggered.
- b) 'production configuration change' (**event-name**)—at least one parameter controlling the configuration of service production has been changed. Unless otherwise specified by the procedure using the operation, the associated **event-value** shall be set to 'empty'.

NOTE – Each CSTS specification defines how the Functional Resource Instances directly associated with the service production of an instance of that CSTS type are determined and which set of parameters of those Functional Resource Instances form the production configuration and therefore also the production configuration change event.

3.11.2.2.3.3 The Published Identifiers for the Event Names of the above listed events are specified in F4.17 as `svcProductionStatusChange`, and `svcProductionConfigurationChange`, respectively.

3.11.2.2.3.4 The events defined in 3.11.2.2.3.2 shall be transferred with the Functional Resource Name of the Functional Resource Instance triggering the events, i.e., the Functional Resource Instance representing the CSTS instance of which the production status or production configuration changed.

3.11.2.2.3.5 Procedures may require that the occurrence of events related to the procedure be notified; such procedure shall specify the Published Identifier for each of these events as well as the **event-value** associated with the given event.

3.11.2.2.3.6 Events of the kind addressed in 3.11.2.2.3.5 shall be transferred with the procedure instance identifier of the procedure triggering the events.

3.11.2.2.3.7 A derived procedure that inherits one or more procedure related events from a parent procedure shall notify the event by using the Published Identifier defined for this event by the parent procedure.

3.11.2.2.4 event-value

3.11.2.2.4.1 The **event-value** allows the notification to optionally carry additional information in the form of the type `SequenceOfQualifiedValues` as defined in F4.3 or in the form of an extension.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.11.2.2.4.2 In case a derived procedure inherits one or more procedure related events, the derived procedure shall specify for each of these events the associated **event-value** parameter regardless of the **event-value** specification given in the parent procedure.

3.11.2.2.4.3 The **event-value** of the 'production status change' event shall report the **svcProductionStatus** value of the service instance that notifies the 'production status change' event. The first part of the path specifying the type to be used is 'NotifyInvocation': 'eventValue': 'EventValue': 'qualifiedValues': 'SequenceOfQualifiedValues': 'SEQUENCE OF QualifiedValues' where this sequence has the length 1. The second part of the path is 'QualifiedValues': 'valid': 'TypeAndValueComplexQualified': 'typeAndValue': 'enumerated': 'SEQUENCE OF INTEGER' where this sequence has the length 1. This enumerated type may have one of the values defined in table B-1.

3.11.2.2.5 NOTIFY Invocation Syntax

The type **NotifyInvocation**, as defined in F4.4, shall specify the syntax of the NOTIFY invocation PDU and its parameters.

3.12 GET (CONFIRMED)

3.12.1 BEHAVIOR

3.12.1.1 The service user shall invoke the GET operation to retrieve the values of specific parameters.

3.12.1.2 The service user shall have the capability to retrieve individual parameters or a set of parameters represented by a list of Parameter Labels (see annex E).

NOTE – The list of Parameter Labels to be retrieved may be a list explicitly named in the invocation or a default list to be specified by the procedures or services using this operation.

3.12.1.3 The GET invocation is valid if it meets any one of the following conditions:

- a) if the **list-of-parameters** parameter is 'empty', signifying the selection of the default list of Parameter Labels and if such default list has been established;
- b) if the **list-of-parameters** parameter contains one parameter list name for a list of Parameter Labels that is contained in the set of label lists that has been established for the service for use by the GET operation;
- c) if the **list-of-parameters** parameter contains one Functional Resource Type that is associated with the service instance that executes the procedure that contains the GET operation;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- d) if the `list-of-parameters` parameter contains one name of a Functional Resource Instance that is associated with the service instance that executes the procedure containing the GET operation;
- e) if the `list-of-parameters` parameter contains one procedure type that is associated with the service instance that executes the procedure containing the GET operation;
- f) if the `list-of-parameters` parameter contains one procedure instance identifier of a procedure that is associated with the service instance that executes the procedure containing the GET operation;
- g) if (1) the `list-of-parameters` parameter contains one or more Functional Resource Parameter Names or Functional Resource Parameter Labels and (2) every one of these names or labels is the name or label of a parameter of a Functional Resource that is associated with the service instance that executes the procedure that contains the GET operation;
- h) if (1) the `list-of-parameters` parameter contains one or more procedure configuration Parameter Labels or Parameter Names and (2) every one of these labels or name is the label or name of a configuration parameter of a procedure that is associated with the service instance that executes the procedure that contains the GET operation.

3.12.1.4 If the GET invocation is valid, the service provider shall return the qualified parameters (Parameter Name, the value, the type, and the qualifier of the parameter—see C2.1) using the `qualified-parameters` parameter. More specifically, if `list-of-parameters`:

- a) is left empty, then:
 - 1) for each Functional Resource Parameter Label represented by the default list (see annex E), the service provider shall return the qualified parameter (see C2.1) for that label for the Functional Resource Instances of the given type that are directly associated with the service instance that executes the procedure containing the GET operation;
 - 2) for each procedure configuration Parameter Label in the default list, the service provider shall return the qualified parameter for that label for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;
- b) contains the name of a list of Parameter Labels, then:
 - 1) for each Functional Resource Parameter Label in the named list (see E), the service provider shall return the qualified parameter for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the procedure containing the GET operation;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 2) for each procedure configuration Parameter Label in the named list, the service provider shall return the qualified parameter for that label for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;
- c) contains one Functional Resource Type, then the service provider shall return the qualified parameters for all parameters of all Functional Resource Instances of the given type that are directly associated with the service instance invoking the GET operation;
- d) contains one Functional Resource Name, then the service provider shall return the qualified parameters for all parameters of the named Functional Resource Instance;
- e) contains one procedure type, then the service provider shall return the qualified parameter for all parameters of every configured instance of that procedure type that is directly associated with the service instance invoking the GET operation;
- f) contains one procedure instance identifier, then the service provider shall return the qualified parameters for all configuration parameters for that procedure instance;
- g) contains any Functional Resource Parameter Labels, then for each Functional Resource Parameter Label the service provider shall return the qualified parameter for that label for each of the Functional Resource Instances of the given type that is directly associated with the service instance that executes the procedure containing the GET operation;
- h) contains any labels for procedure configuration parameters, then for each procedure configuration Parameter Label the service provider shall return the qualified parameter for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;
- i) contains one or more Parameter Names, then the service provider shall return the qualified parameter for each of the listed parameters.

3.12.1.5 If the GET invocation is invalid, the service provider shall issue a negative return using one of the diagnostics specified in 3.12.2.4.

3.12.1.6 Procedures using this operation shall define

- a) the names of the lists of Parameter Labels;
- b) the Parameter Labels contained in the named lists;
- c) which of the named lists shall serve as default list, if any.

3.12.2 INVOCATION, RETURN, AND PARAMETERS

3.12.2.1 General

The parameters of the GET operation shall be present in the invocation and return as specified in table 3-11.

Table 3-11: GET Operation Parameters

Parameters	Invocation	Return
<i>Standard Operation Header (confirmed)</i>	M	M
list-of-parameters	M	
qualified-parameters		C

3.12.2.2 Operation Parameters Definitions

3.12.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.12.2.2.2 list-of-parameters

3.12.2.2.2.1 The list-of-parameters parameter shall contain one of the following: (a) 'empty' (signifying default list), (b) the name of a list, (c) one Functional Resource Type, (d) one Functional Resource Name, (e) one procedure type, (f) one procedure instance identifier, (g) a set of individual Parameter Labels, or (h) a set of individual Parameter Names.

3.12.2.2.2.2 If the list-of-parameters parameter is set to 'empty', the service provider shall transmit the values of the parameters represented by the default list of Parameter Labels provided such list is known to the service provider.

NOTE – The definition of what is represented by the list of Parameter Labels can be found in annex E.

3.12.2.2.2.3 A name of a list of Parameter Labels shall be defined as a string.

NOTE – The composition of Parameter Names is discussed in annex E.

3.12.2.2.3 qualified-parameters

If the result is 'positive' (i.e., positive GET return), the parameter values requested via list-of-parameters shall be returned in the qualified-parameters parameter as specified in annex C2.1.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.12.2.2.4 GET Invocation Syntax

The type `GetInvocation`, as defined in F4.4, shall specify the syntax of the GET invocation PDU and its parameters.

3.12.2.2.5 GET Return Syntax

The type `GetReturn`, as defined in F4.4, shall specify the syntax of the GET return PDU and its parameters.

3.12.2.3 positive Parameter Extension Value Definitions

The type `GetPosReturnExt`, as defined in F4.4, shall specify the syntax of the positive return extension of the GET operation.

3.12.2.4 diagnostic Parameter Extension Value Definitions

3.12.2.4.1 If a negative GET return is sent, one of the diagnostics specified in 3.3.2.7, or one of the following diagnostics shall be used:

- a) 'default not defined'—the default list (`list-of-parameters` set to 'empty') is unknown to the service provider.
- b) 'unknown list name'—the list name contained in the `list-of-parameters` is unknown to the service provider. The unknown list name shall be returned with the diagnostic.
- c) 'unknown Functional Resource Type'—the Functional Resource Type contained in the `list-of-parameters` is unknown to the service provider (see 3.12.2.2.2) or the Functional Resource Type is not associated with the service instance that executes the procedure containing the GET operation. The unknown Functional Resource Type shall be returned with the diagnostic.
- d) 'unknown Functional Resource Name'—while the Functional Resource Type is known, the Functional Resource Name contained in the `list-of-parameters` is unknown to the service provider (see 3.12.2.2.2) or the selected Functional Resource Instance is not associated with the service instance that executes the procedure containing the GET operation. The unknown Functional Resource Name shall be returned with the diagnostic.
- e) 'unknown procedure type'—the procedure type contained in the `list-of-parameters` is unknown to the service provider (see 3.12.2.2.2). The unknown procedure type shall be returned with the diagnostic.
- f) 'unknown procedure instance identifier'—while the procedure type is known, the procedure instance identifier contained in the `list-of-parameters` is unknown

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

to the service provider (see 3.12.2.2.2). The unknown procedure instance identifier shall be returned with the diagnostic.

- g) 'unknown parameter identifier'—one or more Parameter Identifiers contained in the `list-of-parameters` parameter are unknown to the service provider (see 3.12.2.2.2) for one of the following reasons:
- 1) the Functional Resource or procedure type specified as part of the Parameter Label is not associated with the service instance executing the procedure containing the GET operation;
 - 2) the Functional Resource or procedure instance specified as part of the Parameter Name is not associated with the service instance executing the procedure containing the GET operation;
 - 3) a parameter with the given Published Identifier does not exist for the specified Functional Resource or procedure type.

The list of unknown Parameter Names or Parameter Labels shall be returned with the diagnostic. For each unknown Parameter Identifier that is contained in a Parameter Name in the `list-of-parameters`, the Parameter Name shall be returned. For each unknown Parameter Identifier that is contained in a Parameter Label in the `list-of-parameters`, the Parameter Label shall be returned.

3.12.2.4.2 The type `GetDiagnosticExt`, as specified in F4.4 shall define the syntax of the extended diagnostics listed in this section.

3.13 EXECUTE-DIRECTIVE (ACKNOWLEDGED)

3.13.1 PURPOSE

NOTE – The EXECUTE-DIRECTIVE is an acknowledged operation, which provides intermediate feedback to the service user to acknowledge that the invocation has been received and is valid, as well as a final feedback regarding the outcome of the operation which is returned some time after the acknowledgement.

3.13.1.1 The service user shall invoke the EXECUTE-DIRECTIVE operation to cause the Complex to perform a specified action.

3.13.1.2 The specified action shall be defined by one of the following:

- a) a `directive-identifier` registered for the procedure containing the invoked EXECUTE-DIRECTIVE operation;
- b) a `directive-identifier` registered for a procedure type, if that type is associated with the service instance executing the procedure containing the invoked EXECUTE-DIRECTIVE;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- c) a **directive-identifier** registered for a Functional Resource Type, if that type is associated with the service instance executing the procedure containing the invoked EXECUTE-DIRECTIVE.

3.13.1.3 The service provider shall provide a report (acknowledgement) on the acceptance of the EXECUTE-DIRECTIVE invocation to the service user.

3.13.1.4 If the EXECUTE-DIRECTIVE invocation is valid, the service provider shall execute the action and then provide a report (return) on the outcome of the overall performance of the EXECUTE-DIRECTIVE operation.

3.13.2 INVOCATION, RESPONSES AND PARAMETERS

3.13.2.1 General

The parameters of the EXECUTE-DIRECTIVE operation shall be present in the invocation, acknowledgement and return as specified in table 3-12.

Table 3-12: EXECUTE-DIRECTIVE Operation Parameters

Parameters	Invocation	Acknowledgement	Return
<i>Standard Operation Header (confirmed)</i>	M	M	M
directive-identifier	M		
directive-qualifier	M		

3.13.2.2 Operation Parameters Definitions

3.13.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.13.2.2.2 **directive-identifier**

3.13.2.2.2.1 The **directive-identifier** shall identify the action that is to be performed by the Complex.

3.13.2.2.2.2 The **directive-identifier** parameter shall be of the type Published Identifier and may be registered either for a procedure type or for a Functional Resource Type (see E6.1).

3.13.2.2.3 directive-qualifier

3.13.2.2.3.1 The `directive-qualifier` shall contain complementary data necessary to perform the action specified by the `directive-identifier` parameter.

3.13.2.2.3.2 Depending on the scope of the `directive-identifier` (see 3.13.1.2) the `directive-qualifier` parameter shall be comprised of one of the following:

- a) the directive qualifier values;
- b) the type and instance number of the procedure the directive shall act on and the directive qualifier values;
- c) the type and instance number of the Functional Resource the directive shall act on and the directive qualifier values.

3.13.2.2.3.3 The directive qualifier values shall be one of the following:

- a) 'noQualifierValues' to indicate that for the given `directive-identifier` the `directive-qualifier` parameter does not carry complementary information;
- b) a possibly complex structure of values not associated with formally defined parameters identified by means of Published Identifiers; the data structure shall be of the type `TypeAndValueComplexQualified` defined in F4.3;
- c) a sequence of parameter identifiers and the associated parameter values where the parameter identifier is the Published Identifier assigned to this parameter and the parameter value is of the type `TypeAndValueComplexQualified` defined in F4.3.

3.13.2.2.3.4 A procedure using this operation may extend the operation by defining the structure and the semantics of the extension field in the `directive-qualifier` parameter.

3.13.2.2.4 EXECUTE-DIRECTIVE Invocation Syntax

The type `ExecutedDirectiveInvocation`, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE invocation PDU and its parameters.

3.13.2.2.5 EXECUTE-DIRECTIVE Acknowledgement Syntax

The type `ExecutedDirectiveAcknowledge`, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE acknowledgement PDU and its parameters.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

3.13.2.2.6 EXECUTE-DIRECTIVE Return Syntax

The type `ExecuteDirectiveReturn`, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE return PDU and its parameters.

3.13.2.3 diagnostic Parameter Extension Value Definitions

3.13.2.3.1 If a negative EXECUTE-DIRECTIVE acknowledgement is sent, one of the diagnostics specified in 3.3.2.7, or one of the following diagnostics shall be used:

- a) 'unknown directive'—the `directive-identifier` specified in the invocation is not valid, i.e., the `directive-identifier` is not registered for the procedure or for the Functional Resource Type specified in the `directive-qualifier` parameter;
- b) 'unknown qualifier'—the `directive-qualifier` specified in the invocation is not valid for the given `directive-identifier`;
- c) 'invalid procedure instance'—the specified instance of the procedure type that the directive shall act on does not exist;
- d) 'invalid functional resource instance'—the specified instance of the given Functional Resource Type that the directive shall act on does not exist;
- e) 'invalid Functional Resource parameter'—either (1) one or more of the Parameter Identifiers in the sequence of Parameter Identifiers in the `directive-qualifier` is not a published Parameter Identifier of the Functional Resource the directive shall act on, or (2) the associated parameter value is not of the type specified for that parameter of the Functional Resource. This diagnostic value shall include a list of all Parameter Names contained in the `directive-qualifier` which are invalid for the given Functional Resource Type or for which the type of the parameter value is invalid;
- f) 'invalid procedure parameter'—either (1) one or more of the Parameter Identifiers in the sequence of Parameter Identifiers in the `directive-qualifier` is not a published Parameter Identifier of a configuration parameter of the procedure the directive shall act on, or (2) the associated parameter value is not of the type specified for that configuration parameter of the procedure. This diagnostic value shall include a list of all Parameter Names contained in the `directive-qualifier` which are invalid for the given procedure or for which the type of the parameter value is invalid;
- g) 'parameter value out of range'—one or more of the parameters in the parameter sequence of the `directive-qualifier` has a value that is outside the range that is defined for that parameter. This diagnostic value shall include a list of all Parameter Names contained in the `directive-qualifier` for which the parameter value falls outside the valid range.

3.13.2.3.2 The type `ExecDirNegAckDiagnosticExt` specified in F4.4 shall define the syntax of the extended diagnostics defined in this section.

3.13.2.3.3 If a negative EXECUTE-DIRECTIVE return is sent, one of the diagnostics specified in 3.3.2.7, or the following diagnostic shall be used:

‘action not completed’—the requested action was not completed, e.g., because the guard condition of some of the parameters to be updated evaluated to FALSE. This diagnostic value shall include a list of all Parameter Names contained in the `directive-qualifier` for which setting of the parameter value was successful. If the given directive is not intended to change parameter values, the list of Parameter Names shall be empty.

NOTE — The only diagnostic value of those defined in 3.3.2.7 that might be applicable in this case is ‘other reason’. In case any of the other diagnostic values defined in 3.3.2.7 applies, the EXECUTE-DIRECTIVE operation will fail with a negative acknowledgement and therefore a negative return will not be sent.

3.13.2.3.4 The type `ExecDirNegReturnDiagnosticExt` specified in F4.4 shall define the syntax of the extended diagnostics listed in this section.

4 PROCEDURES

4.1 OVERVIEW

This section specifies the procedures defined in this Recommended Standard. Subsection 4.2 specifies behaviors that are generally applicable to all procedures. Subsections 4.3 through 4.12 specify common procedures defined in this Recommended Standard.

NOTE – Unless otherwise specified all statements made in this section shall be understood to refer to a single procedure instance only.

4.2 COMMON PROCEDURES BEHAVIOR

4.2.1 PROCEDURE INSTANCES CREATION

4.2.1.1 The Association Control procedure shall be instantiated at service instance creation and shall exist for the lifetime of the service instance.

4.2.1.2 All procedures other than the Association Control procedure shall be instantiated as soon as a positive BIND return is issued by the service provider.

4.2.1.3 The service provider shall not accept and process any operations except BIND until it returns a positive BIND return. Exception to that statement is the reception of a PEER-ABORT following the reception of a BIND invocation and preceding the issue of the BIND return.

4.2.2 TERMINATION OF THE ASSOCIATION

4.2.2.1 On reception of an UNBIND invocation, the Association Control procedure shall issue a 'terminate procedure' event to all procedure instances of the service instance.

4.2.2.2 On protocol abort (see 1.6.1.6.40) or reception of a PEER-ABORT invocation (see 3.6), the Association Control procedure shall communicate a 'terminate procedure' event to all procedure instances of the service instance.

4.2.2.3 If any procedure other than the Association Control procedure initiates an abort, it shall issue a 'procedure to association abort 'xxx'' event to the Association Control procedure.

4.2.2.4 On reception of the 'procedure to association abort 'xxx'' event from any other procedure, the Association Control procedure shall abort the association.

4.2.2.5 In aborting the association the Association Control procedure shall invoke the PEER-ABORT operation.

4.2.2.6 When invoking the PEER-ABORT, the Association Control procedure of the service provider shall communicate a 'terminate procedure' event to all procedure instances of the service instance.

4.2.3 TERMINATING

4.2.3.1 The Association Control procedure is responsible for sending the 'terminate procedure' event to all procedures of the service instance.

4.2.3.2 On reception of a 'terminate procedure' event from the Association Control procedure all procedures shall terminate all their activities, shall release their resources and shall cease to exist, unless otherwise specified by the procedures.

NOTE – If a procedure is terminated prior to action completion, the service provider will not report on the result of the on-going operations after re-establishing the association.

4.2.4 PROCEDURE STATES

4.2.4.1 Once the association is established all stateful procedures shall be in state 'inactive'.

4.2.4.2 For stateful procedures that have a START and a STOP operation:

- a) the transition from 'inactive' to 'active' occurs after the procedure accepts the START invocation (i.e., when the procedure has sent a positive START return);
- b) the transition from 'active' to 'inactive' occurs after the procedure accepts the STOP invocation (i.e., when the procedure has sent a positive STOP return).

4.2.4.3 For stateful procedures that do not have a START and a STOP operation, the state transition shall be specified by the procedure.

NOTE – Annex G should also be consulted for a description of the service state tables.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.3 ASSOCIATION CONTROL

4.3.1 VERSION NUMBER

The version number of this procedure is 1.

4.3.2 DISCUSSION

4.3.2.1 Purpose

The Association Control procedure establishes and releases an association between a service user and a service provider for a given service instance.

4.3.2.2 Concept

The service user initiates the association by sending a BIND invocation. On reception of the BIND invocation, the service provider reports to the service user whether the association is established or not.

To orderly terminate the association the service user sends an UNBIND invocation. On reception of the UNBIND invocation the service provider reports to the service user whether the association release is accepted or aborted. The Association Control procedure forwards the 'terminate' event to all procedure instances of the service instance.

The association can be aborted by either the service user or the service provider to inform the peer system that the local system detected an error that requires the association be terminated. In case of abort, the Association Control procedure forwards the 'terminate procedure' event to all procedure instances of the service instance.

The values of the `version-number` and `service-type` parameters are selected as part of the service definition.

4.3.3 BEHAVIOR

4.3.3.1 Activities

4.3.3.1.1 At the beginning of the service instance provision period, as specified by Service Management, the Association Control procedure of the service instance shall be placed in the 'unbound' state and made available for binding by the service user.

4.3.3.1.2 At some time during the service instance provision period, the service user shall invoke the BIND operation to establish an association for the given service instance, transitioning from service instance state 1 ('unbound') to service instance state 2 ('bound').

4.3.3.1.3 The service user shall invoke the UNBIND operation to release the association transitioning from service instance state 2 ('bound') to service instance state 1 ('unbound').

4.3.3.1.4 The service user or the service provider may abort the association by invoking the PEER-ABORT operation.

4.3.3.1.5 An association also may be aborted because of certain failures of the underlying communications service; such failures are signaled to the local application by a 'protocol abort' event (see 1.6.1.6.40).

4.3.3.1.6 The deletion of a service instance shall result in the release of all resources associated with that service instance.

4.3.3.1.7 Binding

4.3.3.1.7.1 Except as provided in 4.3.3.1.7.3, after having invoked the BIND operation, the service user shall not invoke any further operations for this service instance until the BIND return from the service provider is received.

4.3.3.1.7.2 If a BIND invocation is received from a service user for a service instance that is already bound to another service user, it shall be rejected with a BIND return with the `result` parameter set to 'negative' and the `diagnostic` parameter set to 'already bound'.

4.3.3.1.7.3 If the return from the BIND invocation is not received after a sufficiently long time, the service user may attempt to recover by invoking the PEER-ABORT operation followed by another BIND invocation.

4.3.3.1.7.4 The length of the duration that constitutes 'a sufficiently long time' shall be defined by the service using this procedure or by a derived procedure (service-user-responding-timer—see table 4-2).

4.3.3.1.7.5 On reception of the BIND invocation, if the invocation is accepted, the service provider shall allocate all resources needed for the service instance.

4.3.3.1.7.6 Once the association is established, the Association Control procedure shall transition to state 2 ('bound').

4.3.3.1.7.7 Following receipt of the return from an UNBIND invocation or following the invocation of PEER-ABORT, the service user may issue another BIND invocation if permissible at that point (e.g., if the end of the service instance provision period has not been reached).

4.3.3.1.8 Unbinding

4.3.3.1.8.1 The service user shall invoke the UNBIND operation to release an association previously established by a BIND operation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.3.3.1.8.2 Except as provided in 4.3.3.1.8.3, the service user shall not invoke any further operations for this service instance until the UNBIND return from the service provider is received.

4.3.3.1.8.3 If the return from the UNBIND operation is not received after a sufficiently long time, the service user may attempt to recover by invoking the PEER-ABORT operation to abort the association.

4.3.3.1.8.4 The length of the duration that constitutes ‘a sufficiently long time’ shall be defined by the service using this procedure or by a derived procedure (service-user-responding-timer—see table 4-2).

4.3.3.1.8.5 The service provider shall accept the UNBIND invocation only in service instance state 2.1 (‘bound.ready’).

4.3.3.1.8.6 If the UNBIND invocation is accepted, then the Association Control procedure shall confirm the release of the association by issuing a positive UNBIND return.

4.3.3.1.9 Aborting

4.3.3.1.9.1 The association may be aborted in one of three ways:

- a) service provider initiated PEER-ABORT;
- b) protocol abort signaled by the underlying communication layer;
- c) service user initiated PEER-ABORT.

4.3.3.1.9.2 Regardless of the way the association is aborted, the service provider shall transition to the state ‘unbound’.

4.3.3.1.9.3 If the event ‘end of service instance provision period’ occurs, then the Association Control procedure of the service provider shall abort the association using the PEER-ABORT operation, delete the service instance and release its resources.

4.3.3.1.9.4 The Association Control procedure shall abort the association upon receipt of a ‘procedure to association abort ‘xxx’’ event from any of the other procedures that constitute the service.

4.3.3.1.9.5 If the occurrence of an underlying communication problem is flagged by means of the ‘protocol abort’ event, then the Association Control procedure shall act as if it had invoked the PEER-ABORT operation.

4.3.3.1.9.6 In case the prime procedure is stateful, any attempt to release the association while the prime procedure is ‘active’ shall result in a PEER-ABORT invoked by the service provider.

4.3.3.1.10 Releasing

Releasing the association has the following effect: The service provider shall transition to state 1 ('unbound').

NOTE – The act of releasing the association for a particular service instance does not necessarily terminate the associated production.

4.3.3.1.11 Access Control

4.3.3.1.11.1 The Association Control procedure shall implement access control based on the identity of the initiator and responder. Access control is performed at two levels:

- a) the initiator must be registered at the responder and the responder must be registered at the initiator;
- b) the initiator and responder must be authorized for the given service instance.

4.3.3.1.11.2 The initiator shall have access to a registry of authorized responders and the responder shall have access to a registry of authorized initiators. These registries shall be maintained by Utilization Management and Complex Management, respectively.

4.3.3.1.11.3 The initiator and responder shall indicate their identity by setting the parameters `initiator-identifier` and `responder-identifier` in the BIND operation to the values assigned by service management.

4.3.3.1.12 Extensibility

4.3.3.1.12.1 The Association Control procedure may be extended with additional parameters.

NOTE – Extending the parameters is not recommended as use of this feature may impact the generality of the Association Control procedure.

4.3.3.1.12.2 The Association Control procedure may be extended with additional diagnostics.

NOTE – Extending the diagnostics is not recommended as use of this feature may impact the generality of the Association Control procedure.

4.3.3.1.12.3 A CSTS shall not derive or refine the Association Procedure through inclusion of operations other than the BIND, UNBIND, and PEER-ABORT operations.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.3.4 REQUIRED OPERATIONS

Table 4-1: Association Control Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
BIND	Common	N	N	Blocking
UNBIND	Common	N	N	Blocking
PEER-ABORT	Common	N	N	Non-Blocking

4.3.5 CONFIGURATION PARAMETERS

The Association Control procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-2.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-2: Association Control Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Configuration Parameter Identifier and Type (F4.16)
service-user-responding-timer (in seconds)	4.3.3.1.7.3, 4.3.3.1.8.3	Yes	pACserviceUserRespTimer PACserviceUserRespTimerType
initiator-identifier	3.4.2.2.2, 4.3.3.1.11.3	Yes	pACinitiatorId PACinitiatorIdType
responder-identifier	3.4.2.2.3, 4.3.3.1.11.3	Yes	pACresponderId PACresponderIdType
service-instance-identifier	3.4.2.2.7	Yes	pACserviceInstanceId PACserviceInstanceIdType

4.3.6 PROCEDURE STATE TABLE

NOTE – The state transition matrix specified in table 4-3 represents one instance of the Association Control procedure. Since there is one and only one instance of the Association Control procedure for each instance of a CSTS, the state table thus represents the single association for that CSTS.

Table 4-3: Association Control Procedure State Table

No.	Incoming Event	State 1 (‘unbound’)	State 2 (‘bound’)
1	(BindInvocation)	IF “positive result” THEN (+BindReturn) → 2 ELSE (-BindReturn) → 1 ENDIF	{peer abort ‘protocol error’} ‘terminate procedure’ → 1
2	‘end of service instance provision period’	‘delete service instance’	{peer abort ‘end-of-service-instance-provision- period’} ‘terminate procedure’ ‘delete service instance’ → 1
3	(UnbindInvocation)	[ignore]	IF “prime procedure is stateful and active” THEN ‘terminate procedure’ {peer abort ‘protocol error’} ELSE (+UnbindReturn) ‘terminate procedure’ ENDIF → 1
4	(PeerAbortInvocation)	[ignore]	‘terminate procedure’ → 1
5	‘procedure to association abort ‘protocol error’”	[ignore]	{peer abort ‘protocol error’} → 1
6	‘invalid PDU’	[ignore]	{peer abort ‘protocol error’} ‘terminate procedure’ → 1
7	‘protocol abort’	[ignore]	‘terminate procedure’ → 1

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-4: Procedure State Table Incoming Event Description References

Event	Reference
'end of service instance provision period'	3.6.2.2, 4.3.3.1.9.3
'invalid PDU'	3.2.3.6
'procedure to association abort 'protocol error''	4.3.3.1.9.4, 4.2.2.3
'protocol abort'	4.3.3.1.9.5
(PeerAbortInvocation)	4.3.3.1.9.1
(UnbindInvocation)	4.3.3.1.8.6
(BindInvocation)	4.3.3.1.7.2, 4.3.3.1.7.5

Table 4-5: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	All checks on the invocation are passed.
"prime procedure is stateful and active"	The prime procedure of the given CSTS instance is stateful and currently in the state 'active'.

Table 4-6: Procedure State Table Simple Action References

Name	References
'delete service instance'	4.3.3.1.6
'abort'	4.2.2.5
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a 'protocol abort' event, a PEER-ABORT, or an UNBIND

Table 4-7: Procedure State Table Compound Action Definitions

Name	Actions Performed
{peer abort 'xxx'}	'terminate procedure' 'abort'

4.4 UNBUFFERED DATA DELIVERY

4.4.1 VERSION NUMBER

The version number of this procedure is 1.

4.4.2 DISCUSSION

4.4.2.1 Purpose

This Unbuffered Data Delivery procedure can be used to accomplish the transfer of data from the service provider to the service user in a 'best effort' manner; i.e., data are delivered as soon as generated if possible and are discarded individually in case of communication link congestion or backpressure from the peer entity.

4.4.2.2 Concept

The Unbuffered Data Delivery procedure supports transfer of data units from the service provider to the service user. The behavior of this process is the following:

As each data unit is generated, it is either immediately transferred or immediately discarded in case the underlying communication service does not accept the data unit for transfer. Each data unit contains a sequence counter allowing the service user to detect the loss of data.

Production of data units might refer to extraction of these data units from the space link or to any other process generating data.

The operations defined in this procedure allow a service user to interact with a service provider to:

- a) request start of the data transfer specifying the selection criteria of the data to be transferred;
- b) receive the specified data units;
- c) stop and optionally later re-start the delivery of data units applying the same or a different selection.

The service user starts the data transfer by invoking the START operation and specifying the selection criteria of the data to be transferred.

The service user can stop the data transfer at any time by invoking the STOP operation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.4.3 BEHAVIOR**4.4.3.1 Starting**

4.4.3.1.1 The service user shall initiate the transfer of data using the START operation.

4.4.3.1.2 The service provider shall reject the START operation with the **diagnostic** value 'out of service' if **production-status** is 'halted'; otherwise the service provider shall perform the START operation.

4.4.3.2 Transferring Data

NOTE – Subsection 3.9.2.2.4.3 stipulates that a procedure using the TRANSFER-DATA operation refines or extends the **data** parameter of that operation. The Unbuffered Data Delivery procedure does not do that. The **data** syntax definition is left to a derived procedure or the service using this procedure.

4.4.3.2.1 After a successful START operation, the service provider shall transfer the data by means of invoking the TRANSFER-DATA operation as the data become available from the production and pass the TRANSFER-DATA PDU to the underlying communications service.

4.4.3.2.2 The transfer shall end when one of the following occurs:

- a) no more data are to be expected;
- b) STOP is invoked by the service user;
- c) the service instance is aborted.

4.4.3.2.3 TRANSFER-DATA is valid only in procedure state 'active' and shall be invoked only by the service provider.

4.4.3.2.4 The transfer shall start with the most recently generated data, where the availability of new data generated by the production engine constitutes the 'data available' event (see table 4-10).

4.4.3.2.5 Data units shall be transmitted in the sequence in which they are generated.

4.4.3.2.6 While the underlying communications service does not accept data units for transfer because of to backpressure, the affected data units shall be discarded.

NOTE – Backpressure may be caused by a congested communication link or by a user application that does not accept the data units at the rate at which they are generated.

4.4.3.3 Stopping

4.4.3.3.1 The service user shall invoke the STOP operation.

4.4.3.3.2 If the service provider accepts the STOP invocation

- a) it shall stop sending TRANSFER-DATA invocations;
- b) it shall send the STOP return.

4.4.3.4 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by:

- a) stopping transmitting TRANSFER-DATA invocations;
- b) releasing the resources.

4.4.4 REQUIRED OPERATIONS

Table 4-8: Unbuffered Data Delivery Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/ Non-Blocking
START	Common	N	N	Blocking
STOP	Common	N	N	Blocking
TRANSFER-DATA	Common	N	N	Non-Blocking

4.4.5 CONFIGURATION PARAMETERS

The Unbuffered Data Delivery procedure does not have any configuration parameters.

NOTE – Consequently the Unbuffered Data Delivery procedure has neither any configuration parameter that can be read by a service using this procedure nor any parameter that can be changed dynamically while the service instance executing the Unbuffered Data Delivery procedure instance is bound.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.4.6 PROCEDURE STATE TABLE

Table 4-9: Unbuffered Data Delivery Procedure State Table

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(StartInvocation)	IF “positive result” THEN (+StartReturn) → 2 ELSE (-StartReturn) ENDIF	‘procedure to association abort ‘protocol error” → 1
2	(StopInvocation)	‘procedure to association abort ‘protocol error”	IF “positive result” THEN (+StopReturn) → 1 ELSE (-StopReturn) ENDIF
3	‘data available’	Not applicable	IF NOT “backpressure” THEN ‘send data to underlying communications service’ ELSE ‘discard data’ ENDIF
4	‘invalid PDU’	‘procedure to association abort ‘protocol error”	‘procedure to association abort ‘protocol error” → 1
5	‘terminate procedure’	‘terminate itself’	‘terminate itself’

Table 4-10: Procedure State Table Incoming Event Description References

Event	Reference
‘data available’	4.4.3.2.4
‘invalid PDU’	3.2.3.6
‘terminate procedure’	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND

Table 4-11: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
“positive result”	All checks on the invocation are passed.

Table 4-12: Procedure State Table Boolean Flags

Flag	Set to TRUE if
"backpressure"	The underlying communications service does not accept the data unit to be transferred because of backpressure.

Table 4-13: Procedure State Table Simple Action References

Name	References
'send data to underlying communications service'	4.4.3.2.1
'discard data'	4.4.3.2.6
'procedure to association abort 'xxx''	Raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure. 4.2.2.3
'terminate itself'	4.4.3.4

4.5 BUFFERED DATA DELIVERY

4.5.1 VERSION NUMBER

The version number of this procedure is 1.

4.5.2 DISCUSSION

4.5.2.1 Purpose

The Buffered Data Delivery procedure is intended to be used for the development of services that transfer bulk data from a service provider to a service user. The data to be delivered is structured into delimited data units by a service production process. These data units are either:

- a) service production data units, which contain data obtained from a service production process; or
- b) service production event notifications, which contain information related to changes in the status of the production process.

The Buffered Data Delivery procedure is suitable for transfer of data under either of the following conditions, which are typical of space mission operations:

- a) The service user requires delivery of the most-recent data available. Some data may be discarded and thus not sent to the user, if necessary to maintain timeliness when communication backpressure occurs.
- b) The service user requires delivery of all data requested. Delayed delivery is acceptable, if necessary to provide complete delivery of data when communication backpressure occurs.

For this purpose, the procedure allows the service instance to be configured to operate in one of the following delivery modes:

- a) real-time;
- b) complete.

NOTE – Strictly speaking, the delivery mode is a characteristic of the Buffered Data Delivery procedure rather than a characteristic of a service instance using this procedure. However, given that `delivery-mode` is a service management parameter that cannot be dynamically modified and given further that Service Management configures the service management parameters of all instances of a procedure type equally (see 2.3), all Buffered Data Delivery procedure instances associated with a given service instance will operate in the same delivery mode. Therefore one can also associate the service instance with that delivery mode.

4.5.2.2 Concept

4.5.2.2.1 Overview

The Buffered Data Delivery (BDD) procedure supports either of the following delivery modes:

- a) **real-time**—the service provider ensures that blocks containing the desired minimum number of the most recent consecutive data units are transferred with a specified maximum latency; if that latency were exceeded, such blocks of data units are discarded and the service user is notified.
- b) **complete**—the service provider transfers previously recorded data accepting potentially high latency in case backpressure on the ground link does not allow transferring the data in a timely manner or the service user requested the delivery after the data generation had happened. The service provider ensures that no data is discarded.

The complete delivery mode has the following objectives:

- a) data retrieved from the recording buffer are delivered to the service user;
- b) data units and event notifications are always delivered in sequence without discarding data.

The BDD procedure reacts to changes of the service production status. Service production status always refers to the production status of the service at the time the service instance using for instance the BDD procedure is bound. If the procedure is used in real-time delivery mode, this is then also reflects the status of the production process generating the data to be delivered to the service user. In complete mode, the production process generating the data may take place at a time when the service instance using the BDD procedure does not even exist. Nonetheless problems during the production may arise resulting for instance in missing data. Depending on the local implementation of the Functional Resources involved in the production process, they may report events regarding changes of the resource status and these events may be stored together with the to be delivered data in the recording buffer. During the data delivery to the user, the service may evaluate the previously recorded resource status change events and derive from them some aggregate status which may then be notified to the user and explain for instance why certain data are missing. Such status derived from previously stored events is different from the service production status.

The service user can stop the data transfer at any time by invoking the STOP operation.

The formal specification of the delivery modes is provided in 4.5.3.

NOTES

- 1 Transfer of data in real-time delivery mode implies that data units are transmitted as soon as possible after their generation by an ongoing service production session.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 2 Transfer of previously recorded data in complete delivery mode implies that data units are retrieved from a storage filled by an ongoing service production session or by service production sessions terminated in the meantime.
- 3 The delivery mode to be applied to a given service instance needs to be defined by the service using this procedure or by a derived procedure or may be delegated to Service Management.

The operations used by this procedure allow a service user to interact with a service provider to:

- a) request the start of the data transfer, specifying the selection criteria of the data to be transferred;

NOTE – Apart from the start and stop generation times that are included in the START invocation, the specification of the selection criteria of the data depends on the specific service or the derived procedure and is not defined by this procedure.

- b) receive the data units that meet the service user's selection criteria;
- c) receive, synchronized with the transfer of data units, notifications on events that have a direct impact on the production and/or delivery of data units;
- d) stop and optionally later re-start the delivery of data units applying the same or a different selection.

An event that may result in an event notification is:

- a) discardable: in case of backpressure affecting the communications service, notifications reporting such event will be discarded; or
- b) non-discardable: the notifications reporting such events are not discarded and delivery to the service user is ensured.

NOTES

- 1 If a derived procedure introduces events in addition to those specified in 4.5.4.2.2.1.1, then this derived procedure will have to classify those events as discardable or non-discardable.
- 2 In complete delivery mode, all data units and event notifications are delivered to the service user, and therefore the distinction of discardable and non-discardable events is not relevant.

4.5.2.2.2 Buffering

4.5.2.2.2.1 General

As to achieve the characteristics of the real-time and complete delivery modes, the Buffered Data Delivery procedure uses two buffering mechanisms, the return buffer and the recording buffer. A return buffer, as shown in figure 4-1, is used by any instance of the Buffered Data Delivery procedure or a procedure derived from it to prepare data for the transfer to the Service User, regardless of the delivery mode.

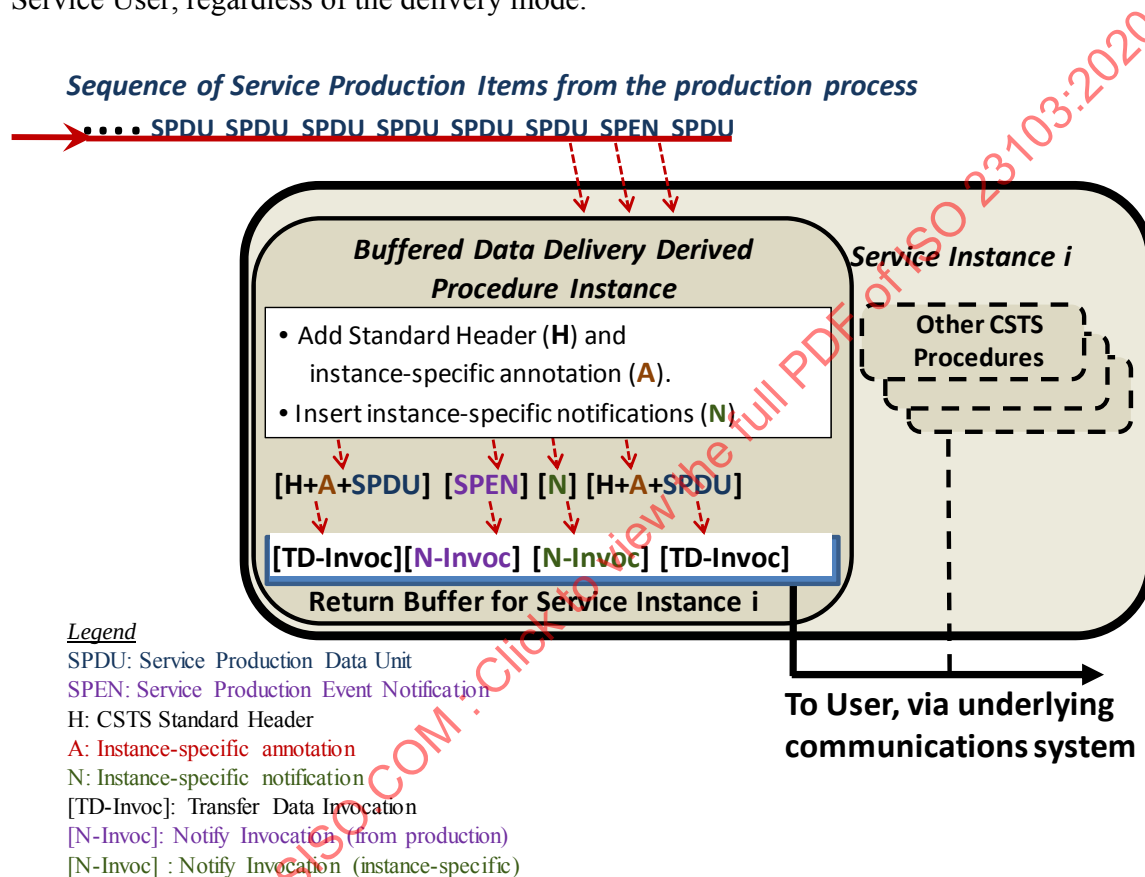


Figure 4-1: Services Using a Buffered Data Delivery Procedure

The recording buffer is used to store service production items for subsequent delivery by instances of services operating in complete delivery mode. Figure 4-2 shows both real-time and complete delivery mode service instances, and the use of the recording buffer for providing data to service instances in complete delivery mode.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

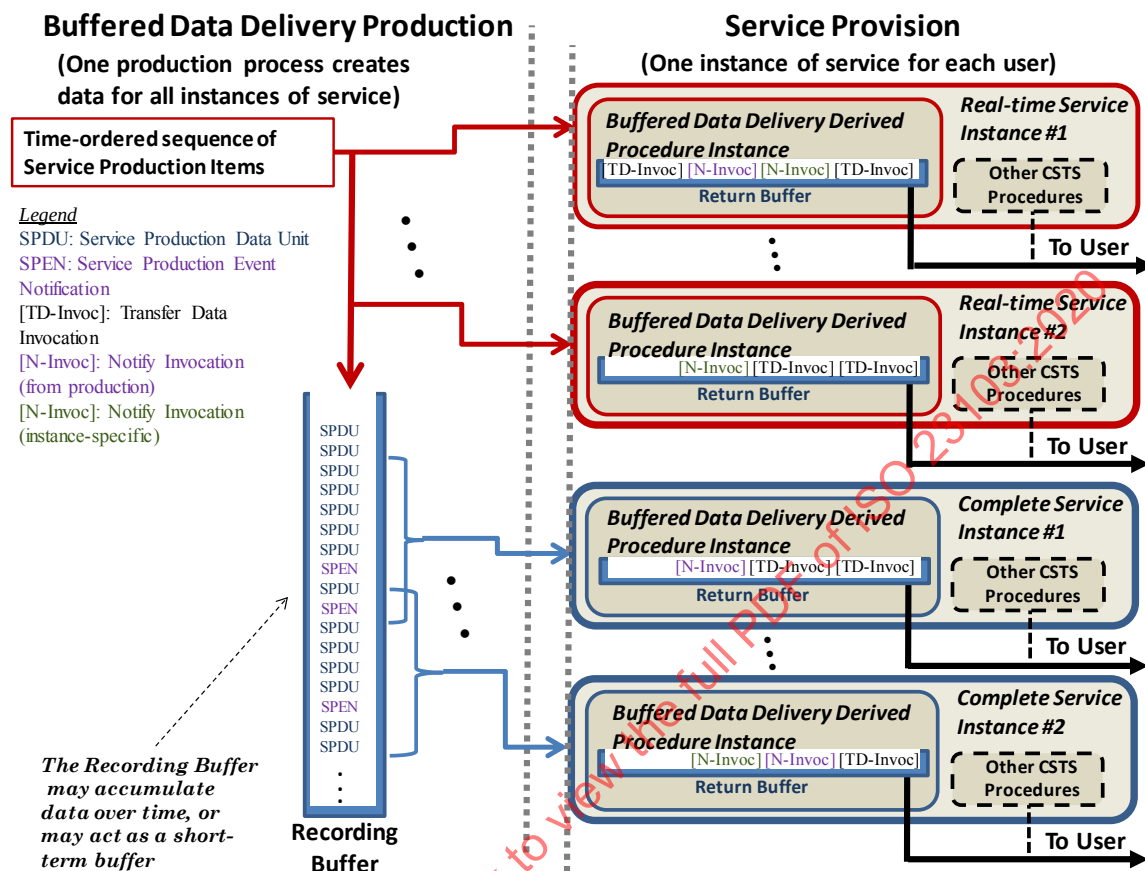


Figure 4-2: Real-Time and Complete Buffered Data Delivery Service Instances and Supporting Buffering Mechanisms

NOTE – For convenience, the following subsections are written as if:

- the contents of the recording buffer consisted of a list of data units which are either service production data units or service production event notifications; and
- the contents of the return buffer consisted of an ordered list of data units which are either service production data units or service production event notifications.

However, this is not intended to constrain how the recording and return buffers are implemented in a real system. It is sufficient that a real system provides the externally visible behaviors that are specified herein.

4.5.2.2.2.2 Return Buffer

Each instance of a Buffered Data Delivery procedure or a procedure derived from it has a dedicated return buffer, which is used to accumulate data prior to the transfer to the service user. For each service production data unit, such procedure adds the Standard Operation Header and other parameters as applicable to create a TRANSFER-DATA invocation (see 3.9). For each service production event notification, such procedure adds the Standard Operation Header and other parameters as applicable to create a NOTIFY invocation. These invocations are inserted into the return buffer in the sequence in which they were generated.

The Buffered Data Delivery procedure or a procedure derived from it may also generate instance-specific notifications in the form of NOTIFY invocations to inform the service user of events or conditions that pertain only to the given instance of this procedure. A service using a Buffered Data Delivery procedure or a derived procedure and requiring such notifications needs to specify the events that trigger the generation of such procedure type specific notifications. It may also specify that multiple notifications of persistent conditions or recurring events are not to be sent in the absence of a to-be-transferred TRANSFER-DATA invocation and/or NOTIFY invocation.

The details of how the return buffer is used by a given instance of the Buffered Data Delivery procedure are specified in 4.5.3.2, 4.5.3.3 and 4.5.3.4.

4.5.2.2.2.3 Recording Buffer

Since the complete delivery mode is intended to deliver all data, even in the case of extended communications service outages or backpressure, or even several days after the service production session, extensive buffering is required. The recording buffer is intended to hold all service production data units and service production event notifications for significant periods of time.

A single instance of a recording buffer type may be shared by multiple instances of the service that share the service production resources that generate the type of data stored by that recording buffer type.

The recording buffer specification in terms of normative behavior, queriable parameters and notifiable events common to all recording buffer types is provided in 4.5.7. Procedures derived from the BDD procedure may extend this recording buffer specification as required by the service using such procedure.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.5.3 BEHAVIOR**4.5.3.1 Starting**

4.5.3.1.1 The service user shall initiate the transfer of data using the START operation including the selection criteria.

NOTE – The only selection criteria specified for this procedure are the start and end generation times (see 4.5.4.1).

4.5.3.1.2 The service provider shall reject the START operation with the diagnostic value ‘out of service’ if `production-status` is ‘halted’; otherwise the service provider shall perform the START operation.

4.5.3.2 Transferring Data and Notifications

NOTE – Subsection 3.9.2.2.4.3 stipulates that a procedure using the TRANSFER-DATA operation refines or extends the `data` parameter of that operation. The Buffered Data Delivery procedure does not do that. The `data` syntax definition is left to a derived procedure or the service using this procedure.

4.5.3.2.1 Upon successful completion of the START operation the service provider shall initialize the return buffer and insert the data that conform to the selection criteria in the form of TRANSFER-DATA and/or NOTIFY invocations into the return buffer as the data become available from the service production process or from the data retrieval from the recording buffer.

4.5.3.2.2 The service provider shall set the value of the `sequence-counter` parameter of the first TRANSFER-DATA invocation to be inserted into the return buffer to 0 as per 3.9.2.2.3.1.

4.5.3.2.3 The service provider shall handle the value of the `sequence-counter` as per 3.9.2.2.3.

4.5.3.2.4 Upon successful completion of the START operation, the service provider shall inform the service user about events affecting the production or the transfer of the data by means of the NOTIFY operation.

4.5.3.2.5 All data and events shall be delivered in the order in which they were generated.

4.5.3.2.6 The service provider shall act in accordance with the applicable delivery mode.

4.5.3.2.7 The TRANSFER-DATA and NOTIFY invocations shall be inserted into the associated return buffer of the Buffered Data Delivery procedure only while the procedure state is ‘active’.

4.5.3.2.7.1 At the time of insertion of a TRANSFER-DATA or NOTIFY invocation into an empty return buffer, the service provider shall start a timer called the release timer.

4.5.3.2.7.2 The duration from the time that the release timer is started until it expires is given by the **delivery-latency-limit** parameter, the value of which is configured by the service using this procedure or by a derived procedure.

4.5.3.2.7.3 For a given instance of the service, the return buffer shall accommodate a set number of TRANSFER-DATA and/or NOTIFY invocations. That number, given by the **ReturnBufferSize** parameter, is initially configured by the service using this procedure or by a derived procedure based on the procedure's **return-buffer-size** parameter.

4.5.3.2.7.4 The contents of the return buffer shall be passed to the communications service (in the form of one **ReturnBuffer** PDU) as soon as one of the following conditions is met:

- a) the buffer becomes full, i.e., the number of TRANSFER-DATA and/or NOTIFY invocation contained in the buffer is equal to the value of the **ReturnBufferSize** parameter;
- b) the release timer expires;
- c) one of the notifications 'end of data', 'production status change', 'production configuration change', or 'buffered data delivery configuration change' is inserted into the return buffer; or
- d) the service user invokes the STOP operation.

4.5.3.2.7.5 The **ReturnBuffer** PDU shall contain the TRANSFER-DATA and NOTIFY invocations in the same sequence as they were inserted into the return buffer.

4.5.3.2.8 The insertion of invocations into the return buffer shall end when one of the following occurs:

- a) no further data or notification meeting the selection criteria specified in the START invocation are available;
- b) data and/or notifications provided by service production have a generation time that is later than the **stop-generation-time** in the START invocation; however, in this case the 'end of data' notification is still to be inserted into the return buffer (see 4.5.3.2.9);
- c) STOP is invoked by the service user;
- d) the association is aborted.

4.5.3.2.9 In case the generated data contains a generation time that is later than the **stop-generation-time** in the START invocation, an 'end of data' notification shall be generated and inserted into the return buffer.

4.5.3.2.10 Further conditions triggering the 'end of data' notification may be defined by derived procedures.

NOTE – The definition of such conditions is in particular needed when the real-time delivery mode is used and the **stop-generation-time** may be 'undefined'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.5.3.3 Transferring Data and Notifications (Real-Time Delivery Mode)

4.5.3.3.1 Having built a TRANSFER-DATA invocation from the data received from service production ready for insertion into the return buffer constitutes the 'data available' event (see 4.5.6).

4.5.3.3.2 A NOTIFY invocation shall be built and inserted into the return buffer whenever one of the events 'end of data', 'production status change', 'production configuration change' or 'buffered data delivery configuration change' triggers.

4.5.3.3.3 Insertion of invocations into the return buffer shall begin with:

- a) the most recent data or notification with a generation time equal to or later than the time specified in the `start-generation-time` parameter in the START invocation; or
- b) if the `start-generation-time` parameter in the START invocation is not set, with the most recent data or notification with a generation time equal to or later than the time at which the positive START return has been sent by the service provider.

4.5.3.3.4 The service provider shall insert notifications into the return buffer after the last data generated before the event occurrence and before the first data generated after the event.

NOTE – Such synchronous insertion of notifications is performed upon production status changes and according to further events being part of the procedure and/or service definition.

4.5.3.3.5 If the underlying communications service generates backpressure, i.e., if the communications service does not accept the ReturnBuffer PDU and the ReturnBuffer PDU does not contain an 'end of data' notification, the service provider shall:

- a) discard this ReturnBuffer PDU;
- b) clear the return buffer with the exception of notifications associated with non-discardable events;
- c) insert a 'data discarded due to excessive backlog' notification at the top of the return buffer;
- d) increase the size of the return buffer (`ReturnBufferSize`) by one plus the number of notifications of non-discardable events; that new size shall remain in effect until the contents of the return buffer are passed to the communications service, after which `ReturnBufferSize` shall be reverted to the original size as configured via the `return-buffer-size` parameter.

NOTE – The temporary increase of the `ReturnBufferSize` ensures a minimum of data flow in case of backpressure. Otherwise, only 'data discarded due to excessive backlog' and non-discardable event notifications might be sent.

4.5.3.4 Transferring Data and Notifications (Complete Delivery Mode)

4.5.3.4.1 Having built a TRANSFER-DATA or NOTIFY invocation from the data retrieved from the recording buffer ready for insertion into the return buffer constitutes the 'data read from recording buffer' event (see 4.5.6).

4.5.3.4.2 A NOTIFY invocation shall be built and inserted into the return buffer whenever one of the events 'end of data', 'production status change', 'production configuration change', or 'buffered data delivery configuration change' triggers.

4.5.3.4.3 Insertion of invocations into the return buffer shall begin with the first data or notification generated at or after the time specified by the `start-generation-time` parameter in the START invocation and stored in the recording buffer.

4.5.3.4.4 Subsequent data units and notification records shall be retrieved from the recording buffer and inserted into the return buffer in the same order in which they were originally generated or received.

NOTE – Recording itself is outside the scope of the Buffered Data Delivery procedure. However, the key characteristics of a recording buffer suitable for this procedure are outlined in 4.5.2.2.2.3 and formally specified in 4.5.7.

4.5.3.4.5 When the underlying communications service has accepted the `ReturnBuffer` PDU, the service provider shall clear the return buffer and resume retrieving data and notifications from the recording buffer as described above.

4.5.3.5 Stopping

4.5.3.5.1 The service user shall invoke the STOP operation.

4.5.3.5.2 If the service provider accepts the STOP invocation:

- a) it shall stop inserting TRANSFER-DATA and NOTIFY invocations into the return buffer;
- b) it shall immediately build from the return buffer contents a `ReturnBuffer` PDU and shall keep attempting to pass that `ReturnBuffer` PDU to the underlying communications service until it is accepted;
- c) it shall send the STOP return.

NOTE – In the case the return buffer cannot be transmitted within a reasonable time, the return buffer may be discarded as the service user is expected to invoke a PEER-ABORT as soon as the return timer expires.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.5.3.6 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the Buffered Data Delivery procedure shall terminate by:

- a) stopping the insertion of invocations into the return buffer;
- b) stopping the extraction of data and events from the recording buffer in case of complete delivery mode;
- c) clearing the return buffer, stopping the release timer, stopping all return timers and releasing associated resources.

4.5.4 REQUIRED OPERATIONS**Table 4-14: Buffered Data Delivery Procedure Required Operations**

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
START	Common	Y	N	Blocking
STOP	Common	N	N	Blocking
TRANSFER-DATA	Common	N	N	Non-Blocking
NOTIFY	Common	Y	N	Non-Blocking

4.5.4.1 START (Confirmed)**4.5.4.1.1 General**

The Buffered Data Delivery procedure shall extend the START operation defined in 3.7.2 by adding two parameters to the invocation and by adding values to the diagnostic parameter of the return.

4.5.4.1.2 Operation Parameters Definitions

NOTE – Table 4-15 shows the extension parameters of the START operation defined by this procedure.

Table 4-15: START Extension Parameters

Extension Parameters	Invocation	Return
start-generation-time	M	
stop-generation-time	M	

4.5.4.1.2.1 Extension Parameters Syntax

4.5.4.1.2.1.1 The type `BuffDataDelStartInvocExt`, as defined in F4.7, shall specify the syntax of the extension parameters of the START invocation.

4.5.4.1.2.1.2 The type `BuffDataDelStartDiagnosticExt`, as specified in F4.7, shall define the additional values of the diagnostic parameter of the START return.

4.5.4.1.2.2 start-generation-time

4.5.4.1.2.2.1 For the real-time delivery mode, if `start-generation-time` is 'undefined', the data transfer shall begin with the next data unit that is acquired from the data acquisition process.

4.5.4.1.2.2.2 For the real-time delivery mode, `start-generation-time` when not 'undefined' must satisfy the following criteria:

- a) `start-generation-time` must be equal to or later than the start time of the service instance provision period for this service instance;
- b) `start-generation-time` must be earlier than the end time of the service instance provision period for this service instance;
- c) if `stop-generation-time` and `start-generation-time` are not 'undefined', `start-generation-time` must be earlier than `stop-generation-time` (see 4.5.4.1.2.3).

4.5.4.1.2.2.3 For the complete delivery mode, the service provider shall deliver all available data that meet the delivery criteria regardless of the service production session in which they were acquired.

4.5.4.1.2.2.4 For the complete delivery mode, `start-generation-time` must not be set to 'undefined'.

4.5.4.1.2.2.5 For the complete delivery mode, `start-generation-time` must be earlier than `stop-generation-time` (see 4.5.4.1.2.3).

4.5.4.1.2.3 stop-generation-time

4.5.4.1.2.3.1 For the real-time delivery mode, if `stop-generation-time` is 'undefined', the service provider shall continue to transfer all data that are acquired from the service production session and satisfy the delivery criteria until either the service user invokes a STOP operation, the production terminates, or the association is released or aborted.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.5.4.1.2.3.2 For the real-time delivery mode, **stop-generation-time** must satisfy the following criteria:

- a) **stop-generation-time**, if not 'undefined', must be later than **start-generation-time**;
- b) **stop-generation-time**, if not 'undefined', must be earlier than or equal to the end time of the service instance provision period for this service instance.

4.5.4.1.2.3.3 For the complete delivery mode, **stop-generation-time** must satisfy the following criteria:

- a) it must not be 'undefined';
- b) it must be later than **start-generation-time**;
- c) it must be earlier than or equal to the end time of the service instance provision period for this service instance.

4.5.4.1.3 diagnostic Parameter Extension Value Definitions

If a negative START return is sent, the **diagnostic** parameter shall use one of the **diagnostic** values specified in 3.7.2.3, or one of the following values:

- a) 'missing time value'—for the complete delivery mode, the value of **start-generation-time** or **stop-generation-time** is 'undefined';
- b) 'invalid start generation time'—the value of **start-generation-time** provided in the invocation is not valid;
- c) 'invalid stop generation time'—the value of **stop-generation-time** provided in the invocation is not valid;
- d) 'inconsistent time'—the value of **start-generation-time** is later than the value of **stop-generation-time**.

4.5.4.2 NOTIFY (Unconfirmed)

4.5.4.2.1 General

The Buffered Data Delivery procedure shall extend the NOTIFY operation defined in 3.11 by adding four permissible Event Identifiers to the **event-name** parameter.

4.5.4.2.2 Invocation and Parameters

4.5.4.2.2.1 event - name Extension

4.5.4.2.2.1.1 The value of the event - name shall be one of the following:

- a) one of the values specified for the common NOTIFY operation in 3.11.2.2.3;

NOTE – The notifications specified in the common NOTIFY are discardable for the Buffered Data Delivery procedure.

- b) ‘data discarded due to excessive backlog’ (event-name)—some data was discarded by the service provider because of timeliness considerations (real-time delivery mode);
 - 1) the event-name of this event shall contain the Functional Resource Name of the service triggering the event;
 - 2) unless otherwise specified by the service using that procedure or by a derived procedure, the associated event-value shall be empty;
 - 3) this notification is discardable;
- c) ‘bdd recording buffer overflow’ (event-name)—some data may have been lost because during the service production session a recording buffer overflow occurred and therefore recording of service production data stopped; this event applies only to complete delivery mode (see 4.5.7.5);
 - 1) the event-name of this event shall contain the Functional Resource Name of the Functional Resource modeling the recording buffer;
 - 2) unless otherwise specified by the service using that procedure or by a derived procedure, the associated event-value shall be empty;

NOTES

- 1 Each recording buffer generates a ‘bdd recording buffer overflow’ event notification when the overflow event occurs and stores it for subsequent retrieval by BDD-using CSTSes operating in complete delivery mode. When a BDD procedure instance reads the overflow event notification from the recording buffer that procedure creates a NOTIFY invocation that reports to the user of a service containing such procedure that a recording buffer overflow had occurred during the production process.
- 2 In addition to storing a ‘bdd recording buffer overflow’ event notification for subsequent retrieval by a BDD-using CSTS, the recording buffer Functional Resource also emits an ‘fr recording buffer overflow’ notifiable event that triggers when the recording buffer overflow occurs. Services containing procedures with NOTIFY operations capable of subscribing to real-time

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

events (e.g., the Notification procedure) may subscribe to the 'fr recording buffer overflow' event and will then be notified of the occurrence in real time (see 4.5.7.5).

- d) 'end of data' (**event - name**)—the service provider has no more data to send;
 - 1) as stated in 4.5.3.2.10 the conditions triggering the 'end of data' insertion in addition to the condition specified in 4.5.3.2.9 shall be defined by the service using that procedure or by the derived procedure;
 - 2) the **event - name** of this event shall contain the Functional Resource Name of the service triggering the event;
 - 3) the associated **event - value** shall be empty;
 - 4) this notification is non-discardable;
- e) 'buffered data delivery configuration change' (**event - name**)—a dynamic modification of the **return-buffer-size** parameter or the **delivery-latency-limit** parameter has occurred:
 - 1) the **event - name** of this event shall contain the procedure instance identifier of the procedure instance in which the event occurs;
 - 2) the associated **event - value** shall contain the current values of the **return-buffer-size** and **delivery-latency-limit** parameters;
 - i) the first part of the path specifying the type to be used is 'NotifyInvocation':
 'eventValue': 'EventValue': 'qualifiedValues':
 'SequenceOfQualifiedValues': 'SEQUENCE OF QualifiedValues' where this sequence has the length 2;
 - ii) the first element of this sequence shall report the **return-buffer-size** and the second element the **delivery-latency-limit**; for each of the two parameters the following shall apply: if the qualifier of the to-be-reported value is not 'valid', then the second part of the path is one of the following:
 - (a) 'QualifiedValues': 'unavailable': 'NULL';
 - (b) 'QualifiedValues': 'undefined': 'NULL'; or
 - (c) 'QualifiedValues': 'error': 'NULL';
 - iii) If the qualifier of the to-be-reported value is 'valid', then the second part of the path is 'QualifiedValues': 'valid': 'TypeAndValueComplexQualified':
 'typeAndValue': 'integerPositive': 'SEQUENCE OF IntPos', where this sequence shall have the length 1;

NOTE — All relevant types are defined in F4.3.

- 3) This notification is discardable.

NOTE – A change of the configuration of a procedure can only be accomplished by invoking the associated directive by means of the EXECUTE-DIRECTIVE operation. Although the notification reporting the procedure configuration change may be discarded, the service user is nonetheless informed of the configuration change by the EXECUTE-DIRECTIVE return.

4.5.4.2.2.1.2 The Published Identifiers for the above defined new Event Identifier values are specified in F4.16 as pBDDdataDiscardedExcessBacklog, pBDDrecordingBufferOverflow, pBDDendOfData, and pBDDconfigurationChange, respectively.

NOTE – The end of data to be transferred is notified to the service user (see 4.5.4.2), but does not stop the procedure. The service user is expected to terminate the procedure by invoking the STOP operation when receiving this notification.

4.5.4.2.2.2 notification-invocation-extension Extension

The NOTIFY invocation is not further extended and therefore notification-invocation-extension shall be set to 'notUsed'.

4.5.5 CONFIGURATION PARAMETERS

The Buffered Data Delivery procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-16.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and Type to be used in reporting the value of the parameter.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-16: Buffered Data Delivery Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Dynamically modifiable	Configuration Parameter Identifier and Type (F4.16)
return-buffer-size (in number of TRANSFER-DATA and/or NOTIFY invocations the buffer will accommodate)	4.5.3.2.7.3	Yes	Yes	pBDDreturnBufferSize PBDDreturnBufferSizeType
delivery-latency-limit (in seconds)	4.5.3.2.7.2	Yes	Yes	pBDDdeliveryLatencyLimit PBDDdeliveryLatencyLimitType
delivery-mode	4.5.2.2.2.1, 4.5.3.2.6	Yes	No	pBDDdeliveryMode PBDDdeliveryModeType

NOTE – A notification of the occurrence of the pBDDconfigurationChange when the BDD procedure is operating in real time delivery mode will be inserted into the return buffer by that procedure. A delay in reporting of this event is kept to a minimum in that the return buffer is released to the underlying communications service as soon as such notification is inserted into the return buffer. However, that notification may be discarded in case of backpressure on the link to the CSTS user. If the service using the Buffered Data Delivery procedure shall ensure that this event is notified to the service user rather than possibly being discarded, the service must also use a procedure that contains a NOTIFY operation and will regardless of potential backpressure never discard a notification. For example, the service could use the Notification procedure, through which the user could subscribe to the pBDDconfigurationChange event.

4.5.6 PROCEDURE STATE TABLE

Table 4-17: Buffered Data Delivery Procedure State Table

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(StartInvocation)	IF “positive result” THEN (+StartReturn) → 2 ‘initialize return buffer’ Set “data ended” to FALSE ELSE (-StartReturn) ENDIF	‘procedure to association abort ‘protocol error’’ → 1
2	(StopInvocation)	‘procedure to association abort ‘protocol error’’	IF “positive result” THEN IF (NOT “buffer empty”) THEN {pass buffer contents} ENDIF Set “data ended” to FALSE ‘stop all return timers’ (+StopReturn) → 1 ELSE (-StopReturn) ENDIF
3	‘data available’	Not applicable	IF “return buffer full” THEN {pass buffer contents} IF “backpressure” THEN ‘Increment buffer size’ ‘notify ‘data discarded’’ ‘copy non-discardable notifications’ ENDIF ‘Insert data in return buffer’ {init and start release timer} ELSE IF “buffer empty” THEN {init and start release timer} ENDIF ‘insert data in return buffer’ IF “return buffer full” THEN {attempt pass buffer contents} ENDIF ENDIF
4	‘data read from recording buffer’	Not applicable	IF “buffer empty” THEN {init and start release timer} ENDIF ‘insert data in return buffer’ IF “return buffer full” THEN {transmit buffer} ENDIF
5	‘real-time, release timer expired’	Not applicable	{pass buffer contents} IF “backpressure” THEN ‘Increment buffer size’ ‘notify ‘data discarded’’ ‘copy non-discardable notifications’ {init and start release timer} ENDIF

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
6	‘complete, release timer expired’	Not applicable	{transmit buffer}
7	‘end of data’	Not applicable	IF not “data ended” THEN ‘notify ‘end of data’ {transmit buffer} Set “data ended” to TRUE ENDIF
8	‘production status change’ [when Buffered Data Delivery procedure is in real-time delivery mode]	Not applicable	IF “return buffer full” THEN {pass buffer contents} IF “backpressure” THEN ‘Increment buffer size’ ‘notify ‘data discarded’ ‘copy non-discardable notifications’ ENDIF ENDIF ‘notify ‘production status change’ in return buffer {attempt pass buffer contents}
9	‘production status change’ [when Buffered Data Delivery procedure is in complete delivery mode]	Not applicable	‘notify ‘production status change’ in return buffer {transmit buffer}
10	‘production configuration change’ [when Buffered Data Delivery procedure is in real-time delivery mode]	Not applicable	IF “return buffer full” THEN {pass buffer contents} IF “backpressure” THEN ‘Increment buffer size’ ‘notify ‘data discarded’ ‘copy non-discardable notifications’ ENDIF ENDIF ‘notify ‘production configuration change’ in return buffer {attempt pass buffer contents}
11	‘production configuration change’ [when Buffered Data Delivery procedure is in complete-time delivery mode]	Not applicable	‘notify ‘production configuration change’ in return buffer {transmit buffer}
12	‘buffered data delivery configuration change’ [when Buffered Data Delivery procedure is in real-time delivery mode]	Not applicable	IF “return buffer full” THEN {pass buffer contents} IF “backpressure” THEN ‘Increment buffer size’ ‘notify ‘data discarded’ ‘copy non-discardable notifications’ ENDIF ENDIF ‘notify ‘buffered data delivery configuration change’ in return buffer {attempt pass buffer contents}
13	‘buffered data delivery configuration change’ [when Buffered Data Delivery procedure is in complete delivery mode]	Not applicable	‘notify ‘buffered data delivery configuration change’ in return buffer {transmit buffer}
14	‘invalid PDU’	‘procedure to association abort ‘protocol error’	‘procedure to association abort ‘protocol error’ → 1
15	‘terminate procedure’	‘terminate itself’	‘terminate itself’

Table 4-18: Procedure State Table Incoming Event Description References

Event	Reference
'data available'	4.5.3.3.1
'data read from recording buffer'	4.5.3.4.1
'end of data'	4.5.3.2.7.4, 4.5.3.2.8, 4.5.3.2.9, 4.5.3.2.10, 4.5.4.2.2.1.1
'production status change'	B2.4
'production configuration change'	3.11.2.2.3.2 b)
'buffered data delivery configuration change'	4.5.4.2.2.1.1
'real-time, release timer expired'	4.5.3.2.7.2
'complete, release timer expired'	4.5.3.2.7.2
'invalid PDU'	3.2.3.6
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND

Table 4-19: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"return buffer full"	The return buffer cannot accommodate the currently available data or notification.
"buffer empty"	The return buffer does not contain any data or notification.
"complete"	Delivery mode is complete.
"real-time"	Delivery mode is real-time.
"positive result"	All checks on the invocation are passed.

Table 4-20: Procedure State Table Boolean Flags

Flag	Set to TRUE if
"backpressure"	The underlying communications service does not accept the contents of the return buffer because of backpressure.
"data ended"	The service provider has sent the 'end of data' notification.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-21: Procedure State Table Simple Action References

Name	References
'increment buffer size'	4.5.3.3.5
'set release timer to delivery latency limit'	4.5.3.2.7.2
'start release timer'	4.5.3.2.7.4
'stop release timer'	4.5.3.6 c)
'stop all return timers'	4.5.3.6 c)
'initialize return buffer'	4.5.3.2.1
'copy non-discardable notifications'	4.5.3.3.5
'notify 'xxx''	4.5.3.2.4
'submit content of return buffer to underlying communications service'	4.5.3.2.7.4
'procedure to association abort 'xxx''	Raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure. 4.2.2.3
'insert data in return buffer'	4.5.3.2.7
'reinitialize return buffer using the nominal size'	4.5.3.3.5
'terminate itself'	4.5.3.6

Table 4-22: Procedure State Table Compound Action Definitions

Name	Actions Performed
{attempt pass buffer contents}	'submit contents of return buffer to underlying communications service' IF successful THEN 'stop release timer' 'reinitialize return buffer using the normal size' ENDIF
{pass buffer contents}	'stop release timer' 'submit contents of return buffer to underlying communications service' IF successful THEN set "backpressure" to FALSE ELSE set "backpressure" to TRUE ENDIF 'reinitialize return buffer using the normal size'
{init and start release timer}	'set release timer to delivery latency limit' 'start release timer'
{transmit buffer}	'stop release timer' 'submit the contents of return buffer to underlying communications service' until accepted by that service 'reinitialize return buffer using the nominal size'

4.5.7 REQUIREMENTS FOR RECORDING BUFFERS FOR USE BY THE BUFFERED DATA DELIVERY PROCEDURE

4.5.7.1 Each recording buffer type shall be represented by an associated Functional Resource Type. A CSTS type using the BDD procedure or a procedure derived from it shall specify the associated recording buffer type and the associated Functional Resource Type and its Object Identifier.

NOTE – The Functional Resource Type shall be registered on the crossSupportFunctionalities subbranch of the OID tree structure (see figure 1-6). More information regarding the registration of derived recording buffer Functional Resources and the associated events and parameters can be found in reference [I3].

4.5.7.2 The time between data being inserted into the recording buffer by the production process and availability of this data for retrieval from this buffer for transfer to a service user shall be kept to a minimum.

4.5.7.3 Multiple service instances requiring access to data generated by the same production process shall be able to share the same recording buffer.

4.5.7.4 The production process shall continue inserting acquired service production data units and service production related events as emitted by the Functional Resources taking part in the production process in the form of 'resource status change' notifications into the recording buffer. This recording shall be performed as specified for the given recording buffer type (see 4.5.7.1) and as determined by the controlling service agreement and service package, regardless of the state of any service instance and regardless of whether an association with any service user is established.

NOTE – The events recorded in the recording buffer relate only to the recording buffer itself and to the production process that needs to be active as to produce the data that shall be stored in the recording buffer. Such events do not have any impact on the production status reported by the CSTS that at some point in time will retrieve the data of interest from the recording buffer. The CSTS production status always refers to the current status of the CSTS service instance. Typically the CSTSes that will transfer the data stored earlier in the recording buffer will not be bound or not even exist at the time the service production related events to be stored in the recording buffer occur. However, when a CSTS includes the BDD procedure or a procedure derived from it and the recording buffer type is specified to record events that may be notified by the Functional Resources modeling the production process filling the recording buffer, such CSTS may specify that the procedure used to read from the recording buffer shall extract such events from that buffer and report them or some aggregate events derived from them synchronously with the data. The derivation of aggregate events is never done by the recording buffer, but always by the CSTS instance. However, a CSTS regardless of its specification will only be able to provide such notifications if the local implementation of the Functional Resources modeling the production process emit the required event notifications.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.5.7.5 If the recording buffer overflows, the recording buffer shall

- a) store a 'bdd recording buffer overflow' event notification in the recording buffer (see 4.5.4.2.2.1.1 c)):
 - 1) the latest data unit previously stored on the recording buffer shall be deleted if that is necessary to have sufficient storage space for storing the 'bdd recording buffer overflow' event;
 - 2) following this event, no further service production data units shall be stored on the recording buffer;

NOTE – It is normally expected that the recording buffer is sufficiently large to hold all data that might be accumulated during several service production sessions. The time span over which data is retained in the recording buffer, the policy for deleting data from the recording buffer, and the conditions under which the recording buffer begins to accept data following an overflow condition are outside the scope of this Recommended Standard. In general, this may be specified by the CSTS using a specific recording buffer type or the service provider and service user will agree on a data custody transfer protocol.

- b) emit an 'fr recording buffer overflow' event.

NOTE – Given that the 'fr recording buffer overflow' event is notifiable, a service including the Notify procedure could subscribe to it. However, the production process and therefore filling of the recording buffer may take place well before a service instance that might subscribe to the event is bound. Such service instance might not even exist at the time the overflow occurs. In general it is therefore not useful if services using a recording buffer implement the capability to be notified of the recording buffer overflow in real-time.

4.5.7.6 The 'fr recording buffer overflow' event for each derived recording buffer Functional Resource Type shall be registered under the eventsId branch of the functionalResourceType Published Identifier for that derived recording buffer Functional Resource Type (see D6.2.3).

4.5.7.7 The Functional Resources that are relevant for the production process generating the data to be captured in a given recording buffer type should emit 'resource status change' and 'resource configuration change' event notifications which then will be stored in the recording buffer.

4.5.7.8 The CSTS specification shall specify the recording buffer type to be used for that service type and the Functional Resources of which the 'resource status change' and 'resource configuration change' event notifications shall be captured in the recording buffer. Such events shall be inserted into the recording buffer after the last data acquired before the occurrence of the event and before the first data acquired following the event.

NOTE – The kind of notifications addressed in 4.5.7.7 will not be defined as events of the Functional Resource representing the recording buffer, but as events notified by the individual Functional Resources being part of the production process.

4.5.7.9 If a BDD derived procedure extends the recording buffer Functional Resource to have buffer-operation-related events beyond the recording buffer overflow that are to be emitted in real-time, then those events shall be specified as notifiable events of the derived recording buffer Functional Resource and registered under the eventsId branch of the functionalResourceType Published Identifier for that derived recording buffer Functional Resource Type.

4.5.7.10 A Functional Resource Type representing a recording buffer shall have a queriable `recording-buffer-size` parameter that specifies the storage capacity of the recording buffer. The `recording-buffer-size` parameter for each derived recording buffer Functional Resource shall be registered under the parametersId branch of the functionalResourceType Published Identifier for that derived recording buffer Functional Resource Type (see D6.2.3).

NOTE – Given that the `recording-buffer-size` parameter is queriable, it is accessible to the GET operation as, e.g., contained in the Information Query procedure. In particular, monitoring of this parameter by the service including the Buffered Data Delivery procedure or a procedure derived from it is possible if that service includes a procedure containing the GET operation as does, e.g., the Information Query procedure.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.6 DATA PROCESSING

4.6.1 VERSION NUMBER

The version number of this procedure is 1.

4.6.2 DISCUSSION

4.6.2.1 Purpose

The purpose of the Data Processing procedure is to provide transfer of data units from the service user to the service provider for processing of the data units by the service provider. This procedure does neither define the data units being transferred, nor the processing to be performed by the service provider. It is assumed, however, that processing is part of service production and will be specified by the service using this procedure.

The Data Processing procedure is abstract and cannot be implemented directly because the specification is incomplete. To be implementable, derived procedures must provide the missing specifications.

4.6.2.2 Concept

The Data Processing procedure supports transfer of data units from the service user to the service provider by means of PROCESS-DATA operations. When the service provider receives a PROCESS-DATA invocation it stores the invocation on an Input Queue and processes the contained data unit as soon as possible. The service provider processes the data sequentially in the order transmitted by the service user, processing only one unit at any point in time. Derived procedures may specify more complex data processing behaviors.

The ability of the service provider to process the data depends on the production status described to more detail in annex B. If `production-status` is 'operational', the service provider is able to perform data processing; otherwise, the service provider is unable to perform data processing. As long as `production-status` is 'operational', the service provider removes PROCESS-DATA invocations from the Input Queue and processes the enclosed data unit; otherwise, PROCESS-DATA invocations already queued remain on the queue until `production-status` becomes 'operational', until the service user stops the procedure, or until the associated service instance is aborted or unbound.

The service provider will inform the service user by means of a NOTIFY operation if the production status changes and the procedure instance is in the 'active' state. However, change of `production-status` to 'interrupted' will only be reported when processing of a data unit is affected. If `production-status` changes to 'interrupted' while no PROCESS-DATA invocations are queued for processing, then there might be a chance that `production-status` reverts back to 'operational' before a PROCESS-DATA invocation is submitted by the service user for processing and therefore the transition is not notified.

Should `production-status` still be 'interrupted' when the next `PROCESS-DATA` operation is invoked by the service user, then the service provider will notify the service user of the transition of the production status to 'interrupted'. The notification has the purpose to make the service user aware that the processing of the data unit will be delayed until `production-status` becomes 'operational' and that the input queue might fill up if further `PROCESS-DATA` operations are invoked.

Successful completion of processing is reported to the service user by means of a `NOTIFY` operation only if a report has been explicitly requested for that data unit by the service user. As to enable requesting such report, this procedure has extended the `PROCESS-DATA` operation (see 4.6.4.1.4). Failure of processing is always notified to the service user.

In order to enable the identification of the data unit for which a report is issued, the `PROCESS-DATA` invocation that transfers the data unit also includes the `data-unit-id` parameter the value of which is used to refer to that data unit in notifications sent to the service user. The service user can freely choose the `data-unit-id` parameter value and the service provider does not check if the identification of the related data unit is unique. If such uniqueness is required, it has to be ensured by the service user.

The method by which the size of the Input Queue for incoming `PROCESS-DATA` operations is configured is defined by a derived procedure or by the service using this procedure, possibly delegating the definition to service management. Handling of a queue overflow condition is left undefined by this procedure and because such a condition cannot be excluded this procedure specification remains abstract and cannot be directly implemented. In order to be implementable, derived procedures must provide the missing specification.

As this procedure neither specifies the content of the data units transferred for processing nor the type of processing to be performed, it does not specify what processing failures can occur and shall be notified to the service user, with the exception of production status changes that affect processing of data units. If the occurrence of a failure causes more than one data unit to be discarded, then the service provider sends only a single notification. All `NOTIFY` operations issued include information from which the service user can derive the state of processing.

The service user can terminate processing of data units at any time by invocation of the `STOP` operation. When `PROCESS-DATA` invocations are still queued for processing at the time the `STOP` invocation is received, the service provider discards all `PROCESS-DATA` invocations stored in the queue, i.e., all invocations for which processing has not yet started, but the service provider completes processing of the data unit for which processing has already started if that is possible. The user can avoid inadvertent discarding of data units by requesting a processing report for the last data unit in the sequence and not invoking the `STOP` operation before that processing report has been received.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.6.3 BEHAVIOR**4.6.3.1 Starting**

4.6.3.1.1 The service user shall invoke the START operation to request that the service provider prepares to receive PROCESS-DATA invocations for processing.

4.6.3.1.2 The service provider shall reject the START operation with the diagnostic value 'out of service' if the `production-status` is 'halted'; otherwise the service provider shall perform the START operation.

4.6.3.2 Transfer and Queuing of PROCESS-DATA Invocations

4.6.3.2.1 The service user shall invoke the PROCESS-DATA operation for each data unit to be transferred to the service provider for processing.

4.6.3.2.2 The provider shall accept any value of the `data-unit-id` parameter received with a PROCESS DATA invocation and memorize it for later use in notifications related to the processing of the given data unit.

4.6.3.2.3 If the service provider receives a PROCESS-DATA invocation, then the invocation shall be queued until either processing of the enclosed data unit begins or the invocation is discarded.

NOTE – The Input Queue decouples the timing of the processing of the PROCESS-DATA invocations from the transfer of those invocations.

4.6.3.2.4 The size of the Input Queue for incoming PROCESS-DATA operations expressed as the number of PROCESS-DATA invocations the Input Queue can hold shall be defined using the `input-queue-size` procedure configuration parameter (see 4.6.5).

4.6.3.2.5 The service provider shall queue received PROCESS-DATA invocations regardless of the value of `production-status`.

NOTES

- 1 Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the `data` parameter of that operation. The Data Processing procedure does not do that. The `data` syntax definition is left to a derived procedure or the service using this procedure.
- 2 If the `production-status` is not 'operational' PROCESS-DATA invocations will not be processed (see 4.6.3.3) and the queue may fill up.
- 3 If the queue is full at the time the service provider receives a PROCESS-DATA invocation the behavior of the provider is not defined by this procedure. Because of this missing specification this procedure is abstract and cannot be directly implemented. To be implementable, derived procedures must provide the missing specification.

4.6.3.3 Processing of Data Units

4.6.3.3.1 The service provider shall remove PROCESS-DATA invocations from the Input Queue and process the data units included as soon as possible as long as **production-status** is 'operational'.

4.6.3.3.2 If **production-status** changes to a value other than 'operational' then the service provider shall suspend processing of data units until **production-status** changes to 'operational' again.

NOTES

1 Processing of data units for which processing has already started at the time **production-status** changes to 'interrupted' or 'halted' may fail and processing will not be resumed for that data unit (see 4.6.3.3.6).

2 PROCESS-DATA invocations for which processing has not started remain queued and will be processed when **production-status** changes to 'operational'.

4.6.3.3.3 The service provider shall process the data units sequentially in the order in which they were received.

NOTE – The term sequential processing as used here excludes all concurrency and in particular means that at most one data unit is being processed at any point in time.

4.6.3.3.4 The service provider shall invoke the NOTIFY operation to inform the service user of changes of **production-status** as further detailed by 4.6.3.5.

4.6.3.3.5 The **data-unit-id** parameter value of the PROCESS-DATA invocation shall be used as a reference to data units in any NOTIFY invocations sent by the service provider to the service user.

4.6.3.3.6 If a data unit has started but has not completed processing at the time **production-status** changes from 'operational' to 'interrupted' or 'halted' the service provider shall discard the data unit.

4.6.3.4 Positive Feedback

If the processing of a data unit completes successfully and if the value of the **process-completion-report** parameter (see 4.6.4.1.4) in the associated PROCESS-DATA invocation was 'produce report', the service provider shall notify the service user with Event Identifier 'data unit processing completed'.

NOTE – This procedure defines only one report to be issued when processing is completed. Derived procedures might define additional processing steps, the completion of which should be reported.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.6.3.5 Notifications**4.6.3.5.1 Notification of Production Status Changes**

4.6.3.5.1.1 The service provider shall notify the service user when **production-status** changes to ‘operational’ or ‘halted’ independent of the effect this change has on the processing of data units.

NOTE – When **production-status** changes to ‘halted’ this may imply that processing of a data unit fails; whether this is the case or not can be derived from the information provided in the notification.

4.6.3.5.1.2 If **production-status** changes to ‘interrupted’ at a time when a data unit has started processing but has not completed processing or when at least one **PROCESS-DATA** invocation is queued for processing the service provider shall invoke the **NOTIFY** operation with the **event-name** set to ‘production status change’ and the **event-value** to ‘interrupted’.

NOTES

- 1 Whether a data unit has started but not completed processing and will therefore be discarded can be derived from the information provided in the notification.
- 2 As specified in 4.6.3.3.2, the **PROCESS-DATA** invocations on the Input Queue for which processing has not started are not discarded and will be processed as soon as **production-status** changes to ‘operational’.

4.6.3.5.1.3 If **production-status** changes to ‘interrupted’ at a time when no **PROCESS-DATA** invocation is queued for processing the service provider shall not notify the service user.

NOTE – The **production-status** being ‘interrupted’ is considered transient in nature. The **production-status** may revert to ‘operational’ before the service user invokes the next **PROCESS-DATA** operation.

4.6.3.5.1.4 If **production-status** is ‘interrupted’ at the time the service provider receives a **PROCESS-DATA** invocation and the transition to ‘interrupted’ has not yet been reported, then the service provider shall queue the invocation and invoke the notification with the **event-name** set to ‘production status change’ and the **event-value** set to ‘interrupted’.

NOTE – The notification has the purpose to make the service user aware that the processing of the data unit will be delayed until **production-status** becomes ‘operational’ and that the Input Queue might fill up if further **PROCESS-DATA** operations are invoked.

4.6.3.5.2 Notification of Production Configuration Changes

The service provider shall notify the service user when the production configuration is changed (see 3.11.2.2.3.2 b) while the service is bound.

4.6.3.5.3 Notification of Procedure Configuration Changes

The service provider shall notify the service user when the value of a dynamically modifiable configuration parameter is changed while the service is bound.

4.6.3.6 Stopping

4.6.3.6.1 The service user shall invoke the STOP operation to inform the service provider that the service user is stopping the sending of PROCESS-DATA invocations.

4.6.3.6.2 When receiving a STOP invocation while there are PROCESS-DATA invocations in the service provider's Input Queue, the service provider shall:

- a) discard any PROCESS-DATA invocations for which processing has not yet started; notifications shall not be issued for the data units enclosed in those PROCESS-DATA invocations;
- b) complete processing of the data unit, if any, for which processing has already started.

NOTE – The procedure being stopped, the service provider cannot notify the service user when the remaining data unit completes processing.

4.6.3.7 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by:

- a) completing processing of any data unit for which processing has already started;
- b) discarding all PROCESS-DATA invocations for which processing has not yet started;
- c) discarding pending notifications;
- d) releasing the resources.

4.6.4 REQUIRED OPERATIONS

Table 4-23: Data Processing Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non- Blocking
START	Common	N	N	Blocking
STOP	Common	N	N	Blocking
PROCESS-DATA	Common	Y	N	Non-Blocking
NOTIFY	Common	Y	N	Non-Blocking

4.6.4.1 PROCESS-DATA (Unconfirmed)

4.6.4.1.1 General

The Data Processing procedure shall extend the PROCESS-DATA operation defined in 3.10 by adding one parameter to the invocation. The Data Processing procedure uses the unconfirmed variant of the PROCESS-DATA operation.

4.6.4.1.2 Operation Parameters Definitions

NOTE – Table 4-24 shows the extension parameters of the PROCESS-DATA operation defined by this procedure.

Table 4-24: PROCESS-DATA Extension Parameter

Extension Parameters	Invocation
process-completion-report	M

4.6.4.1.3 Extension Parameters Syntax

The type DataProcProcDataInvocExt, as defined in F4.8, shall specify the syntax of the extension parameter of the PROCESS-DATA invocation.

4.6.4.1.4 process-completion-report

The process-completion-report parameter shall specify whether the service provider shall invoke a NOTIFY operation to inform the service user that processing of the data unit enclosed in the PROCESS-DATA invocation has been completed successfully.

4.6.4.2 NOTIFY (Unconfirmed)

4.6.4.2.1 General

The Data Processing procedure shall extend the NOTIFY operation defined in 3.11 through the addition of six parameters to the invocation and through adding two permissible Event Identifier values to the `event-name` parameter.

4.6.4.2.2 Operation Parameters Definitions

NOTE – The most precise and meaningful reporting will only be obtained if the service user applies sequential numbers with a fixed increment for identifying the data units.

4.6.4.2.2.1 Overview

Table 4-25 shows the extension parameters of the NOTIFY operation defined by this procedure.

Table 4-25: NOTIFY Extension Parameters

Extension Parameters	Invocation
<code>data-unit-id-last-processed</code>	M
<code>data-processing-status</code>	C
<code>data-processing-start-time</code>	C
<code>data-unit-id-last-OK</code>	M
<code>data-processing-stop-time</code>	C
<code>production-status</code>	C

4.6.4.2.2.2 Extension Parameter Syntax

The type `DataProcNotifyInvocExt`, as defined in F4.8, shall specify the syntax of the extension parameters of the NOTIFY invocation.

4.6.4.2.2.3 `data-unit-id-last-processed`

For all notifications, the `data-unit-id-last-processed` parameter shall be present. Its value shall be set as follows:

- a) if the service provider has not yet processed or attempted to process any data from the service user during the given association established by the service instance using this

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

instance of the Data Processing procedure, the value of the `data-unit-id-last-processed` parameter shall be set to 'noDataProcessed', i.e., 'null';

- b) otherwise, the `data-unit-id-last-processed` parameter shall specify the identifier of the data unit, i.e., the value of the `data-unit-id` parameter of that data unit that the service provider most recently processed or attempted to process, regardless of whether the data was successfully processed or an exception occurred.

4.6.4.2.2.4 **data-processing-status**

4.6.4.2.2.4.1 For all notifications, if the value of the `data-unit-id-last-processed` parameter is 'noDataProcessed', the `data-processing-status` parameter shall not be present.

4.6.4.2.2.4.2 Whenever the value of the `data-unit-id-last-processed` parameter is not 'noDataProcessed', the `data-processing-status` parameter shall be present and shall contain one of the following values representing the processing state of the data identified by `data-unit-id-last-processed`:

- a) 'successfully processed'—the processing of the data completed; i.e., the data is guaranteed to have been processed nominally;
- b) 'processing interrupted'—the processing of the data started but did not complete because `production-status` became 'interrupted' or 'halted';
- c) 'processing started'—the processing of the data started but did not yet complete.

4.6.4.2.2.4.3 Additional values of the `data-processing-status` can be introduced by using `dataProcessingStatusExtension` (see F4.8) if needed in procedures derived from the Data Processing procedure.

4.6.4.2.2.4.4 The Data Processing procedure does not extend the `data-processing-status` parameter, and therefore the CHOICE `dataProcessingStatusExtension` must not be selected (see F4.8).

4.6.4.2.2.5 **data-processing-start-time**

4.6.4.2.2.5.1 For all notifications, if the `data-unit-id-last-processed` is 'noDataProcessed', the `data-processing-start-time` parameter shall not be present.

4.6.4.2.2.5.2 Whenever `data-unit-id-last-processed` is not 'noDataProcessed', the `data-processing-start-time` parameter shall be present and shall contain the time at which the service provider started to process the data identified by the `data-unit-id-last-processed` parameter.

4.6.4.2.2.6 data-unit-id-last-OK

For all notifications, the `data-unit-id-last-OK` parameter shall be present. Its value shall be set as follows:

- a) if no data have been successfully processed during the given association established by the service instance using this instance of the Data Processing procedure the value of the `data-unit-id-last-OK` parameter shall be set to 'noSuccessfulProcessing';
- b) otherwise, the `data-unit-id-last-OK` parameter shall specify the sequence number, i.e., the value of the `data-unit-id` parameter of the most recent data unit that was successfully processed.

4.6.4.2.2.7 data-processing-stop-time

4.6.4.2.2.7.1 For all notifications, if the `data-unit-id-last-OK` is 'noSuccessfulProcessing', the `data-processing-stop-time` parameter shall not be present.

4.6.4.2.2.7.2 Whenever `data-unit-id-last-OK` is not 'null', the `data-processing-stop-time` parameter shall be present and shall contain the time at which processing of the data, identified by `data-unit-id-last-OK`, successfully completed.

4.6.4.2.2.8 production-status

4.6.4.2.2.8.1 For all notifications, except 'production status change' the `production-status` parameter shall be present and shall contain the value of the production status at the time of the event notification (see annex B).

4.6.4.2.2.8.2 If the notified event is 'production status change', the `production-status` parameter shall be absent.

NOTE – The 'production status change' notification reports the post event production status value by means of the `event-value` parameter (see 3.11.2.2.4.3).

4.6.4.2.3 event-name Extension

The value of the `event-name` shall be one of the following:

- a) one of the values specified for the common NOTIFY operation in 3.11.2.2.3.2;
- b) 'data processing completed' (`event-name`)—processing of the data unit identified in the parameter `data-unit-id-last-OK` completed successfully; or

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 1) the **event-name** of this event shall contain the procedure instance identifier of the procedure instance triggering the event;
- 2) unless otherwise specified by the service using this procedure or by a derived procedure, the associated **event-value** shall be 'empty';
- c) 'data processing configuration change' (**event-name**)—at least one of the dynamically modifiable configuration parameters defined in 4.6.5 has been changed;

NOTE – The **input-queue-size** parameter defined in 4.6.5 is the only dynamically modifiable parameter of the Data Processing procedure.

- 1) the **event-name** of this event shall contain the procedure instance identifier of the procedure instance in which the event occurs;
- 2) the notification of the data processing configuration change event shall report the **input-queue-size** value by means of the **event-value** parameter:
 - i) the first part of the path specifying the type to be used is 'NotifyInvocation':
 '**eventValue**': 'EventValue'; '**qualifiedValues**':
 '**SequenceOfQualifiedValues**': 'SEQUENCE OF QualifiedValues' where this sequence has the length 1;
 - ii) if the qualifier of the to-be-reported value is not 'valid', then the second part of the path is one of the following: (a) '**QualifiedValues**': 'unavailable': 'NULL'; or (b) '**QualifiedValues**': 'undefined': 'NULL'; or (c) '**QualifiedValues**': 'error': 'NULL';
 - iii) if the qualifier of the to-be-reported value is 'valid', then the second part of the path is '**QualifiedValues**': 'valid': 'TypeAndValueComplexQualified': '**typeAndValue**': 'integerPositive': 'SEQUENCE OF IntPos', where this sequence shall have the length 1.

NOTE – All relevant types are defined in F4.3.

4.6.4.2.4 The Published Identifier, i.e., the Event Identifier, for the **event-name** of the 'data processing complete' event is specified in F4.16 as **pDPdataProcessingCompleted**.

4.6.4.2.5 The Published Identifier i.e., the Event Identifier, for the **event-name** of the 'data processing configuration change' event is specified in F4.16 as **pDPconfigurationChange**.

4.6.5 CONFIGURATION PARAMETERS

The Data Processing procedure configuration parameter that needs to be configured in the context of the procedure shall be as defined in table 4-26.

NOTE – For the configuration parameter, the table provides the engineering unit, a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-26: Data Processing Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Dynamically modifiable	Configuration Parameter Identifier and Type (F4.16)
input-queue-size (in number of PROCESS-DATA invocations the queue will store)	4.6.3.2.4	Yes	Yes	pDPinputQueueSize PDPinputQueueSizeType

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.6.6 PROCEDURE STATE TABLE

Table 4-27: Data Processing Procedure State Table

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(StartInvocation)	IF “positive result” THEN set “interrupt notified” to FALSE (+StartReturn) → 2 ELSE (-StartReturn) ENDIF	{procedure to association abort ‘protocol error’} → 1
2	(StopInvocation)	{procedure to association abort ‘protocol error’}	IF “positive result” THEN {initiate stop} ELSE (-StopReturn) ENDIF
3	(ProcessDataInvocation)	{procedure to association abort ‘protocol error’}	‘queue data unit’ IF “interrupted” THEN IF (NOT “interrupt notified”) THEN ‘notify ‘production status change’ / ‘interrupted’ set “interrupt notified” to TRUE ENDIF ENDIF
4	‘data unit ready’	Not applicable	‘process data unit’
5	‘data unit processing complete’	[ignore]	IF “report” THEN ‘notify ‘data processing completed’ ENDIF
6	‘production status change to interrupted’	[ignore]	IF (“processing data unit” OR “data queued”) THEN ‘notify ‘production status change’ / ‘interrupted’ set “interrupt notified” to TRUE ELSE [ignore] ENDIF
7	‘production status change to ‘halted’	[ignore]	‘notify ‘production status change’ / ‘halted’
8	‘production status change to ‘operational’	[ignore]	IF “interrupt notified” THEN ‘notify ‘production status change’ / ‘operational’ set “interrupt notified” to FALSE ELSE [ignore] ENDIF
9	‘production status change to ‘configured’	[ignore]	‘notify ‘production status change’ / ‘configured’
10	‘production configuration change’	[ignore]	‘notify ‘production configuration change’
11	‘data processing configuration change’	[ignore]	‘notify ‘data processing configuration change’ / ‘procedure configuration parameter values’ (see 4.6.4.2.3 c) 2))
12	‘invalid PDU’	{procedure to association abort ‘protocol error’}	{procedure to association abort ‘protocol error’} → 1
13	‘terminate procedure’	‘terminate itself’	‘terminate itself’

Table 4-28: Procedure State Table Incoming Event Description References

Event	Reference
'data unit processing completed'	4.6.3.4
'data unit ready'	4.6.3.3.1 A PROCESS-DATA invocation is available at the head of the Input Queue, the production engine is ready to process the enclosed data unit and production-status is 'operational'
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND
'production status change to 'halted''	B2.4
'production status change to 'interrupted''	B2.4
'production status change to 'operational''	B2.4
'production status change to 'configured''	B2.4
'production configuration change'	3.11.2.2.3.2 b)
'data processing configuration change'	4.6.4.2.3 c)
'invalid PDU'	3.2.3.6

Table 4-29: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	All checks on the invocation are passed.
"data queued"	At least one PROCESS-DATA invocation is waiting on the Input Queue
"report"	The process-completion-report parameter value in the associated (ProcessDataInvocation) PDU is 'produce report'
"processing data unit"	Processing for a data unit has started but not completed
"interrupted"	The production-status is 'interrupted'

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-30: Procedure State Table Boolean Flags

Predicate Flag	Set to TRUE if
"interrupt notified"	A NOTIFY invocation with the event - name 'production status change' and the event - value 'interrupted' has been sent to the service user

Table 4-31: Procedure State Table Simple Action References

Name	References
'queue data unit'	4.6.3.2.3
'process data unit'	4.6.3.3
'complete data processing'	4.6.3.3
'notify 'xxx''	(NotifyInvocation) with event - name set to 'xxx', i.e., to the value corresponding to the incoming event.
'notify 'xxx' / 'yyy''	(NotifyInvocation) with event - name set to 'xxx' and event - value set to 'yyy'
'procedure to association abort 'xxx''	raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure (see 4.2.2.3)
'clear the input queue'	Remove and discard all PROCESS-DATA invocations from the Input Queue
'terminate itself'	4.6.3.7

Table 4-32: Procedure State Table Compound Action Definitions

Name	Actions Performed
{initiate stop}	'clear the input queue' (+StopReturn) → 1 IF "data processing started" THEN 'complete data processing' END
{procedure to association abort 'xxx'}	'clear the input queue' 'procedure to association abort 'xxx''

4.7 BUFFERED DATA PROCESSING

4.7.1 VERSION NUMBER

The version number of this procedure is 1.

4.7.2 DISCUSSION

4.7.2.1 Purpose

The purpose of the Buffered Data Processing procedure is to support transfer of large volumes of data at high data rates from the service user to the service provider for processing by the service provider where the maximum latency of data units may have to be limited. For this purpose the procedure allows a service to select one of the following transfer modes:

- a) complete transfer mode, in which data are transmitted to the service provider completely based on the flow control capabilities of the underlying data communications service and any latency that might be implied is accepted;
- b) timely transfer mode, in which the service provider ensures that data units will not be queued longer than a configurable latency limit and will discard the oldest unprocessed data units if the capacity of the configurable Input Queue is exceeded.

4.7.2.2 Concept

The Buffered Data Processing procedure extends the Data Processing procedure (see 4.6) and in particular provides specifications for the handling of Input Queue overflow conditions that are left unspecified by the Data Processing procedure. The specification of this behavior makes the Buffered Data Processing procedure implementable.

In order to support transfer of large data volumes at high data rates, the service user blocks PROCESS-DATA invocations into a data unit called forward buffer. The forward buffer is used exclusively for the purpose of transferring the PROCESS-DATA invocations from the service user to the service provider. When the service provider receives a forward buffer it extracts the PROCESS-DATA invocations and places them on the Input Queue in the order they have been inserted into the forward buffer by the service user. The maximum size of the forward buffer is expressed as the number of PROCESS-DATA invocations that may be stored in the buffer. It is a configuration parameter that is specified by the service using the procedure or by a derived procedure.

The service user may also send individual PROCESS-DATA invocations that as specified for the parent procedure are not enclosed in a forward buffer. The service provider will handle such unbuffered PROCESS-DATA invocations in the same manner as a forward buffer enclosing a single PROCESS-DATA invocation.

The Buffered Data Processing procedure defines two modes for the transfer of PROCESS-DATA invocations from the service user to the service provider; these modes differ in the method of handling or preventing overflow of the Input Queue:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) In complete transfer mode, the service provider stops reading data from the underlying data communications service when the available space on the Input Queue drops below the maximum size of a forward buffer and resumes reading data when there is sufficient room on the Input Queue to store all PROCESS-DATA invocations that might be included in a maximum sized forward buffer. This approach has the effect that backpressure is built up on the transport layer, eventually preventing the service user from transmitting further data. In effect, data will always be transferred completely accepting any delay that might be implied.
- b) In timely transfer mode, when there is insufficient room on the Input Queue to store all PROCESS-DATA invocations received within a forward buffer, the service provider discards as many of the oldest PROCESS-DATA invocations, for which processing has not started, as needed to store all PROCESS-DATA invocations contained in the most recently received forward buffer. The objective of this approach is to minimize the overall processing latency at the expense of dropping data with the highest accumulated latency.

The service specification may fix the transfer mode to be used as part of the service specification or may require the selection of the transfer mode by means of a service management parameter.

When adding a PROCESS-DATA invocation to the Input Queue in timely transfer mode, the service provider starts a latency timer for that PROCESS-DATA invocation and sets its initial value to the value defined by the parameter `processing-latency-limit`. The service provider discards the PROCESS-DATA invocation if the latency timer expires before processing of the data unit enclosed in the PROCESS-DATA invocation starts.

When data are discarded in timely transfer mode because of queue overflow or because of expiry of the processing latency timer (see 4.7.3.2.2.5), the service user is not notified. This procedure assumes that detection and handling of data loss is performed by higher processing layers. Where this assumption does not apply, notification of the service user will have to be added by derived procedures.

4.7.2.3 Derivation

The Buffered Data Processing procedure extends the Data Processing procedure specified in 4.6 by the following features:

- a) buffering of PROCESS-DATA invocations for the purpose of transfer from the service user to the service provider;
- b) support for timely and complete transfer modes for PROCESS-DATA invocations including specifications how Input Queue overflow shall be prevented or handled;
- c) support of a processing latency limit in the timely transfer mode to constrain the time a PROCESS-DATA invocation may be queued by the service provider before processing of the enclosed data unit starts.

4.7.3 BEHAVIOR

4.7.3.1 Starting

The Buffered Data Processing procedure shall be started as defined in the parent procedure in 4.6.3.1.

4.7.3.2 Transfer and Queuing of PROCESS-DATA Invocations

NOTES

- 1 Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the `data` parameter of that operation. The Buffered Data Processing procedure does not do that. The `data` syntax definition is left to the service using this procedure.
- 2 The following behavior is specified in addition to the specifications for the parent procedure in 4.6.3.2.

4.7.3.2.1 Forward Buffer

4.7.3.2.1.1 For transfer to the service provider, the service user may group PROCESS-DATA invocations into a forward buffer, which shall be transmitted in its entirety.

NOTES

- 1 The forward buffer is used exclusively for the purpose of transferring the PROCESS-DATA invocations from the service user to the service provider and is not an operation invocation or response.
- 2 The service user may also send individual PROCESS-DATA invocations as specified for the parent procedure in 4.6.3.2.

4.7.3.2.1.2 The maximum forward buffer size, expressed as the maximum number of PROCESS-DATA invocations that can be stored in a forward buffer, shall be specified by the service using this procedure or by a derived procedure, where setting of this parameter may be delegated to Service Management.

NOTES

- 1 The number of PROCESS-DATA invocations included in a forward buffer is at the discretion of the service user as long as it is less than or equal to the specified maximum forward buffer size.
- 2 Even if for a given service type the forward buffer will not be used, as only individual PROCESS-DATA invocations will be sent, the size of the forward buffer needs to be specified. In case only individual PROCESS-DATA invocations shall be handled, the size will be limited to a single invocation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.7.3.2.1.3 The maximum forward buffer size shall be less than the configured Input Queue size.

4.7.3.2.1.4 The service provider shall consider a forward buffer including more PROCESS-DATA invocations than the specified maximum a protocol error and shall invoke PEER-ABORT with the diagnostic 'forward buffer too large'.

4.7.3.2.1.5 When receiving a forward buffer, the service provider shall extract the PROCESS-DATA invocations and place them on the Input Queue in the same order as they have been inserted into the forward buffer by the service user.

4.7.3.2.1.6 When receiving an individual unbuffered PROCESS-DATA invocation as specified in the parent procedure (see 4.6), the service provider shall handle it in the same way as a forward buffer containing a single PROCESS-DATA invocation.

4.7.3.2.2 Data Transfer Modes

4.7.3.2.2.1 The service provider shall support the following transfer modes for the reception of forward buffers:

- a) complete transfer mode;
- b) timely transfer mode.

NOTES

- 1 The complete transfer mode ensures that all data transmitted by the service user are received, queued, and processed by the service provider accepting any delay that might be implied.
- 2 In the timely transfer mode, the service provider will discard PROCESS-DATA invocations that are queued longer than given by the value of the **processing-latency-limit** parameter (see 4.7.2.2). In addition, the service provider will discard PROCESS-DATA invocations with the highest accumulated latency when the Input Queue overflows.

4.7.3.2.2.2 The transfer mode to be applied shall be defined by the service using the procedure or by a derived procedure or may be delegated to Service Management.

4.7.3.2.2.3 In complete transfer mode the service provider shall stop reading data from the data communications service when the available space on the Input Queue drops below the maximum forward buffer size and shall resume reading data from the data communications service when the available space on the Input Queue enables accommodating at least the number of PROCESS-DATA invocations that can be included in a maximum sized forward buffer.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTES

- 1 When reading from the data communications service is suspended, backpressure will build up that may eventually prevent the service user from sending further PROCESS-DATA invocations.
- 2 In this situation the service user will not be able to terminate the procedure nominally by invocation of the STOP operation until all transmitted data have been read and queued by the service provider. The only way to terminate the procedure earlier is by invocation of PEER-ABORT.
- 3 This specification assumes that a service will only use a single instance of the Buffered Data Processing procedure if that is operated in complete transfer mode. If more than one instance is used then all instances of the Buffered Data Processing procedure as well as any other procedures communicating via the same connection may be blocked if one of the instances stops reading data from the communications service.
- 4 Most of the points addressed in the notes above will apply regardless of the specifics of the underlying communications technology as long as such technology has the characteristics as specified in 1.3.1. The behavior as described in the notes above applies fully in case the underlying communication is as specified in reference [2].

4.7.3.2.2.4 In timely transfer mode, when the available space on the Input Queue does not allow storing all PROCESS-DATA invocations extracted from a forward buffer, the service provider shall discard as many of the oldest PROCESS-DATA invocations for which processing has not started as needed to queue all PROCESS-DATA invocations received.

NOTE – The service user is not notified that PROCESS-DATA invocations have been discarded.

4.7.3.2.2.5 The parameter `processing-latency-limit` shall specify the maximum time that a PROCESS-DATA invocation may be queued in timely transfer mode before processing of the enclosed data unit has to start.

4.7.3.2.2.6 A value of zero for the `processing-latency-limit` parameter shall specify that the processing latency shall not be controlled by the service provider; i.e., the ‘processing latency timer expired’ event (see table 4-35) shall not occur.

NOTE – As in complete data transfer mode the service provider does not control the processing latency; i.e., except as provided in 4.7.3.2.2.5, data units will be discarded only in case the Input Queue overflows. The `processing-latency-limit` parameter is set to zero as long as complete transfer mode applies.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.7.3.2.2.7 The value of the parameter `processing-latency-limit` shall be specified by the service using the procedure or by a derived procedure or may be delegated to Service Management.

4.7.3.2.2.8 When placing a PROCESS-DATA invocation on the Input Queue the service provider shall start a specific latency timer for that PROCESS-DATA invocation if the value of the `processing-latency-limit` parameter is not zero.

4.7.3.2.2.9 The initial value of latency timer shall be set to the value specified by the parameter `processing-latency-limit`.

4.7.3.2.2.10 When processing of the data unit enclosed in the PROCESS-DATA invocation starts or the PROCESS-DATA invocation is discarded the associated latency timer shall be canceled.

4.7.3.2.2.11 If the latency timer expires before processing of the enclosed data unit starts, the PROCESS-DATA invocation shall be discarded.

NOTE – The service user is not notified that a PROCESS-DATA invocation has been discarded because of expiry of the latency timer.

4.7.3.3 Processing of Data Units

Data units shall be processed as specified for the parent procedure in 4.6.3.3.

4.7.3.4 Notifications

Events shall be notified as specified for the parent procedure in 4.6.3.5 with the exception specified in 4.7.4.2.

4.7.3.5 Stopping

The procedure shall be stopped as specified for the parent procedure in 4.6.3.6.

4.7.3.6 Terminating

The procedure shall terminate as specified for the parent procedure in 4.6.3.7.

4.7.4 REQUIRED OPERATIONS

Table 4-33: Buffered Data Processing Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non- Blocking
START	Data Processing	N	N	Blocking
STOP	Data Processing	N	N	Blocking
PROCESS-DATA	Data Processing	N	N	Non-Blocking
NOTIFY	Data Processing	Y	N	Non-Blocking

4.7.4.1 PROCESS-DATA (Unconfirmed)

The Buffered Data Processing procedure uses the unconfirmed variant of the PROCESS-DATA operation.

4.7.4.2 NOTIFY (Unconfirmed)

4.7.4.2.1 General

The Buffered Data Processing procedure shall inherit the notifications defined for the parent procedure in 4.6.4.2.3.

Notification shall be performed as defined in the parent procedure in 4.6.3.5.

4.7.4.2.2 event-value

4.7.4.2.2.1 Except for the 'data processing configuration change' (event-name) event the event-value specifications of the parent procedure shall apply.

4.7.4.2.2.2 For the 'data processing configuration change' (event-name) event the event-value shall report the values of the dynamically modifiable parameters maximum-forward-buffer-size, input-queue-size and processing-latency-limit defined in 4.7.5. The first part of the path specifying the type to be used is 'NotifyInvocation': 'eventValue': 'EventValue': 'qualifiedValues': 'SequenceOfQualifiedValues': 'SEQUENCE OF QualifiedValues' where this sequence has the length 3. The first element of this sequence shall report the maximum-forward-buffer-size, the second the input-queue-size, and the third the processing-latency-limit parameter value. For each of the three parameters the following shall apply: If the qualifier of the to-be-reported value is not 'valid', then the second part of the path is one of the following: (a) 'QualifiedValues': 'unavailable': 'NULL'; or (b) 'QualifiedValues': 'undefined': 'NULL'; or (c) 'QualifiedValues': 'error': 'NULL'. If the

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

qualifier of the to-be-reported value is 'valid', then the second part of the path is 'QualifiedValues': 'valid': 'TypeAndValueComplexQualified': 'typeAndValue': 'integerPositive': 'SEQUENCE OF IntPos', where this sequence shall have the length 1. All relevant types are defined in F4.3.

4.7.5 CONFIGURATION PARAMETERS

4.7.5.1 The Buffered Data Processing procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-34.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-34: Buffered Data Processing Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Dynamically modifiable	Configuration Parameter Identifier and Type (F4.16)
data-transfer-mode	4.7.3.2.2	Yes	No	pBDPdataTransferMode PBDPdataTransferModeType
maximum-forward-buffer-size (in number of PROCESS-DATA invocations the buffer will store)	4.7.3.2.1.2	Yes	Yes	pBDPmaxForwardBufferSize PBDPmaxForwardBufferSizeType
input-queue-size (in number of PROCESS-DATA invocations the queue will store)	4.6.3.2.4	Yes	Yes	pDPinputQueueSize PDPinputQueueSizeType (inherited from the parent Data Processing procedure)
processing-latency-limit (in milliseconds)	4.7.3.2.2.5	Yes	Yes	pBDPprocessingLatencyLimit PBDPprocessingLatencyLimitType

4.7.6 PROCEDURE STATE TABLE

Table 4-35: Buffered Data Processing Procedure State Table

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(StartInvocation)	IF “positive result” THEN set “interrupt notified” to FALSE set “reading suspended” to FALSE (+StartReturn) → 2 ELSE (-StartReturn) ENDIF (See table 4-27)	(See table 4-27)
2	(StopInvocation)	(See table 4-27)	(See table 4-27)
3	(ProcessDataInvocation) ¹	(See table 4-27)	IF “timely mode” THEN IF “queue overflow” THEN ‘discard oldest data units’ ENDIF ‘queue data unit’ IF “complete mode” THEN IF “queue full” THEN ‘suspend reading’ set “reading suspended” to TRUE ENDIF ENDIF IF “interrupted” THEN IF (NOT “interrupt notified”) THEN ‘notify ‘production status change’ / ‘interrupted’ set “interrupt notified” to TRUE ENDIF ENDIF

¹ In terms of Service Provider behavior, handling of an incoming PROCESS-DATA invocation and handling of an incoming forward buffer containing only one PROCESS-DATA invocation are identical.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
4	(ForwardBuffer)	{procedure to association abort ‘protocol error’}	IF “timely mode” THEN IF “queue overflow” THEN ‘discard oldest data units’ ENDIF ENDIF ‘queue all data units’ IF “complete mode” THEN IF “queue full” THEN ‘suspend reading’ set “reading suspended” to TRUE ENDIF ENDIF IF “interrupted” THEN IF (NOT “interrupt notified”) THEN ‘notify ‘production status change’ / ‘interrupted’ set “interrupt notified” to TRUE ENDIF ENDIF ENDIF
5	‘data unit ready’	(See table 4-27)	(See table 4-27)
6	‘data unit processing complete’	(See table 4-27)	IF “report” THEN ‘notify ‘data processing completed’ ENDIF IF “reading suspended” THEN IF (NOT “queue full”) THEN ‘resume reading’ set “reading suspended” to FALSE ENDIF ENDIF ENDIF
7	‘processing latency timer expired’	Not applicable	‘discard data unit’
8	‘production status change to ‘interrupted’	(See table 4-27)	(See table 4-27)
9	‘production status change to ‘halted’	(See table 4-27)	(See table 4-27)
10	‘production status change to ‘operational’	(See table 4-27)	(See table 4-27)
11	‘production status change to ‘configured’	(See table 4-27)	(See table 4-27)
12	‘production configuration change’	(See table 4-27)	(See table 4-27)
13	‘data processing configuration change’	(See table 4-27)	‘notify ‘data processing configuration change’ / ‘procedure configuration parameter values’ (see 4.7.4.2.2.2)
14	‘invalid PDU’	(See table 4-27)	(See table 4-27)
15	‘terminate procedure’	(See table 4-27)	(See table 4-27)

Table 4-36: Procedure State Table Incoming Event Description References

Event	Reference
'data unit processing completed'	4.6.3.4
'data unit ready'	4.6.3.3.1
'processing latency timer expired'	4.7.3.2.2.11
'terminate procedure'	4.2.3
'production status change to 'halted''	B2.4
'production status change to 'interrupted''	B2.4
'production status change to 'operational''	B2.4
'production status change to 'configured''	B2.4
'production configuration change'	3.11.2.2.3.2 b)
'data processing configuration change'	4.7.4.2.2.2
'invalid PDU'	3.2.3.6

Table 4-37: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"queue overflow"	There is not sufficient space on the Input Queue to store the PROCESS-DATA invocations received. The transfer mode is 'timely'.
"queue full"	There is not enough space on the Input Queue to store all PROCESS-DATA invocations that might be contained in a maximum sized forward buffer. The transfer mode is 'complete'.
"complete mode"	Complete transfer mode is in effect (see 4.7.3.2.2).
"timely mode"	Timely transfer mode is in effect (see 4.7.3.2.2).
"interrupted"	The production-status is 'interrupted'.
"report"	The process-completion-report parameter value in the associated (ProcessDataInvocation) PDU is 'produce report' (see 4.6.4.1.4).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-38: Procedure State Table Boolean Flags

Predicate Flag	Set to TRUE if
"reading suspended"	In complete transfer mode reading data from the data communications service has been suspended.
"interrupt notified"	A NOTIFY invocation with the event - name 'production status change' and the event - value 'interrupted' has been sent to the service user.

Table 4-39: Procedure State Table Simple Action References

Name	References
'queue data unit'	4.7.3.2
'queue all data units'	4.7.3.2
'suspend reading'	4.7.3.2
'resume reading'	4.7.3.2
'discard oldest data units'	4.7.3.2
'discard data unit'	4.7.3.2.2.11
'notify 'xxx' / 'yyy''	(NotifyInvocation) with event - name set to 'xxx' and event - value set to 'yyy'
'procedure to association abort 'xxx''	raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure (see 4.2.2.3)

Table 4-40: Procedure State Table Compound Action Definitions

Name	Actions Performed
{procedure to association abort 'xxx'}	'clear the Input Queue' 'procedure to association abort 'xxx''

4.8 SEQUENCE-CONTROLLED DATA PROCESSING

4.8.1 VERSION NUMBER

The version number of this procedure is 1.

4.8.2 DISCUSSION

4.8.2.1 Purpose

The purpose of the Sequence-Controlled Data Processing procedure is:

- a) to provide strict sequential transfer and processing of data units in the sequence defined by the service user;
- b) to enable the service user to resynchronize transfer and processing of data units in case a problem is detected during processing of a data unit.

The procedure is intended for use in Cross Support Transfer Services that involve sequence-controlled data transfer and processing and that need confirmation of data transfer and status reports on the ongoing production process.

4.8.2.2 Concept

The Sequence-Controlled Data Processing procedure extends the Data Processing procedure (see 4.6). Before data units can be transferred for processing, the service user invokes a START operation, which contains the `data-unit-id` value the service provider shall accept in the first PROCESS-DATA invocation after the successful completion of the START operation.

When the service provider receives the first PROCESS-DATA invocation, it verifies that the contained `data-unit-id` value is equal to the one defined in the START operation, otherwise the service provider rejects the PROCESS-DATA invocation.

NOTE – The Sequence-Controlled Data Processing procedure uses the confirmed variant of the PROCESS-DATA operation.

For all following PROCESS-DATA invocations, the service provider verifies that the `data-unit-id` is one greater than the one received in the previous accepted PROCESS-DATA invocation; if that is not the case, the PROCESS-DATA invocation is rejected.

Before a PROCESS-DATA invocation can finally be accepted, the service provider checks:

- a) whether `production-status` is not 'halted';
- b) whether the included earliest and latest production times are consistent;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- c) whether the Input Queue is not full; and
- d) whether the service provider is in the 'active.processing' state (see table 4-46).

If any of these checks fails, the PROCESS-DATA invocation is rejected.

NOTE – Further details on production status changes are defined in annex B.

After acceptance of the PROCESS-DATA invocation, the service provider sends a positive return to the service user and buffers the PROCESS-DATA invocation on the Input Queue. The service provider starts processing not earlier than the `earliest-data-process-start-time` and not later than the `latest-data-process-start-time` included in the PROCESS-DATA invocation. In case no `earliest-data-process-start-time` is given for the data unit, processing starts as soon as possible regardless if the `latest-data-process-start-time` is given or not; otherwise the service provider starts data unit processing within the time frame defined by the earliest and latest processing times.

NOTE – Regardless of the service user having defined `earliest-data-process-start-time` and `latest-data-process-start-time`, the service provider processes the data units in the sequence defined by the `data-unit-id` in the PROCESS-DATA operation, which in this procedure serves as a sequence counter. This means that the PROCESS-DATA operations are always processed in the order they have been received and buffered.

Reporting of the completion of processing steps is performed as defined by the parent Data Processing procedure in 4.6.3.4.

If processing of a data unit fails, the service provider enters a 'locked' state and notifies the service user of the problem. While in the 'locked' state, the service provider does not perform any data processing, nor does it accept any new PROCESS-DATA invocations from the service user. To recover from the 'locked' state, the service user may issue a STOP invocation; the service provider then clears the Input Queue, exits the 'locked' state and terminates the procedure. After the completion of the STOP operation, the service user issues a START invocation (as soon as `production-status` becomes 'operational' again—see NOTE) with the next `data-unit-id` the service provider shall accept.

NOTE – Because the STOP operation puts the procedure in the 'inactive' state, the service user in this case must use other means to obtain the production status if provided by the service.

Alternatively to invoking a STOP operation followed by a START operation, the service user may invoke an EXECUTE-DIRECTIVE operation with the `directive-identifier` 'reset' to clear the Input Queue and exit the 'locked' state, where the `directive-qualifier` parameter defines the next `data-unit-id` the service provider shall accept.

NOTE – The 'locked' state is a substate of the 'active' state that does not affect the state of the service instance.

4.8.2.3 Derivation

The Sequence-Controlled Data Processing procedure extends the parent Data Processing procedure specified in 4.6 by the following features:

- a) use of the confirmed variant of the PROCESS-DATA operation;
- b) start of processing of the data units not earlier than an earliest and not later than a latest processing start time defined by the service user;
- c) transition to a 'locked' state and notification of the service user in case processing of a data unit fails;

NOTE – In such a case the service provider is blocked, and does not accept any further PROCESS-DATA invocations, as the strict sequential processing cannot be guaranteed anymore.

- d) resynchronization of data unit processing by the service user in case of a problem detected during data unit processing.

4.8.3 BEHAVIOR

4.8.3.1 Starting

NOTE – The following behavior is specified in addition to the specifications for the parent procedure in 4.6.3.1.

4.8.3.1.1 The service user shall invoke the START operation with the **first-data-unit-id** parameter, to request that the service provider prepare to receive data units for processing. The service provider shall memorize the **first-data-unit-id** parameter value that shall be accepted with the first PROCESS-DATA invocation.

4.8.3.1.2 If **production-status** is 'interrupted' at the time the START invocation is received, the service provider shall issue a negative return with the diagnostic 'unable to comply'.

4.8.3.2 Transfer and Queuing of Data Units

NOTES

- 1 Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the **data** parameter of that operation. The Sequence-Controlled Data Processing procedure does not do that. The **data** syntax definition is left to the service using this procedure.
- 2 The following behavior is specified in addition to the specifications for the parent procedure in 4.6.3.2.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.8.3.2.1 The service user shall set the value of the `data-unit-id` parameter of the first PROCESS-DATA operation invocation after a successful START operation to the value of the `first-data-unit-id` parameter of the START operation.

4.8.3.2.2 The service user shall set the `data-unit-id` of all PROCESS-DATA operations following the first PROCESS-DATA operation invocation to the value of the `data-unit-id` parameter of the previous accepted PROCESS-DATA operation incremented by one.

4.8.3.2.3 If the `data-unit-id` value has reached the maximum value given by the range of the `data-unit-id` parameter and has to be incremented by one, the parameter value shall wrap around to zero.

4.8.3.2.4 If the service provider detects an unexpected value of the `data-unit-id` parameter of the PROCESS-DATA operation, it shall issue a negative return with the diagnostic 'out of sequence'.

4.8.3.2.5 If the Input Queue used for buffering of incoming PROCESS-DATA operations is full at the time the service provider receives a PROCESS-DATA invocation, the service provider shall issue a negative PROCESS-DATA return with the diagnostic 'unable to store'.

4.8.3.2.6 If `production-status` is 'halted' at the time of reception of a PROCESS-DATA invocation, the service provider shall issue a negative PROCESS-DATA return with the diagnostic 'unable to process'.

4.8.3.2.7 If `production-status` is not 'halted' at the time of reception of a PROCESS-DATA operation invocation, but the service provider is in the 'locked' substate, the service provider shall issue a negative PROCESS-DATA return with the diagnostic 'service instance locked'.

4.8.3.2.8 If the service provider does not accept a PROCESS-DATA invocation, it shall discard the data unit.

4.8.3.3 Processing of Data Units

NOTE – The following behavior is specified in addition to the specifications for the parent procedure in 4.6.3.3.

4.8.3.3.1 Data Processing Start Time

4.8.3.3.1.1 The service provider shall start processing of the data unit not earlier than the time defined by the `earliest-data-process-start-time` parameter and not later than the time defined by the `latest-data-process-start-time` parameter, both defined in the PROCESS-DATA operation.

4.8.3.3.1.2 If the value of the `earliest-data-process-start-time` parameter is 'undefined' in the `PROCESS-DATA` invocation, the service provider shall process the data unit included as soon as possible as long as `production-status` is 'operational'.

NOTE – This implies that while `production-status` is 'configured' or 'interrupted' the service provider waits until `production-status` changes to 'operational'.

4.8.3.3.1.3 If the value of the `latest-data-process-start-time` parameter is 'undefined' in the `PROCESS-DATA` operation, then the service provider shall process the included data unit as long as the production status is 'operational'.

4.8.3.3.1.4 If the `latest-data-process-start-time` parameter in the `PROCESS-DATA` operation is not 'undefined', the service provider shall defer processing of the data unit if the current `production-status` is 'interrupted'. Processing shall be deferred until either `production-status` changes to 'operational' before `latest-data-process-start-time` expires, or the `latest-data-process-start-time` expires, in which case the service provider shall discard the data unit.

4.8.3.3.1.5 If processing of a data unit has not begun at or before `latest-data-process-start-time`, a `NOTIFY` operation shall be issued with the Event Identifier 'expired' (`event-name`) and the data unit shall be discarded.

4.8.3.3.1.6 If `production-status` changes to 'interrupted', and there is a data unit at the head of the queue, and its `latest-data-process-start-time` is 'undefined', and no other data unit is being processed, the service provider shall not start processing but wait until `production-status` changes back to 'operational'.

4.8.3.3.2 Positive Feedback

Status reporting shall be performed as defined in the parent procedure in 4.6.3.4.

4.8.3.4 Notification of Production Status Changes

Production status changes shall be reported as defined in the parent procedure in 4.6.3.5.1.

4.8.3.5 Notification of Production Configuration Changes

Production configuration changes shall be reported as defined in the parent procedure in 4.6.3.5.2.

4.8.3.6 Locking

4.8.3.6.1 The state 'active.locked' shall be a substate of the 'active' state.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.8.3.6.2 The service provider shall enter the 'active.locked' substate when:

- a) the data unit has already expired at the time when processing shall start; or
- b) `production-status` changes to 'interrupted' and a data unit is currently being processed; or
- c) `production-status` changes to 'halted'.

4.8.3.6.3 In the 'active.locked' substate, the service provider shall reject PROCESS-DATA invocations from the service user with the `diagnostic` 'service instance locked'; it shall not perform any processing of data units in its Input Queue.

4.8.3.6.4 To recover from the 'active.locked' substate, the service user may issue a STOP invocation followed by a START invocation or an EXECUTE-DIRECTIVE invocation with the `directive-identifier` equal to 'reset'.

NOTE – Both options clear the Input Queue.

4.8.3.7 Resetting

If the service user invokes the EXECUTE-DIRECTIVE operation with the `directive-identifier` equal to 'reset', the service provider shall:

- a) send the EXECUTE-DIRECTIVE acknowledgement to the service user;
- b) clear the Input Queue;
- c) wait for processing to complete, and provide feedback as described in 4.6.3.4, if any data unit is currently being processed;
- d) if in 'active.locked' substate, wait for `production-status` to become 'operational' and then transition to the 'active.processing' substate;
- e) set the `first-data-unit-id` to the value requested in the EXECUTE-DIRECTIVE invocation;
- f) send the EXECUTE-DIRECTIVE return to the service user.

4.8.3.8 Stopping

The procedure shall be stopped as specified for the parent procedure in 4.6.3.6.

4.8.3.9 Terminating

The procedure shall terminate as specified for the parent procedure in 4.6.3.7. In addition any pending acknowledgements shall be deleted.

4.8.4 REQUIRED OPERATIONS

Table 4-41: Sequence-Controlled Data Processing Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
START	Data Processing	Y	N	Blocking
STOP	Common	N	N	Blocking
PROCESS-DATA	Data Processing	Y	N	Non-Blocking
NOTIFY	Data Processing	Y	N	Non-Blocking
EXECUTE-DIRECTIVE	Common	Y	N	Blocking

4.8.4.1 START (Confirmed)

4.8.4.1.1 General

The Sequence-Controlled Data Processing procedure shall extend the START operation defined in 3.7 through the addition of one parameter to the invocation.

4.8.4.1.2 Operation Parameters Definitions

The Sequence-Controlled Data Processing procedure shall extend the START operation defined in 3.7 through the addition of the `first-data-unit-id` parameter.

Table 4-42: START Extension Parameters

Extension Parameters	Invocation	Return
<code>first-data-unit-id</code>	M	

4.8.4.1.3 Extension Parameter Syntax

4.8.4.1.3.1 The type `SequContrDataProcStartInvocExt`, as defined in F4.10, shall specify the syntax of the extension parameter of the START invocation.

4.8.4.1.3.2 `first-data-unit-id`

The `first-data-unit-id` parameter shall contain the value of the `data-unit-id` parameter that will be present in the first PROCESS-DATA invocation after the preceding successful START operation.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – Following a data processing failure, processing of a data unit for which processing started before the failure condition occurred may still continue. Also, reports on the progress of this processing may still be generated. The service user (when restarting the data transfer) shall therefore choose the value of the `first-data-unit-id` parameter such that all data units can still be unambiguously identified.

4.8.4.2 PROCESS-DATA (Confirmed)

4.8.4.2.1 General

4.8.4.2.1.1 The Sequence-Controlled Data Processing procedure shall extend the PROCESS-DATA invocation defined in 3.10 through the addition of the `earliest-data-process-start-time` and `latest-data-process-start-time` parameters, and additional diagnostic values.

4.8.4.2.1.2 The Sequence-Controlled Data Processing procedure shall use the confirmed variant of the PROCESS-DATA operation and as a consequence the confirmed variant of the Standard Operation Header.

4.8.4.2.1.3 The Sequence-Controlled Data Processing procedure shall extend the PROCESS-DATA return defined in 3.10 through the addition of the `data-unit-id` parameter.

Table 4-43: PROCESS-DATA Invocation Extension Parameters

Parameters	Invocation
<i>Standard Operation Header</i> (confirmed)	M
<code>earliest-data-process-start-time</code>	M
<code>latest-data-process-start-time</code>	M

Table 4-44: PROCESS-DATA Return Extension Parameters

Parameters	Return
<code>data-unit-id</code>	M

4.8.4.2.2 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

4.8.4.2.3 Extension Parameters Syntax

4.8.4.2.3.1 The type SequContrDataProcProcDataInvocExt, as defined in F4.10, shall specify the syntax of the extension parameters of the invocation of the PROCESS-DATA operation.

4.8.4.2.3.2 The type SequContrDataProcProcDataPosReturnExt, as defined in F4.10, shall define the syntax of the extended positive return of the PROCESS-DATA operation.

4.8.4.2.3.3 The type SequContrDataProcProcDataNegReturnExt, as defined in F4.10, shall define the syntax of the extended negative return of the PROCESS-DATA operation.

4.8.4.2.3.4 The type SequContrDataProcProcDataDiagnosticExt, as defined in F4.10, shall define the additional values of the diagnostic parameter of the PROCESS-DATA return.

4.8.4.2.4 data-unit-id

4.8.4.2.4.1 The service provider shall set the data-unit-id in the PROCESS-DATA return to the value expected in the next PROCESS-DATA invocation.

4.8.4.2.4.2 If the invocation is accepted, the data-unit-id in the PROCESS-DATA return contains the value of the data-unit-id in the PROCESS-DATA invocation incremented by one.

4.8.4.2.4.3 If the invocation is rejected, the data-unit-id in the PROCESS-DATA return shall contain the value expected by the service provider:

- a) in case of the first PROCESS-DATA operation following a successful START operation, it is the value specified in first-data-unit-id parameter of the START invocation;
- b) otherwise the value is one greater than the value of the data-unit-id of the last accepted PROCESS-DATA invocation.

4.8.4.2.4.4 If the data-unit-id value has reached the maximum value given by the range of the data-unit-id parameter and has to be incremented by one, the parameter value shall wrap around to zero.

4.8.4.2.5 earliest-data-processing-start-time

4.8.4.2.5.1 The earliest-data-process-start-time parameter shall either be 'undefined' or shall contain the earliest time at which processing of the data unit may begin.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.8.4.2.5.2 If the `earliest-data-process-start-time` parameter is 'undefined' the service provider shall begin processing as soon as:

- a) `production-status` becomes or is 'operational'; and
- b) no other data unit that was transferred earlier than this data unit has not yet completed processing.

4.8.4.2.6 latest-data-processing-start-time

4.8.4.2.6.1 The `latest-data-process-start-time` parameter shall either be 'undefined' or shall contain the latest time at which processing of the data unit shall begin.

4.8.4.2.6.2 If the `latest-data-process-start-time` is equal to the `earliest-data-process-start-time`, the processing of the data shall start at this time.

4.8.4.2.7 diagnostic Parameter Extension Value Definitions

If a negative PROCESS-DATA return is sent, the `diagnostic` parameter shall use one of the `diagnostic` values specified in 3.3.2.7.1 or one of the following values:

- a) 'unable to process'—the service provider cannot process data because the service provider has been taken out of service for an indefinite period by management action, i.e., `production-status` is 'halted';
- b) 'service instance locked'—`production-status` is not 'halted', but the service provider is in the 'active.locked' substate and therefore cannot process the data;

NOTE – The service provider has reported the fault condition causing the 'active.locked' substate to the service user via a NOTIFY operation. (For possible reasons, see 4.8.3.6.2).

- c) 'out of sequence'—the value of the `data-unit-id` parameter is not equal to the value expected by the service provider; the expected value is one of the following:
 - 1) in the case of the first PROCESS-DATA operation following a successful START, the value of the `first-data-unit-id` parameter of that START invocation;
 - 2) otherwise, the value of the `data-unit-id` parameter of the last positive PROCESS-DATA return;
- d) 'inconsistent time range'—the time specified in the `earliest-data-process-start-time` parameter is later than the time specified in the `latest-data-process-start-time` parameter;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- e) 'invalid time'—the production time window is invalid for one of the following reasons:
 - 1) the period from `earliest-data-process-start-time` to `latest-data-process-start-time` does not overlap with the range of times for which service production is scheduled;
 - 2) the period from `earliest-data-process-start-time` to `latest-data-process-start-time` does not overlap with the service instance provision period;

NOTE – The production may be scheduled to terminate earlier than the service instance provision period ends. A service provider's Complex may do so to have the production engine available for support of a different mission as soon as possible, but permitting the service users of the previous production period some extra time to retrieve for example a status report reflecting the final accounting information.

- f) 'late data'—`latest-data-process-start-time` is earlier than the time the PROCESS -DATA operation is received by the service provider;
- g) 'data error'—the service provider has performed error checks as provided in the service agreement and has determined that this data is in error; for example, the data exceeds the maximum size allowed for this service instance;
- h) 'unable to store'—the service provider has not enough buffer space available to store this PROCESS-DATA invocation.

4.8.4.3 NOTIFY (Unconfirmed)

4.8.4.3.1 General

The Sequence-Controlled Data Processing procedure shall inherit the notifications defined for the parent procedure in 4.6.4.2.3, but shall extend the NOTIFY operation by introducing additional values for the `data-processing-status` parameter and by adding two permissible Event Identifier values to the `event-name` parameter as specified in the following subsections.

4.8.4.3.2 `data-processing-status` Parameter Extension

4.8.4.3.2.1 The type `DataProcNotifyInvocExt`, as defined in F4.8, is inherited from the parent procedure, but is extended for the Sequence-Controlled Data Processing procedure by the type `SequContrDataProcStatus` as defined in F4.10.

4.8.4.3.2.2 By means of this extension, the `data-processing-status` parameter can also have one of the following values:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) ‘expired’—at the time processing of the data unit identified by the `data-unit-last-processed` parameter was attempted, the `latest-data-process-start-time` was already in the past;
- b) ‘processing not started’—processing of the data unit identified by the `data-unit-last-processed` parameter was attempted, but could not be started because the `production-status` was ‘interrupted’.

4.8.4.3.3 event - name Extension

4.8.4.3.3.1 The value of the `event - name` shall be one of the following:

- a) one of the events specified by the Data Processing procedure NOTIFY operation in 4.6.4.2.3; or
- b) ‘expired’ (`event - name`)—at the time when processing is being started, the `latest-data-process-start-time` is already in the past; the `event - name` of this event shall contain the procedure instance identifier of the procedure instance triggering the event; or

NOTE – When the ‘expired’ event occurs, the procedure enters the ‘active.locked’ substate (see 4.8.3.6.2) which in turn means that the ‘locked’ event is to be reported. Therefore, whenever the ‘expired’ event occurs, two notifications will be sent by this procedure.

- c) ‘locked’ (`event - name`)—at the time when processing is supposed to be started or while a data unit is being processed, one of the conditions specified in 4.8.3.6.2 occurred: the `event - name` of this event shall contain the procedure instance identifier of the procedure instance triggering the event.

4.8.4.3.3.2 The Published Identifiers for the values (`event - name`) ‘expired’ and ‘locked’ are specified in F4.16 as `pSCDPexpired` and `pSCPDlocked`, respectively.

4.8.4.3.4 event - value

4.8.4.3.4.1 For the ‘data processing configuration change’ (`event - name`) event the `event - value` shall report the value of the dynamically modifiable parameter `input-queue-size` defined in 4.8.5. The first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventValue’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValues’: ‘SEQUENCE OF QualifiedValues’ where this sequence has the length 1. If the qualifier of the to-be-reported value is not ‘valid’, then the second part of the path is one of the following: (a) ‘QualifiedValues’: ‘unavailable’: ‘NULL’; or (b) ‘QualifiedValues’: ‘undefined’: ‘NULL’; or (c) ‘QualifiedValues’: ‘error’: ‘NULL’. If the qualifier of the to-be-reported value is ‘valid’, then the second part of the path is ‘QualifiedValues’: ‘valid’: ‘TypeAndValueComplexQualified’: ‘typeAndValue’: ‘integerPositive’: ‘SEQUENCE OF IntPos’, where this sequence shall have the length 1. All relevant types are defined in F4.3.

4.8.4.3.4.2 For the ‘expired’ (event-name) event the event-value shall be ‘empty’ unless otherwise specified by the service using this procedure or by a derived procedure.

4.8.4.3.4.3 For the ‘locked’ (event-name) event the event-value shall be ‘empty’ unless otherwise specified by the service using this procedure or by a derived procedure.

4.8.4.3.4.4 Except for the ‘data processing configuration change’, the ‘expired’ and the ‘locked’ (event-name) events the event-value specifications of the parent procedure apply.

4.8.4.4 EXECUTE-DIRECTIVE (Acknowledged)

4.8.4.4.1 General

The Sequence-Controlled Data Processing procedure shall extend the EXECUTE-DIRECTIVE operation defined in 3.13 through the definition of one value possible for the directive-identifier parameter.

4.8.4.4.2 directive-identifier Extension

The Sequence-Controlled Data Processing procedure shall add ‘reset’ to the set of Directive Identifiers possible for the directive-identifier parameter (see the pSCDPdirectivesId branch of the Object Identifier tree). This Directive Identifier requests that the service provider clears the Input Queue.

4.8.4.4.3 directive-qualifier Value

4.8.4.4.3.1 The value of the directive-qualifier shall identify the next-data-unit-id parameter value, i.e., the data-unit-id parameter value the service provider shall accept in the next PROCESS-DATA invocation.

4.8.4.4.3.2 The directive-qualifier parameter is defined by ‘ExecuteDirectiveInvocation’: ‘directiveQualifier’: ‘localProcDirQualifier’: ‘DirectiveQualifierValues’: ‘TypeAndValueComplexQualified’: ‘typeAndValue’: ‘TypeAndValue’: ‘intUnsigned’: ‘SEQUENCE OF IntUnsigned’ where this SEQUENCE has the length 1.

4.8.5 CONFIGURATION PARAMETERS

4.8.5.1 The Sequence-Controlled Data Processing procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-45.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-45: Sequence-Controlled Data Processing Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Dynamically modifiable	Configuration Parameter Identifier and Type (F4.16)
input-queue-size (in number of PROCESS-DATA invocations the queue will store)	4.6.3.2.4	Yes	Yes	pDPinputQueueSize PDPinputQueueSizeType (inherited from the parent Data Processing procedure)

4.8.6 PROCEDURE STATE TABLE

Table 4-46: Sequence-Controlled Data Processing Procedure State Table

No.	Incoming Event	State 1 (‘inactive’)	State 2.1 (‘active.processing’)	State 2.2 (‘active.locked’)
1	(StartInvocation)	IF “positive result” THEN (+StartReturn) → 2.1 ELSE (-StartReturn) ENDIF	{procedure to association abort ‘protocol error’} → 1	{procedure to association abort ‘protocol error’} → 1
2	(StopInvocation)	(See table 4-27)	IF “positive result” THEN {initiate stop} → 1 ELSE (-StopReturn) ENDIF	IF “positive result” THEN {initiate stop} → 1 ELSE (-StopReturn) ENDIF
3	(ProcessDataInvocation)	(See table 4-27)	IF “positive result” THEN {‘queue data unit’ (+ProcessDataReturn) ELSE {‘discard data unit’ (-ProcessDataReturn) ENDIF	{‘discard data unit’ (-ProcessDataReturn)
4	‘data unit ready’	Not applicable	‘process data unit’	Not applicable
5	‘data unit processing complete’	[ignore]	IF “report” THEN {‘notify ‘data processing completed’ ENDIF	Not applicable
6	‘expired’	Not applicable	‘notify ‘expired’ → 2.2	Not applicable
7	‘production status change to ‘interrupted’	[ignore]	IF “processing data unit” THEN {‘notify ‘production status change’ / ‘interrupted’ → 2.2 ELSE [ignore] ENDIF	[ignore]
8	‘production status change to ‘halted’	[ignore]	‘notify ‘production status change’ / ‘halted’ → 2.2	‘notify ‘production status change’ / ‘halted’
9	‘production status change to ‘operational’	[ignore]	Not applicable	‘notify ‘production status change’ / ‘operational’
10	‘production status change to ‘configured’	[ignore]	Not applicable	‘notify ‘production status change’ / ‘configured’
11	‘production configuration change’	(See table 4-27)	‘notify ‘production configuration change’	‘notify ‘production configuration change’
12	‘data processing configuration change’	(See table 4-27)	‘notify ‘data processing configuration change’ / ‘procedure configuration parameter values’ (see 4.8.4.3.4.1)	‘notify ‘data processing configuration change’ / ‘procedure configuration parameter values’ (see 4.8.4.3.4.1)

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

No.	Incoming Event	State 1 (‘inactive’)	State 2.1 (‘active.processing’)	State 2.2 (‘active.locked’)
13	‘invalid PDU’	(See table 4-27)	{procedure to association abort ‘xxx’} → 1	{procedure to association abort ‘xxx’} → 1
14	‘terminate procedure’	(See table 4-27)	‘terminate itself’	‘terminate itself’
15	‘reset directive received’	{procedure to association abort ‘protocol error’}	(+ExecuteDirectiveAcknowledge) {reset} (+ExecuteDirectiveReturn)	(+ExecuteDirectiveAcknowledge) {reset} → 2.1 (+ExecuteDirectiveReturn)

Table 4-47: Procedure State Table Incoming Event Description References

Event	Reference
‘expired’	4.8.4.3.2. A data unit is available at the head of the Input Queue, but its latest-data-process-start-time has expired.
‘data unit processing completed’	4.6.3.4
‘data unit ready’	4.8.3.3.1 <i>A data unit is available at the head of the Input Queue, and production-status is ‘operational’; neither earliest-data-process-start-time nor latest-data-process-start-time is specified, or the current time is between earliest-data-process-start-time and latest-data-process-start-time, and production-status is ‘operational’.</i>
‘terminate procedure’	4.2.3
‘production change to ‘halted’’	B2.4
‘production status change to ‘interrupted’’	B2.4
‘production status change to ‘operational’’	B2.4
‘production status change to ‘configured’’	B2.4
‘production configuration change’	3.11.2.2.3.2 b)
‘data processing configuration change’	4.6.3.5.3
‘reset directive received’	4.8.3.7
‘invalid PDU’	3.2.3.6

Table 4-48: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	(See table 4-29)
"report"	(See table 4-29)
"processing data unit"	(See table 4-29)

Table 4-49: Procedure State Table Simple Action References

Name	References
'queue data unit'	table 4-31
'process data unit'	table 4-31
'clear the Input Queue'	table 4-31
'notify 'xxx''	table 4-31
'notify 'xxx' / 'yyy''	(NotifyInvocation) with event - name set to 'xxx' and event - value set to 'yyy'
'discard data unit'	4.8.3.3.1.4, 4.8.3.3.1.5
'procedure to association abort 'xxx''	table 4-31
'terminate itself'	table 4-31
'wait' <event>	Wait until the event <event> occurs

Table 4-50: Procedure State Table Compound Action Definitions

Name	Actions Performed
{initiate stop}	(See table 4-32)
{procedure to association abort 'xxx'}	(See table 4-32)
{reset}	'clear the Input Queue' 'wait 'data unit processing completed'' 'wait 'production status operational'' 'set the data-unit-id parameter as per the received directive-qualifier parameter value'

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.9 INFORMATION QUERY

4.9.1 VERSION NUMBER

The version number of this procedure is 1.

4.9.2 DISCUSSION

4.9.2.1 Purpose

The Information Query procedure enables the service user to request from the service provider the provision of a standard set of parameters reflecting either the configuration of the transfer service instance using this procedure or the status of other service provider parameters.

4.9.2.2 Concept

The Information Query procedure provides the CSTS user with the capability to request the current values of registered parameters. A CSTS that incorporates the Information Query procedure is hereinafter referred to as a *queriable* CSTS.

The set of queriable parameters for a CSTS is identified by the Parameter Names of individual queriable parameters and/or parameter list names where such list contains a set of Parameter Labels for that service. The `list-of-parameters` includes one of the following: (a) 'empty' signifying the default list is selected, (b) a parameter list name of a list of Parameter Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or (g) Parameter Names or Parameter Labels of individual queriable parameters.

Each parameter list name consists of a string that represents multiple individual Parameter Labels. One special case of parameter list may also exist for each queriable CSTS: the default list. The default list is named as any other list that may exist for the CSTS, but it is automatically applied when the `list-of-parameters` parameter is set to 'empty'. The default list is specified by the CSTS using the Information Query procedure or by a derived procedure or may be delegated to Service Management.

For a given queriable CSTS, the set of Parameter Labels included in the default list (if any) and/or the set of Parameter Labels represented by named label lists and the set of individual queriable Parameter Labels or Parameter Names are defined by the specification of that CSTS or a derived Information Query procedure. A CSTS using this procedure will have to:

- a) select the Functional Resource Types and associated gettable parameters from the Published Identifiers used for cross support or Agencies functionalities (see D6) and select the procedure types and the associated gettable parameters from the Published Identifiers used for the framework or services branches;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- b) define the grouping of Parameter Labels into lists and allocate a list name for each list;
- c) identify which of the defined lists will be the default list, if any.

While a queriable CSTS instance is bound, the service user invokes the GET operation of the Information Query procedure to query parameter values in one of the following ways:

- a) by leaving the selection of parameters unspecified, thereby selecting the default list of Parameter Labels;
- b) by specifying a list name, where the list represents a predefined set of Parameter Labels;
- c) by specifying a Functional Resource Type thereby identifying all parameters belonging to the instances of that Functional Resource Type that are directly associated with the transfer service executing the Information Query procedure;
- d) by specifying a Functional Resource Name (Functional Resource Type and Instance Number), thereby identifying all parameters belonging to that Functional Resource Instance;
- e) by specifying a procedure type thereby selecting all configuration parameters of all active instances of the given procedure type that are associated with the service instance that executes the Information Query procedure;
- f) by specifying a procedure instance identifier thereby selecting the configuration parameters of that procedure instance; or
- g) by specifying Parameter Names or Parameter Labels of the individual queriable parameters.

The service provider sends to the service user the requested qualified parameter values using the GET operation return. As specified in annex C2.1, the qualified value for each parameter value indicates whether the value is valid, unavailable, undefined, or in error.

4.9.3 BEHAVIOR

4.9.3.1 Getting Parameters

The service user shall invoke the GET operation (see 3.12).

4.9.3.2 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by releasing all pending GET operations without answering them.

4.9.4 REQUIRED OPERATIONS

Table 4-51: Information Query Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
GET	Common	N	N	Non-Blocking

4.9.5 CONFIGURATION PARAMETERS

The Information Query procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-52.

NOTE – For each configuration parameter, the table provides a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-52: Information Query Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Configuration Parameter Identifier and Type (F4.16)
default list of parameters	4.9.2.2	No	N/A
named label lists	3.12.1.3 b)	Yes	pIQnamedLabelLists PIQnamedLabelListsType

NOTE – The default list of parameters is shown in table 4-52 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each list it is stated whether this list is specified to be the default list.

4.9.6 PROCEDURE STATE TABLE

Table 4-53: Information Query Procedure State Table

No.	Incoming Event	Stateless
1	(GetInvocation)	IF "positive result" THEN (+GetReturn) ELSE (-GetReturn) ENDIF
2	'terminate procedure'	'terminate itself'

Table 4-54: Procedure State Table Incoming Event Description References

Event	Reference
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND

Table 4-55: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	All checks on the invocation are passed.

Table 4-56: Procedure State Table Simple Action References

Name	References
'terminate itself'	4.9.3.2

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.10 CYCLIC REPORT

4.10.1 VERSION NUMBER

The version number of this procedure is 1.

4.10.2 DISCUSSION

4.10.2.1 Purpose of the Procedure

The Cyclic Report procedure enables a service user to receive periodically parameter values from a service provider.

4.10.2.2 Concept

The Cyclic Report procedure extends the Unbuffered Data Delivery procedure with the following capabilities:

- a) the procedure defines the structure of the data as a set of parameter values;
- b) the selected parameter values are delivered periodically.

Each instance of a CSTS that incorporates the Cyclic Report procedure (hereinafter referred to as a *reporting CSTS*) cyclically (periodically) reports on the current value of a set of predefined and selected parameters.

The set of reportable parameters for a CSTS is identified by parameter list names of lists of Parameter Labels for that service and/or the Parameter Names of individual reportable parameters. The `list-of-parameters` parameter includes one of the following: (a) 'empty', i.e., the `list-of-parameters` parameter is unspecified, (b) a parameter list name where the list contains Parameter Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or the Parameter Names or Parameter Labels of individual reportable parameters.

Each parameter list name consists of a string that represents multiple individual Parameter Labels. One special case of parameter list may also exist for each reporting CSTS: the default list. The default list is named as any other list that may exist for the given CSTS, but it is automatically applied when the `list-of-parameters` parameter is set to 'empty'. The definition of the default list is controlled by the specification of the CSTS using the Cyclic Report procedure or by a derived procedure or may be delegated to Service Management.

For a given reporting CSTS, the Parameter Labels included in the default list (if any) and/or the Parameter Labels represented by named Parameter Label lists, the set of Parameter Labels or the set of Parameter Names are defined by the specification of that CSTS or by a derived procedure. A CSTS using this procedure or a derived procedure will have to:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) select the Functional Resource Types and associated reportable parameters from the Published Identifiers used for cross support or Agencies functionalities (see D6) and select the procedure types and the associated reportable parameters from the Published Identifiers used for the framework or services branches;
- b) define the grouping of Parameter Labels into lists and allocate a list name for each list;
- c) identify which of the defined lists will be the default list.

In starting the Cyclic Report procedure, the service user subscribes to the particular parameters that are to be reported by that procedure in one of the following ways:

- a) by leaving the `list-of-parameters` parameter unspecified (i.e., set to 'empty'), thus selecting the parameters represented by the default list of Parameter Labels to be reported;
- b) by specifying a list name, which represents a predefined set of Parameter Labels;
- c) by specifying a Functional Resource Type, thereby identifying all parameters belonging to the instances of that Functional Resource Type that are directly associated with the CSTS executing the Cyclic Report procedure;
- d) by specifying a Functional Resource Name, thereby identifying all parameters belonging to that Functional Resource Instance;
- e) by specifying a procedure type, thus selecting the configuration parameters of all active instances of that procedure type associated with the service instance executing the Cyclic Report procedure;
- f) by specifying a procedure instance identifier, thereby selecting the configuration parameters of that procedure instance; or
- g) by identifying the Parameter Names or Parameter Labels of the individual parameters that are reportable by that service instance.

The service user requests periodic reporting by invoking the START operation and specifying the following criteria:

- a) the delivery cycle to be used for periodic delivery;
- b) the default list of parameters to be delivered, the name of a list defining the parameters to be delivered, a Functional Resource Type, a Functional Resource Name, a procedure type, a procedure instance, or the set of individual parameters to be delivered.

The service provider delivers the qualified parameters the service user has subscribed to using the TRANSFER-DATA operation until the service user invokes a STOP operation. A qualified parameter consists of the Parameter Name, value, type, and qualifier of that parameter (see C2.1).

After stopping the procedure, the service user may optionally re-start the cyclic delivery of parameter values, applying the same or a different selection of parameters.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.10.3 BEHAVIOR**4.10.3.1 Starting**

4.10.3.1.1 The service user shall invoke the START operation to:

- a) subscribe to the set of parameters that are to be cyclically reported either by selecting the default list by leaving the selection of parameters unspecified, or by selecting one of the named Parameter Label lists, or by using a Functional Resource Type, a Functional Resource Name, a procedure type, or a procedure instance identifier, or by listing the parameters individually;
- b) configure the cyclic timer by setting the value of the `delivery-cycle` parameter.

4.10.3.1.2 The service provider shall perform the START operation except if

- a) the `production-status` is 'halted' in which case the START operation shall be rejected with the `diagnostic` 'out of service'; or
- b) the `delivery-cycle` parameter is less than the limit set by the configuration parameter `PCRminimumAllowedDeliveryCycleType` (see 4.10.5) in which case the START operation shall be rejected with the `diagnostic` 'out of range'.

4.10.3.1.3 Upon arrival of the START operation, the service provider shall confirm that the invocation is valid. A START invocation for the Cyclic Report procedure is valid if it meets any one of the following conditions:

- a) if the `list-of-parameters` parameter is set to 'empty' signifying subscription to the default list of Parameter Labels, provided a default list has been established;
- b) if the `list-of-parameters` parameter contains one parameter list name for a list of Parameter Labels that is contained in the set of label lists that has been established for the CSTS for use for use by the Cyclic Report procedure;
- c) if the `list-of-parameters` parameter contains one Functional Resource Type that is associated with the service instance that executes the Cyclic Report procedure;
- d) if the `list-of-parameters` parameter contains the name of one Functional Resource Instance that is associated with the service instance that executes the Cyclic Report procedure;
- e) if the `list-of-parameters` parameter contains one procedure type that is associated with the service instance that executes the Cyclic Report procedure;
- f) if the `list-of-parameters` parameter contains one procedure instance identifier of a procedure instance that is associated with the service instance that executes the Cyclic Report procedure;
- g) if (1) the `list-of-parameters` parameter contains one or more Functional Resource Parameter Names or Functional Resource Parameter Labels and (2) every

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

one of these names or labels is the name or label of a parameter of a Functional Resource that is associated with the service instance that executes the Cyclic Report procedure; or

- h) if (1) the `list-of-parameters` parameter contains one or more procedure configuration Parameter Names or Parameter Labels and (2) every one of these names or labels is the name or label of a parameter of a configured procedure that is associated with the service instance that executes the Cyclic Report procedure.

4.10.3.1.4 The service provider shall start the cyclic timer.

4.10.3.2 Transferring Data

4.10.3.2.1 After a successful START operation, the service provider shall transfer the qualified parameters cyclically by means of invoking the TRANSFER-DATA operation.

NOTE – The availability of a TRANSFER-DATA invocation for delivery to the communications service constitutes the ‘data available’ event.

4.10.3.2.2 Qualified parameter delivery shall be governed by the cyclic timer. The cyclic timer expiration constitutes the ‘cyclic timer expired’ event.

4.10.3.2.3 Upon expiration of the cyclic timer the service provider shall send the up-to-date qualified parameters selected by means of the START invocation parameter `list-of-parameters` to the service user and restart the cyclic timer.

4.10.3.2.4 The service provider shall deliver the qualified parameters (Parameter Name, the value, the type, and the qualifier of the parameters (see C2.1) using the `qualified-parameters` parameter. If `list-of-parameters`

- a) is left empty, then

- 1) for each Functional Resource Parameter Label in the default list (see E), the service provider shall deliver the qualified parameter (see C2.1) for that label for each of the Functional Resource Instances of the given type that are directly associated with the service instance that executes the Cyclic Report procedure;
- 2) for each procedure configuration Parameter Label in the default list, the service provider shall deliver the qualified parameter for that label for every configured instance of the procedure that is directly associated with the service instance that executes the Cyclic Report procedure;

- b) contains the name of a list of Parameter Labels, then;

- 1) for each Functional Resource Parameter Label in the named list, the service provider shall deliver the qualified parameter for that label for each instance of the given Functional Resource Type that is directly associated with the service instance that executes the Cyclic Report procedure;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 2) for each procedure configuration Parameter Label in the named list, the service provider shall deliver the qualified parameter for that label for every configured instance of the procedure that is directly associated with the service instance that executes the Cyclic Report procedure;
- c) contains a Functional Resource Type, the service provider shall deliver for each Parameter Label associated with that Functional Resource Type the qualified parameter for that label of each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Cyclic Report procedure;
- d) contains a Functional Resource Name, the service provider shall deliver the qualified parameters for all the parameters of the named Functional Resource Instance;
- e) contains a procedure type, then the service provider shall deliver the qualified parameters for all configuration parameters of every configured instance of that procedure type that is associated with the service instance executing the Cyclic Report procedure;
- f) contains a procedure instance identification, then the service provider shall deliver the qualified parameters for all configuration parameters for that procedure instance;
- g) contains any Parameter Labels for Functional Resource parameters, the service provider shall deliver the qualified parameter for that label for each instance of the given Functional Resource Type that is associated with the service instance that executes the Cyclic Report procedure;
- h) contains any Parameter Labels for procedure configuration parameters, the service provider shall deliver for each label the qualified parameters for every configured instance of the procedure that is associated with the service instance that executes the Cyclic Report procedure; or
- i) contains one or more Parameter Names, the service provider shall deliver the qualified parameter for each of the listed parameters.

4.10.3.3 Stopping

Upon reception of a STOP invocation, the service provider shall:

- a) stop the cyclic timer;
- b) stop transferring the qualified parameters.

4.10.3.4 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by:

- a) stopping transmitting TransferDataInvocation PDUs;
- b) releasing the resources.

4.10.4 REQUIRED OPERATIONS

Table 4-57: Cyclic Report Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non- Blocking
START	Unbuffered Data Delivery	Y	N	Blocking
STOP	Unbuffered Data Delivery	N	N	Blocking
TRANSFER- DATA	Unbuffered Data Delivery	N	Y	Non-Blocking

4.10.4.1 START (Confirmed)

4.10.4.1.1 General

The Cyclic Report procedure shall extend the START operation defined by the Unbuffered Data Delivery procedure (see 4.10.3.1) through the addition of two parameters to the invocation and through the addition of one value for the diagnostic parameter of the return.

4.10.4.1.2 Operation Parameters Definitions

NOTE – Table 4-58 shows the extension parameters of the START operation defined by this procedure.

Table 4-58: START Extension Parameters

Extension Parameters	Invocation	Return
delivery-cycle	M	
list-of-parameters	M	

4.10.4.1.2.1 Extension Parameters Syntax

The type `CyclicReportStartInvocExt`, as defined in F4.12, shall specify the syntax of the extension parameters of the START invocation.

4.10.4.1.2.2 delivery-cycle

The `delivery-cycle` parameter shall be present in the invocation and shall specify the requested interval between subsequent TRANSFER-DATA invocations.

4.10.4.1.2.3 list-of-parameters

4.10.4.1.2.3.1 The list of Parameter Names / Parameter Labels or the names of the lists that can be requested shall be defined by the service using this procedure or a procedure derived from this procedure.

4.10.4.1.2.3.2 The `list-of-parameters` parameter shall contain one of the following: (a) 'empty' value, i.e., left unspecified, (b) the name of a list, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, (g) a list of individual Parameter Labels, or (h) a list of individual Parameter Names.

4.10.4.1.2.3.3 The Parameter Names and parameter list names shall comply with the definition in annex E.

4.10.4.1.3 diagnostic Parameter Extension Value Definitions

4.10.4.1.3.1 If a negative START return is sent, the `diagnostic` parameter shall use one of the `diagnostic` values specified by the START operation in the Unbuffered Data Delivery procedure (see 4.10.3.3), or one of the following values:

- a) 'default not defined'—the default list (`list-of-parameters` set to 'empty') is unknown to the service provider.
- b) 'unknown list name'—the list name contained in the `list-of-parameters` is unknown to the service provider. The unknown list name shall be returned with the diagnostic.

- c) 'unknown Functional Resource Type'—the Functional Resource Type contained in the `list-of-parameters` parameter is unknown to the service provider (see 4.10.4.1.2.3) or the Functional Resource Type is not associated with the service instance that executes the Cyclic Report procedure. The unknown Functional Resource Type shall be returned with the diagnostic.
- d) 'unknown Functional Resource Name'—while the Functional Resource Type is known, the Functional Resource Name contained in the `list-of-parameters` parameter is unknown to the service provider (see 4.10.4.1.2.3) or the Functional Resource Name is not associated with the service instance that executes the Cyclic Report procedure. The unknown Functional Resource Name shall be returned with the diagnostic.
- e) 'unknown procedure type'—the procedure type contained in the `list-of-parameters` parameter is unknown to the service provider (see 4.10.4.1.2.3). The unknown procedure type shall be returned with the diagnostic.
- f) 'unknown procedure instance identifier'—while the procedure type is known, the procedure instance identifiers contained in the `list-of-parameters` parameter is unknown to the service provider (see 4.10.4.1.2.3). The unknown procedure instance identifier shall be returned with the diagnostic.
- g) 'unknown parameter identifier'—one or more Parameter Identifiers contained in the `list-of-parameters` parameter are unknown to the service provider (see 4.10.4.1.2.3) for one of the following reasons:
 - 1) the Functional Resource or procedure type specified as part of the Parameter Label is not associated with the service instance executing the given Cyclic Report procedure instance;
 - 2) a parameter with the given Published Identifier does not exist for the specified Functional Resource or procedure type or instance.

The list of unknown Parameter Names or Parameter Labels shall be returned with the diagnostic. For each unknown Parameter Identifier that is contained in a Parameter Name in the `list-of-parameters`, the Parameter Name shall be returned. For each unknown Parameter Identifier that is contained in a Parameter Label in the `list-of-parameters`, the Parameter Label shall be returned.

- h) 'out of range'—the service user requested a delivery cycle which is shorter than the limit set by the configuration parameter `PCRminimumAllowedDeliveryCycleType` (see 4.10.5).

4.10.4.1.3.2 The type `CyclicReportStartDiagnosticExt`, as defined in F4.12, shall specify the syntax of the diagnostic parameter of the START return.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.10.4.2 TRANSFER-DATA (Unconfirmed)**4.10.4.2.1 General**

This procedure refines the TRANSFER-DATA operation defined in 4.4.3.2 defining the syntax of one parameter of the invocation.

4.10.4.2.2 Operation Parameters Definitions

NOTE – The common parameters of the TRANSFER-DATA operation are defined in 3.9.2. This procedure refines the **data** parameter of the TRANSFER-DATA operation.

4.10.4.2.2.1 data Parameter Syntax

The type `CyclicReportTransferDataInvocDataRef` defined in F4.12 shall specify the syntax of the **data** parameter of the TRANSFER-DATA invocation using the **qualified-parameters** definition.

NOTE – The **data** parameter syntax is structured as a sequence of qualified parameters, each of which carries the name, the value, the type, and the qualifier of the parameter (see annex C).

4.10.4.2.2.2 qualified-parameters

The **qualified-parameters** parameter shall carry the name, the value, the type, and the qualifier of the parameters (see annex C).

4.10.5 CONFIGURATION PARAMETERS

The Cyclic Report procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-59.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-59: Cyclic Report Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Configuration Parameter Identifier and Type (F4.16)
named-label-lists	4.10.3.1.3 b)	Yes	pCRnamedLabelLists PCRnamedLabelListsType
minimum-allowed-delivery-cycle (in milliseconds)	4.10.4.1.2.2	Yes	pCRminimumAllowedDeliveryCycle PCRminimumAllowedDeliveryCycleType
default list of parameters	4.10.3.1.3 a)	No	N/A

NOTE – The default list of parameters is shown in table 4-59 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each list it is stated whether this list is specified to be the default list (see `LabelList` in F4.16).

4.10.6 PROCEDURE STATE TABLE

Table 4-60: Cyclic Report Procedure State Table

No.	Incoming Event	State 1 ('inactive')	State 2 ('active')
1	(StartInvocation)	IF "positive result" THEN (+StartReturn) 'start cyclic timer' → 2 ELSE (-StartReturn) ENDIF	(See table 4-9)
2	(StopInvocation)	(See table 4-9)	IF "positive result" THEN (+StopReturn) 'stop cyclic timer' → 1 ELSE (-StopReturn) ENDIF
3	'cyclic timer expired'	Not applicable	{periodic delivery}
4	'data available'	Not applicable	(See table 4-9)
5	'invalid PDU'	(See table 4-9)	(See table 4-9)
6	'terminate procedure'	(See table 4-9)	(See table 4-9)

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table 4-61: Procedure State Table Incoming Event Description References

Event	Reference
'cyclic timer expired'	4.10.3.2.1
'invalid PDU'	3.2.3.6
'terminate procedure'	4.2.3; internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND

Table 4-62: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	All checks on the invocation are passed.

Table 4-63: Procedure State Table Simple Action References

Name	References
'set cyclic timer to delivery-cycle value'	4.10.3.1.1
'start cyclic timer'	4.10.3.1.4
'data available'	4.10.3.2.1
'restart cyclic timer'	4.10.3.2.3
'stop cyclic timer'	4.10.3.3
'terminate itself'	4.10.3.4

Table 4-64: Procedure State Table Compound Action Definitions

Name	Actions Performed
{periodic delivery}	IF data is available THEN trigger the 'data available' incoming event ENDIF 'restart cyclic timer'
{start cyclic timer}	'set cyclic timer to delivery-cycle value' 'start cyclic timer'

4.11 NOTIFICATION

4.11.1 VERSION NUMBER

The version number of this procedure is 1.

4.11.2 DISCUSSION

4.11.2.1 Purpose

The Notification procedure provides a means by which a service user is able to select from a set of pre-identified events and subsequently receive notification of the occurrence of those selected events while the Notification procedure is active.

NOTE – A CSTS can issue notifications without using the Notification procedure by using a procedure that directly includes the NOTIFY operation. For each such NOTIFY-extended procedure, the definition of the events that are to be reported via the NOTIFY operation is specified for that procedure and/or for the service that incorporates the procedure.

4.11.2.2 Concept

Each instance of a CSTS that incorporates the Notification procedure (hereinafter referred to as a *notification-enabled CSTS*) reports on each occurrence of any event belonging to a set of predefined and selected events.

The set of notifiable events for a CSTS is identified by named event lists, i.e., named lists of Event Labels for that service or the Event Labels or Event Names of individual notifiable events. The `list-of-events` parameter includes one of the following: (a) 'empty' signifying that the default list shall be applied, (b) a named list of Event Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or (g) the Event Labels or Names of individual notifiable events.

Each named event list has a string naming that list that represents multiple individual Event Labels. One special case of a notifiable named event list exists for each notification-enabled CSTS: the default list. The default list is named as any other list that may exist for the given CSTS, but it is automatically subscribed to when the `list-of-events` parameter is left empty. The definition of the default list is controlled by the specification of the CSTS using the Notification procedure or by a derived procedure or may be delegated to Service Management.

For a given notification-enabled CSTS, the event list names, the Event Labels represented by the list names and the Event Labels included in the default list (if any) and the set of Event Labels or Event Names are defined by the specification of that CSTS. A CSTS using this procedure will have to:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) select the Functional Resource Types and procedure types as well as the associated events from the Published Identifiers (maintained by SANA);
- b) define the grouping of Event Labels into lists and allocate a list name for each list;
- c) identify which of the defined lists will be the default list.

In starting the Notification procedure as part of a CSTS, the service user subscribes to the particular events that are to be reported by that procedure in one of the following ways:

- a) by leaving the **list-of-events** unspecified (i.e., set to 'empty'); then for each Event Label represented by the default list of Event Labels the reporting of the associated events is enabled;
- b) by specifying the name of a list of Event Labels which represents a predefined set of Event Labels;
- c) by selecting a Functional Resource Type, thereby enabling the reporting of all events belonging to the instances of that Functional Resource Type that is directly associated with the CSTS executing the Notification procedure;
- d) by selecting a Functional Resource Name, thereby enabling the reporting of all events belonging to that Functional Resource Instance;
- e) selecting a procedure type, thereby enabling the reporting of all configuration change events of all procedure instances of the given procedure type associated with the service instance executing the Notification procedure;
- f) selecting a procedure instance identification, thereby enabling the reporting of all configuration change events belonging to that procedure instance; or
- g) by listing the Event Labels or Event Names of the individual events that are reportable by that service instance.

The operations defined in this procedure allow a service user to interact with a service provider to:

- a) request the start of reporting the occurrence of any of the set of pre-identified notifiable events;
- b) receive notification of the occurrence of the specified events;
- c) stop and optionally later re-start the delivery of event notifications, applying the same or a different selection of notifiable events.

4.11.3 BEHAVIOR

4.11.3.1 Starting

4.11.3.1.1 The service user shall invoke the START operation to subscribe to the subset of the notifiable events that are to be reported upon their occurrence.

4.11.3.1.1.1 The subset may be expressed as a single event list name, as a single Functional Resource Type or Name, as a single procedure type or procedure instance, or as a set of individual Event Labels or Event Names.

4.11.3.1.1.2 If no Event Name or event list name is specified in the START invocation, the default list shall be applied.

4.11.3.1.2 The service provider shall reject the START operation with the diagnostic value 'out of service' if `production-status` is 'halted'; otherwise the service provider shall perform the START operation.

4.11.3.1.3 Upon receipt of the START invocation, the service provider shall confirm that the invocation is valid. A START invocation for the Notification procedure is valid if it meets any one of the following conditions:

- a) if the `list-of-events` parameter is 'empty', signifying subscription to the default list of Event Labels provided such default list has been established;
- b) if the `list-of-events` parameter contains one event list name for a list of Event Labels that is contained in the set of label lists that has been established for the CSTS for use by the Notification procedure;
- c) if the `list-of-events` parameter contains one Functional Resource Type that is associated with the service instance that executes the Notification procedure;
- d) if the `list-of-events` parameter contains one name of a Functional Resource Instance that is associated with the service instance that executes the Notification procedure;
- e) if the `list-of-events` parameter contains one procedure type that is associated with the service instance that executes the Notification procedure;
- f) if the `list-of-events` parameter contains one procedure instance identifier of a procedure instance that is associated with the service instance that executes the Notification procedure;
- g) if (1) the `list-of-events` parameter contains one or more Functional Resource Event Names or Event Labels, and (2) every one of those labels or names is the label or name of an event of a Functional Resource that is associated with the service instance that executes the Notification procedure;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- h) if (1) the `list-of-events` parameter contains one or more procedure configuration change Event Labels or Event Names, and (2) every one of these labels or names is the label or name of an event of a configured procedure that is associated with the service instance that executes the Notification procedure.

4.11.3.1.4 Upon success of the START operation, the Notification procedure instance shall be subscribed to the published events identified in the START invocation.

4.11.3.2 Notifying Occurrences of Events

4.11.3.2.1 The NOTIFY invocation is valid only in the procedure state 'active' and shall be invoked only by the service provider.

4.11.3.2.2 Upon the occurrence of any of the notifiable events to which the procedure instance has been subscribed (see 4.11.3.1), the service provider shall invoke the NOTIFY operation to inform the service user of the occurrence of the event. If the `list-of-events` parameter:

- a) is left empty, then
 - 1) for each Functional Resource Event Label in the default list (see annex E), the service provider shall notify the occurrence of the event (see C2.1) for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Notification procedure;
 - 2) for each procedure configuration change Event Label in the default list, the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;
- b) contains the name of a list of Event Labels, then
 - 1) for each Functional Resource Event Label in the named list, the service provider shall notify the occurrence of the event for that label for the Functional Resource Instances of the given type that are directly associated with the service instance that executes the Notification procedure;
 - 2) for each procedure configuration change Event Label in the named list, the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;
- c) contains a Functional Resource Type, then the service provider shall notify the occurrence of all events for all instances of that Functional Resource Type that are directly associated with the service instance that executes the Notification procedure;
- d) contains a Functional Resource Name, then the service provider shall notify the occurrence of all events of the named Functional Resource Instance;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- e) contains a procedure type, then the service provider shall notify the occurrence of any configuration parameter change event for all configured instances of the procedure type that are associated with the service instance executing the Notification procedure;
- f) contains a procedure instance identification, then the service provider shall notify any occurrence of a configuration parameter change event for that procedure instance;
- g) contains any Functional Resource Event Labels, then for each label the service provider shall notify the occurrence of the event for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Notification procedure;
- h) contains any procedure configuration change Event Labels, then for each label the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;
- i) contains one or more Event Names, then the service provider shall notify the occurrence of any of the listed events.

4.11.3.2.3 If an event is subscribed in terms of an individual Event Name, the corresponding event - name parameter (see 3.11.2.2.3.1) shall contain that Event Name.

4.11.3.2.4 The service specification or derived procedure shall specify the conditions under which it is permissible or required to use the Event Label or Event Name in an event - name parameter that corresponds to an event that is subscribed in terms of an Event Label.

4.11.3.3 Stopping

The service user shall invoke the STOP operation to disable the generation of notifications of the occurrence of subscribed events.

4.11.3.4 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by:

- a) discarding pending notification;
- b) releasing the resources.

4.11.4 REQUIRED OPERATIONS

Table 4-65: Notification Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
START	Common	Y	N	Blocking
STOP	Common	N	N	Blocking
NOTIFY	Common	N	N	Non-Blocking

4.11.4.1 START (Confirmed)

4.11.4.1.1 General

The Notification procedure shall extend the START operation defined in 3.7.2 through the addition of one parameter to the invocation and through the addition of values for the diagnostic parameter of the return.

4.11.4.1.2 Operation Parameters Definitions

NOTE – Table 4-66 shows the extension parameters of the START operation defined by this procedure.

Table 4-66: START Extension Parameters

Extension Parameters	Invocation	Return
list-of-events	M	

4.11.4.1.2.1 Extension Parameters Syntax

4.11.4.1.2.1.1 The type NotificationStartInvocExt, as defined in F4.13, shall specify the syntax of the extension parameter of the START invocation.

4.11.4.1.2.1.2 The type NotificationStartDiagnosticExt, as defined in F4.13, shall specify the additional values the diagnostic parameter of the START return.

4.11.4.1.2.2 list-of-events

4.11.4.1.2.2.1 The list of events or the named event lists that can be requested shall be defined by the service using this procedure or by a procedure derived from this procedure or may be delegated to Service Management.

4.11.4.1.2.2.2 The `list-of-events` parameter shall contain one of the following:

- a) 'empty' which signifies that the service provider shall notify the events defined in the default list of events;
- b) one named event list that defines a predefined set of Event Labels that represent the notifiable events that are to be reported to the service user upon their occurrence;
- c) one Functional Resource Type, in which case the occurrence of events related to any of the instances of the Functional Resource Type associated with the service instance in which the Notification procedure executes shall be notified to the service user;
- d) one Functional Resource Name, for which all associated events shall be notified to the service user upon their occurrence;
- e) one procedure type, in which case the occurrence of any change of the configuration parameters of all configured procedure instances of that procedure type associated with the service instance in which the Notification procedure executes shall be notified to the service user;
- f) one procedure instance identifier, in which case the occurrence of any change of the configuration parameters of that procedure instance shall be notified to the service user; or
- g) one or more individual Event Labels or Event Names of the notifiable events that are to be reported to the service user upon their occurrence.

4.11.4.1.2.2.3 If the service user wishes to subscribe to one or more of the published events defined by this Recommended Standard, the `list-of-events` parameter shall contain one or more of the Event Names corresponding to the following definitions:

- a) `svcProductionStatusChange`: subscription to the 'production status change' event;
- b) `svcProductionConfigurationChange`: subscription to the 'production configuration change' event.

NOTE – The published events listed in a) and b) above are defined as Published Identifiers (see F4.17).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.11.4.1.2.2.4 A service using this procedure or a procedure derived from this procedure may define additional individual notifiable events. For each additional individual notifiable event, an Event Label and (optionally) an event value (along with its type and range) shall be defined.

4.11.4.1.2.2.5 If the service user wishes to subscribe to any of those additional individual notifiable events, the `list-of-events` parameters shall contain the Event Label or Event Name of each notifiable event to be reported.

NOTE – Notifiable Event Labels that are added by services using this procedure or by procedures derived from this procedure may also be included in the list of Event Labels represented by a named event list.

4.11.4.1.2.2.6 A service using this procedure or a procedure derived from this procedure may define one or more lists of Event Labels. Each list shall have an event list name defined for it.

4.11.4.1.2.2.7 If the service user wishes to subscribe to a named event list, the `list-of-events` parameter shall contain the name of the notifiable named event list.

4.11.4.1.2.2.8 A service using this procedure or a procedure derived from this procedure may define a single list of notifiable events as the default list.

NOTE – The default list is a named event list; i.e., a name is assigned also to the default list. However, it is also flagged to serve as the default list and can therefore be selected by setting the `list-of-events` parameter to 'empty'. (See `ListOfParametersEvents` in F4.3.)

4.11.4.1.2.2.9 Each named event list shall contain the Event Identifiers and associated Functional Resource Types of individually published events (see annex E).

4.11.4.1.2.2.10 The Event Identifiers shall be defined using Published Identifiers.

4.11.4.1.2.2.11 The named event list name shall be defined using a string.

4.11.4.1.3 diagnostic Parameter Extension Value Definitions

If a negative START return is sent, the `diagnostic` parameter shall use one of the `diagnostic` values specified in 3.7.2.3, or one of the following values:

- a) 'default not defined'—the default list (`list-of-events` set to 'empty') is unknown to the service provider.
- b) 'unknown list name'— the list name contained in the `list-of-parameters` is unknown to the service provider. The unknown list name shall be returned with the `diagnostic`.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- c) 'unknown Functional Resource Type'—the Functional Resource Type contained in the `list-of-events` parameter is unknown to the service provider (see 4.11.4.1.2.2) or the Functional Resource Type is not associated with the service instance that executes the Notification procedure. The unknown Functional Resource Type shall be returned with the diagnostic.
- d) 'unknown Functional Resource Name'—while the Functional Resource Type is known, the Functional Resource Name contained in the `list-of-events` parameter is unknown to the service provider (see 4.11.4.1.2.2) or the Functional Resource Name is not associated with the service instance that executes the Notification procedure. The unknown Functional Resource Name shall be returned with the diagnostic.
- e) 'unknown procedure type'—the procedure type contained in the `list-of-events` parameter is unknown to the service provider (see 4.11.4.1.2.2). The unknown procedure type shall be returned with the diagnostic.
- f) 'unknown procedure instance identifier'—while the procedure type is known, the procedure instance identifier contained in the `list-of-events` parameter is unknown to the service provider (see 4.11.4.1.2.2). The unknown procedure instance identifier shall be returned with the diagnostic.
- g) 'unknown event identifier'—one or more Event Identifiers contained in the `list-of-events` parameter are unknown to the service provider (see 4.11.4.1.2.2) for one of the following reasons:
 - 1) the Functional Resource specified as part of the Event Name is not associated with the service instance executing the given Notification procedure instance;
 - 2) the Functional Resource Type or procedure type specified as part of the Event Label is not associated with the service instance executing the given Notification procedure instance;
 - 3) an event with the given Published Identifier does not exist for the specified Functional Resource Type;
 - 4) an event with the given Published Identifier does not exist for the specified procedure type.

The list of unknown Event Names or Event Labels shall be returned with the diagnostic. For each unknown Event Identifier that is contained in an Event Name in the `list-of-events`, the Event Name shall be returned. For each unknown Event Identifier that is contained in an Event Label in the `list-of-events`, the Event Label shall be returned.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.11.5 CONFIGURATION PARAMETERS

The Notification procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-67.

NOTE – For each configuration parameter, the table provides a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-67: Notification Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Configuration Parameter Identifier and Type (F4.16)
named label lists	4.11.3.1.3 b)	Yes	pNnamedLabelLists PNnamedLabelListsType
default list of events	4.11.4.1.2.2.8	No	N/A

NOTE – The default list of events is shown in table 4-67 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each named event list it is stated whether this list is specified to be the default list.

4.11.6 PROCEDURE STATE TABLE**Table 4-68: Notification Procedure State Table**

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(StartInvocation)	IF “positive result” THEN (+StartReturn) ‘enable event notification for selected events’ → 2 ELSE (-StartReturn) ENDIF	‘procedure to association abort ‘protocol error’ → 1
2	(StopInvocation)	‘procedure to association abort ‘protocol error’	IF “positive result” THEN (+StopReturn) ELSE (-StopReturn) ENDIF
3	‘notifiable event occurred’	Not applicable	{notify ‘notifiable event’}
4	‘invalid PDU’	‘procedure to association abort ‘protocol error’	‘procedure to association abort ‘protocol error’ → 1
5	‘terminate procedure’	‘terminate itself’	‘terminate itself’

Table 4-69: Procedure State Table Event Description References

Event	Reference
'notifiable event occurred'	4.11.3.2
'invalid PDU'	3.2.3.6
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND.

Table 4-70: Procedure State Table Predicate Descriptions

Predicate	Evaluates to TRUE if
"positive result"	All checks on the invocation are passed

Table 4-71: Procedure State Table Simple Action References

Name	References
'create a notification'	4.11.3.2.2
'send the notification'	4.11.3.2.2
'procedure to association abort 'xxx''	Raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure. 4.2.2.3
'terminate itself'	4.11.3.4

Table 4-72: Procedure State Table Compound Action Definitions

Name	Actions Performed
{notify 'xxx'}	'create a notification' with Event Identifier set to 'xxx' 'send the notification' immediately

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.12 THROW EVENT

4.12.1 VERSION NUMBER

The version number of this procedure is 1.

4.12.2 DISCUSSION

4.12.2.1 Purpose

The Throw Event procedure provides the capability for a service user to request the service provider to initiate predefined actions to be performed by the Complex, to receive acknowledgements of successful receipt of the requests, and to receive reports of the final outcomes of the actions from the service provider.

The service provider executes the actions and checks the guard conditions applicable to the actions. The guard conditions are the conditions under which the service provider can properly and safely execute the actions. The guard conditions are defined by the service using this procedure or by the Functional Resources and their parameters the procedure shall act on.

4.12.2.2 Concept

The Throw Event procedure is intended for use in Cross Support Transfer Services that involve the modification of operating parameters of a Complex during the execution of a service package. The procedure may be incorporated into a CSTS to provide a capability to modify:

- a) production parameters associated with the data being transferred by that transfer service (e.g., a service whose primary purpose is to deliver commands to the space element, which uses the Throw Event procedure to modify the link parameters used to deliver those commands); or
- b) production parameters of the Complex independent of any data transfer via that transfer service (e.g., a service whose purpose is to control parameters of production functions that support multiple Cross Support Service instances, and for which no single service instance has the authority to modify those parameters on behalf of the service user).

NOTE – If the directed action cannot be completed by the CSTS service provider itself (e.g., it must be performed by Complex Management), then the service provider must forward the directive to the appropriate entity of the Complex for completion of the action.

No specific actions are defined as part of the Throw Event procedure. Each service that uses this procedure defines the actions. Also Functional Resources may specify such actions that are intended to modify the Functional Resource configuration.

NOTE – The service itself may defer the definition of the actions to a bilateral agreement between the service providing and service using organizations.

This procedure uses only one operation: the EXECUTE-DIRECTIVE. It allows the service user to transmit a directive to the service provider.

The service user may invoke the EXECUTE-DIRECTIVE operations at any time that the service instance is in the state 'bound'.

4.12.3 BEHAVIOR

4.12.3.1 Activities

4.12.3.1.1 The service user shall invoke the EXECUTE-DIRECTIVE operation to request the performance of a predefined action by the Complex.

4.12.3.1.2 The service provider shall acknowledge the receipt of a valid request and deny any invalid request.

4.12.3.1.3 If the request is valid, the service provider shall subsequently report on the success or failure of the requested action.

4.12.3.1.4 The service using this procedure or the Functional Resources this procedure is acting on shall define the guard conditions required to execute the predefined actions properly and safely.

4.12.3.2 Acknowledging Directives

4.12.3.2.1 If the invocation is a valid directive, the service provider shall:

- a) send a positive acknowledgement; and
- b) begin performing the requested action (see 4.12.3.3).

4.12.3.2.2 If the invocation is not a valid directive, the service provider shall:

- a) send a negative acknowledgement; and
- b) cease performing the operation.

4.12.3.3 Performing Directed Actions

4.12.3.3.1 The Complex shall attempt to perform the directed action. There are no time constraints imposed by the Throw Event procedure on the completion of the action.

NOTE – Procedures derived from the Throw Event procedure may impose time constraints on the completion of the directed action.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

4.12.3.3.2 A single action may involve setting of a sequence of parameters.

4.12.3.3.2.1 In this case the individual parameters shall be set in the same sequence as specified in the `directive-qualifier` parameter.

4.12.3.3.2.2 Parameter-specific parameter guard conditions shall be evaluated only after setting of the previous parameter in the sequence has completed.

NOTE – This approach ensures that each guard condition is checked only once preceding configuration have taken effect and therefore the check is performed based on the up-to-date status.

4.12.3.3.3 When the action is successfully completed, the service provider shall send a positive return.

4.12.3.3.4 If the action cannot be successfully completed, the service provider shall send a negative return.

4.12.3.3.5 After having sent the return of the EXECUTE-DIRECTIVE operation, the service provider shall cease performing the operation.

4.12.3.4 Terminating

Upon receipt of a 'terminate procedure' event from the Association Control procedure, the procedure shall terminate by:

- a) ceasing the performing of any ongoing EXECUTE-DIRECTIVE operations;
- b) releasing the resources.

NOTE – If the execution of directed actions is not yet completed at the time the Throw Event procedure is terminated, completion of these actions will not be reported by this procedure and will have to be determined by other means.

4.12.4 REQUIRED OPERATIONS

Table 4-73: Throw Event Procedure Required Operations

Operations	Source	Extended	Refined	Procedure Blocking/Non-Blocking
EXECUTE-DIRECTIVE	Common	Y	N	Non-Blocking

4.12.4.1 EXECUTE-DIRECTIVE (Acknowledged)

4.12.4.1.1 General

The Throw Event procedure shall extend the EXECUTE-DIRECTIVE operation defined in 3.13 through the addition of one value for the `diagnostic` parameter of the acknowledgement and return.

4.12.4.1.2 Invocation, Acknowledgement, Return, and Parameters

The common parameters of the EXECUTE-DIRECTIVE (acknowledged) operation are defined in 3.13.2.

4.12.4.1.3 diagnostic Parameter Extension Value Definitions

4.12.4.1.3.1 If a negative EXECUTE-DIRECTIVE acknowledgement or return is sent, the `diagnostic` parameter shall use one of the following values:

- a) one of the `diagnostic` values specified in 3.13.2.3, or
- b) the value 'guard condition evaluated to false'—a required condition was found not to be met.

NOTE — Whenever a negative acknowledgement has been sent by the service provider, the action identified by the `directive-identifier` parameter has not been performed. Whenever a negative return has been sent by the service provider, the action identified by the `directive-identifier` parameter has either been performed only partially or not at all. The negative return provides the detailed information to which extent a requested action has been performed, e.g., for which Functional Resource parameters the update has failed.

4.12.4.1.3.2 The type `TcExecDirNegReturnDiagnosticExt`, as defined in F4.14, shall specify the additional value of the `diagnostic` parameter of the EXECUTE-DIRECTIVE return.

4.12.5 CONFIGURATION PARAMETERS

The Throw Event procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-74.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-74: Throw Event Procedure Configuration Parameters

Parameters	Cross-Reference	Readable	Configuration Parameter Identifier and Type
predefined actions and associated directive ids, directive values and guard conditions	4.12.2.2	No	N/A

4.12.6 PROCEDURE STATE TABLE**Table 4-75: Throw Event Procedure State Table**

No.	Incoming Event	State 1 (‘inactive’)	State 2 (‘active’)
1	(ExecuteDirectiveInvocation)	IF “valid directive” THEN ‘initiate action’ (+ExecuteDirectiveAcknowledge) → 2 ELSE (-ExecuteDirectiveAcknowledge) ENDIF	IF “valid directive” THEN ‘initiate action’ (+ExecuteDirectiveAcknowledge) ELSE (-ExecuteDirectiveAcknowledge) ENDIF
2	‘action completed [N]’		(+ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN → 1 ENDIF
3	‘action not successfully completed [N]’		(-ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN → 1 ENDIF
4	‘invalid PDU’	‘procedure to association abort ‘xxx’’	‘procedure to association abort ‘xxx’’ → 1
5	‘terminate procedure’	‘terminate itself’	‘terminate itself’

Table 4-76: Procedure State Table Incoming Event Description References

Event	Reference
'action completed'	4.12.3.3.2
'action not successfully completed'	4.12.3.3.4
'invalid PDU'	3.2.3.6
'terminate procedure'	4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND

Table 4-77: Procedure State Table Predicate Definitions

Predicate	Evaluates to TRUE if
"valid directive"	the conditions specified in 4.12.3.1.2 or 4.12.3.2.1 are met

Table 4-78: Procedure State Table Simple Action References

Name	References
'initiate action'	4.12.3.3.1
'procedure to association abort 'xxx''	Raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure. 4.2.2.3
'terminate itself'	4.12.3.4

ANNEX A

IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA

(NORMATIVE)

A1 INTRODUCTION

A1.1 OVERVIEW

Although it might be possible to implement a software library on the basis of this specification, the prime intent of this document is to provide a framework for the specification of Cross Support Transfer Services. Such service specification will provide a specification for all elements that are left abstract in this document and can thus be implemented.

As an aide to the creation of the Implementation Conformance Statement (ICS) proforma for transfer services developed on the basis of this document, this annex provides the Implementation Conformance Statement (ICS) Requirements List (RL) for the elements specified herein. Service specifications are expected to import this Requirements List and to create a service-specific profile on this basis.

The RL support column in this annex is blank. An implementation's completed RL is called the PICS. The PICS states which capabilities and options have been implemented. The following can use the PICS:

- a) the implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;
- b) a supplier or potential acquirer of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma;
- c) a user or potential user of the implementation, as a basis for initially checking the possibility of interworking with another implementation (it should be noted that, while interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICSes);
- d) a tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

A1.2 ABBREVIATIONS AND CONVENTIONS

The RL consists of information in tabular form. The status of features is indicated using the abbreviations and conventions described below.

Item Column

The item column contains a prefix identifying the element the given table is referring to and sequential numbers for items in the table.

Feature Column

The feature column contains a brief descriptive name for a feature. It implicitly means ‘Is this feature supported by the implementation?’

Status Column

The status column uses the following notations:

- a) M mandatory;
- b) O optional;
- c) O<n> optional, but support of at least one of the group of options labeled by the same numeral <n> is required;
- d) C<n> conditional as defined in corresponding expression below the table;
- e) X prohibited;
- f) N/A not applicable.

Support Column Symbols

The support column is to be used by the implementer to state whether a feature is supported by entering Y, N, or N/A, indicating:

- a) Y Yes, supported by the implementation;
- b) N No, not supported by the implementation;
- c) N/A Not applicable.

The support column should also be used, when appropriate, to enter values supported for a given capability.

Allowed Values Column

All PDU parameter types are specified in annex F using ASN.1. The ASN.1 data type specifications constrain among others the permissible value range, and therefore such constraints are not repeated in the Allowed Values column in the tables contained in this annex. However, if a parameter is constrained for all instances of the given PDU to a subset of the range or set specified for that parameter in annex F, then the subset is identified in the tables that contain the PDU parameters.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Allowed Values Column Symbols

If the specification of allowed values is too large to fit in the Allowed Values cell, the Allowed Values column uses the notation 'AV<n>' as an indication that the allowed values are specified below the table.

Supported Values Column

The Supported Values column is to be used by the implementer to state whether the specified range or set of values for the parameter is supported by entering Y or SV<n>, indicating:

- a) Y Yes, the range/set defined in the Recommended Specification is fully supported by the implementation;
- b) SV<n> The range/set defined in the Recommended Standard is not fully supported by the implementation. The supported subset is documented below the table.

A1.3 INSTRUCTIONS FOR COMPLETING THE RL

An implementer shows the extent of compliance to the Recommended Standard by completing the RL; that is, the state of compliance with all mandatory requirements and the options supported are shown. The resulting completed RL is called PICS. The implementer shall complete the RL by entering appropriate responses in the support or values supported column, using the notation described in A1.2. If a conditional requirement is inapplicable, N/A should be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference X_i , where i is a unique identifier to an accompanying rationale for the noncompliance.

A2 PICS PROFORMA FOR XYZ CSTS PROTOCOL (CCSDS 9NM.I-B-K)**A2.1 GENERAL INFORMATION**

The PICS for a CSTS implementation shall encompass the filled in tables A-1 to A-4.

Table A-1: Identification of PICS

Date of Statement (DD/MM/YYYY)	
PICS serial number	
System Conformance statement cross-reference	

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-2: Identification of Implementation under Test

Implementation name	
Implementation version	
Special Configuration	
Other Information	

Table A-3: Identification of Supplier

Supplier	
Contact Point for Queries	
Implementation Name(s) and Versions	
Other information necessary for full identification, e.g., name(s) and version(s) for machines and/or operating systems;	
System Name(s)	

Table A-4: Identification of Specification

CCSDS 9NM.I-B-K	
Have any exceptions been required? NOTE – A YES answer means that the implementation does not conform to the Recommended Standard. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is nonconforming.	Yes [] No []

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

A2.2 REQUIREMENTS LIST

This subsection provides the Requirement Lists for the elements specified in this Recommended Standard. Depending on which procedures and associated PDUs are actually used in a Cross Support Transfer Service specification, the relevant subset of the tables A-5 to A-24 will become part of the service-specific PICS proforma.

Table A-5: Required Procedures

Procedures				
Item	Description	Reference	Status	Support
proc-1	Association Control	4.3	M	
proc-2	Unbuffered Data Delivery	4.4	O	
proc-3	Buffered Data Delivery	4.5	O	
proc-4	Data Processing	4.6	O	
proc-5	Buffered Data Processing	4.7	O	
proc-6	Sequence-Controlled Data Processing	4.8	O	
proc-7	Information Query	4.9	O	
proc-8	Cyclic Report	4.10	O	
proc-9	Notification	4.11	O	
proc-10	Throw Event	4.12	O	

Table A-6: Required PDUs

Item	PDU	Ref.	Service Provider System		Service User System	
			Status	Support	Status	Support
pdu-1	BindInvocation	F4.5	M		M	
pdu-2	BindReturn	F4.5	M		M	
pdu-3	PeerAbortInvocation	F4.5	M		M	
pdu-4	UnbindInvocation	F4.5	M		M	
pdu-5	UnbindReturn	F4.5	M		M	
pdu-6	ExecuteDirectiveAcknowledge	F4.4	C1		C1	
pdu-7	ExecuteDirectiveInvocation	F4.4	C1		C1	
pdu-8	ExecuteDirectiveReturn	F4.4	C1		C1	
pdu-9	GetInvocation	F4.4	C2		C2	
pdu-10	GetReturn	F4.4	C2		C2	
pdu-11	NotifyInvocation	F4.4	C3		C3	
pdu-12	ProcessDataInvocation	F4.4	C4		C4	
pdu-13	ProcessDataReturn	F4.4	C5		C5	
pdu-14	StartInvocation	F4.4	C6		C6	
pdu-15	StartReturn	F4.4	C6		C6	
pdu-16	StopInvocation	F4.4	C6		C6	
pdu-17	StopReturn	F4.4	C6		C6	
pdu-18	TransferDataInvocation	F4.4	C7		C7	
pdu-19	ReturnBuffer	F4.7	C8		C8	
pdu-20	ForwardBuffer	F4.9	C9		C9	

C1 IF proc-6 OR proc-10 THEN M ELSE N/A

C2 IF proc-7 THEN M ELSE N/A

C3 IF proc-3 OR proc-4 OR proc-5 OR proc-6 OR proc-9 THEN M ELSE N/A

C4 IF proc-4 OR proc-5 OR proc-6 THEN M ELSE N/A

C5 IF proc-6 THEN M ELSE N/A

C6 IF proc-2 OR proc-3 OR proc-4 OR proc-5 OR proc-6 OR proc-8 OR proc-9 THEN M ELSE N/A

C7 IF proc-2 OR proc-3 OR proc-8 THEN M ELSE N/A

C8 If proc-3 THEN M ELSE N/A

C9 If proc-5 THEN M ELSE N/A

Table A-7: BIND Invocation Parameters

Parameters of the BindInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
bindInv-1	invokerCredentials	F4.3	M			
bindInv-2	invokeld	F4.3	M			
bindInv-3	procedureInstanceIcd	F4.3	M		AV1	
bindInv-4	initiatorIdentifier	F4.5	M			
bindInv-5	responderPortIdentifier	F4.5	M			
bindInv-6	serviceType	F4.5	M			
bindInv-7	versionNumber	F4.5	M			
bindInv-8	serviceInstanceIdentifier	F4.5	M			
bindInv-9	bindInvocationExtension	F4.5	M		AV2	

AV1 For the BIND invocation the procedureRole element of the parameter bindInv-3 must be set to 'associationControl'.

AV2 If parameters need to be added to the BIND invocation PDU, the parameter bindInv-9 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND invocation PDU, although permissible, is discouraged (see 4.3.3.1.12). Except if a procedure derived from the parent Association Control procedure that is using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters bindInv-1, bindInv-2 and bindInv-3 are contained in the complex parameter standardInvocationHeader in the BindInvocation type shown in F4.5. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

Table A-8: BIND Return Parameters

Parameters of the BindReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
bindRet-1	performerCredentials	F4.3	M			
bindRet-2	invokeld	F4.3	M			
bindRet-3	result	F4.3	M			
bindRet-4	positive	F4.3	C10		AV3	
bindRet-5	diagnostic	F4.3	C11		AV4	
bindRet-6	negExtension	F4.3	C11		AV5	
bindRet-7	responderIdentifier	F4.5	M			

C10 IF bindRet-3 = 'positive' THEN M ELSE X

C11 IF bindRet-3 = 'negative' THEN M ELSE X

AV3 If parameters need to be added to the positive BIND return PDU, the parameter bindRet-4 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND return PDU, although permissible, is discouraged (see 4.3.3.1.12). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

AV4 For the negative BIND return the parameter bindRet-5 is extended by the type AssocBindDiagnosticExt defined in F4.5. Therefore the parameter bindRet-5 may have (a) any value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by 'diagnosticExtension': 'acBindDiagExt': 'AssocBindDiagnosticExt' defined in F4.5 except 'assocBindDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'acBindDiagExt': 'AssocBindDiagnosticExt': 'assocBindDiagnosticExtExtension', but such extension is discouraged (see 4.3.3.1.12) and not specified in this Recommended Standard.

AV5 If parameters need to be added to the negative BIND return PDU, the parameter bindRet-6 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND return PDU, although permissible, is discouraged (see 4.3.3.1.12). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

All parameters of the BIND return PDU except bindRet-7 are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.5.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-9: PEER-ABORT Invocation Parameters

Parameters of the PeerAbortInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
peerAbortInv-1	diagnostic	F4.5	M		40 .. 126	

Table A-10: UNBIND Invocation Parameters

Parameters of the UnbindInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
unbindInv-1	invokerCredentials	F4.3	M			
unbindInv-2	invokerId	F4.3	M			
unbindInv-3	procedureInstanceId	F4.3	M		AV6	
unbindInv-4	unbindInvocationExtension	F4.5	M		AV7	

AV6 For the UNBIND invocation the procedureRole element of the parameter unbindInv-3 must be set to 'associationControl'.

AV7 If parameters need to be added to the UNBIND invocation PDU, the parameter unbindInv-4 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the UNBIND invocation PDU, although permissible, is discouraged (see 4.3.3.1.12). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters unbindInv-1, unbindInv-2 and unbindInv-3 are contained in the complex parameter standardInvocationHeader in the UnbindInvocation type shown in F4.5. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

Table A-11: UNBIND Return Parameters

Parameters of the UnbindReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
unbindRet-1	performerCredentials	F4.3	M			
unbindRet-2	invokeId	F4.3	M			
unbindRet-3	result	F4.3	M		AV8	

AV8 The value of the parameter unbindRet-3 of the UNBIND return PDU shall always be set to the value 'positive': 'notUsed'; i.e., the result is always positive and not extended.

All parameters of the UNBIND return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-12: EXECUTE-DIRECTIVE Invocation Parameters

Parameters of the ExecuteDirectiveInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
execDirInv-1	invokerCredentials	F4.3	M			
execDirInv-2	invokeId	F4.3	M			
execDirInv-3	procedureInstanceId	F4.3	M		AV9	
execDirInv-4	directiveIdentifier	F4.4	M		AV10	
execDirInv-5	localProcDirQualifier	F4.4	C12		AV11	
execDirInv-6	procedureInstanceId	F4.4	C13			
execDirInv-7	serviceProcDirQualifierValues	F4.4	C13		AV12	
execDirInv-8	functionalResourceInstanceNumber	F4.4	C14			
execDirInv-9	functionalResourceQualifiers	F4.4	C14		AV13	
execDirInv-10	directiveQualifierExtension	F4.4	C15		AV14	
execDirInv-11	executeDirectiveInvocationExtension	F4.4	M		AV15	

C12 IF execDirInv-4 is set to the Published Identifier of a directive that is registered under the procedure type that shall perform the EXECUTE-DIRECTIVE operation THEN M ELSE X

C13 IF execDirInv-4 is set to the Published Identifier of a directive that is registered under a procedure type that is associated with the type of service invoking the EXECUTE-DIRECTIVE operation, but different from the procedure type that shall perform the EXECUTE-DIRECTIVE operation THEN M ELSE X

C14 IF execDirInv-4 is set to the Published Identifier of a directive that is registered under a Functional Resource Type THEN M ELSE X

C15 IF NOT (C12 v C13 v C14) THEN M ELSE X

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV9 The value of the procedureRole element of the parameter execDirInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.
- AV10 The Published Identifier specified in the execDirInv-4 parameter must identify a registered directive.
- AV11 The parameter execDirInv-5 will be one of the following: (a) 'directiveQualifier': 'localProcDirQualifier': 'DirectiveQualifierValues': 'sequenceOfParamIdsAndValues', (b) 'directiveQualifier': 'localProcDirQualifier': 'DirectiveQualifierValues': 'parameterlessValues', or (c) 'directiveQualifier': 'localProcDirQualifier': 'DirectiveQualifierValues': 'noQualifierValues'.
- AV12 The parameter execDirInv-7 will be one of the following: (a) 'directiveQualifier': 'serviceProcDirQualifier': 'serviceProcDirQualifierValues': 'DirectiveQualifierValues': 'sequenceOfParamIdsAndValues', (b) 'directiveQualifier': 'serviceProcDirQualifier': 'serviceProcDirQualifierValues': 'DirectiveQualifierValues': 'parameterlessValues', or (c) 'directiveQualifier': 'serviceProcDirQualifier': 'serviceProcDirQualifierValues': 'DirectiveQualifierValues': 'noQualifierValues'.
- AV13 The parameter execDirInv-9 will be one of the following: (a) 'directiveQualifier': 'functResourceDirQualifier': 'functionalResourceQualifiers': 'DirectiveQualifierValues': 'sequenceOfParamIdsAndValues', (b) 'directiveQualifier': 'functResourceDirQualifier': 'functionalResourceQualifiers': 'DirectiveQualifierValues': 'parameterlessValues', or (c) 'directiveQualifier': 'functResourceDirQualifier': 'functionalResourceQualifiers': 'DirectiveQualifierValues': 'noQualifierValues'.
- AV14 The directive qualifier can be defined by the extension 'directiveQualifier': 'directiveQualifierExtension', but no such extension is specified in this Recommended Standard. Except if a procedure using this PDU defines such extension, this parameter must be absent.
- AV15 If parameters need to be added to the EXECUTE-DIRECTIVE invocation PDU, the parameter execDirInv-11 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters execDirInv-1, execDirInv-2 and execDirInv-3 are contained in the complex parameter standardInvocationHeader in the ExecuteDirectiveInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-13: EXECUTE-DIRECTIVE Acknowledgement Parameters

Parameters of the ExecuteDirectiveAcknowledge PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
execDirAck-1	performerCredentials	F4.3	M			
execDirAck-2	invokeId	F4.3	M			
execDirAck-3	result	F4.3	M			
execDirAck-4	positive	F4.5	C16		AV16	
execDirAck-5	diagnostic	F4.3	C17		AV17	
execDirAck-6	negExtension	F4.3	C17		AV18	

C16 IF execDirAck-3 = 'positive' THEN M ELSE X

C17 IF execDirAck-3 = 'negative' THEN M ELSE X

AV16 If parameters need to be added to the positive EXECUTE-DIRECTIVE acknowledgement PDU, the parameter execDirAck-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

AV17 For the EXECUTE-DIRECTIVE acknowledgement the parameter execDirAck-5 is extended by the type ExecDirNegAckDiagnosticExt defined in F4.4. Therefore the parameter execDirAck-5 may have (a) any value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt' in F4.4 except 'execDirNegAckDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt': 'execDirNegAckDiagnosticExtExtension', but no such extension is defined in this Recommended Standard.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

AV18 If parameters need to be added to the negative EXECUTE-DIRECTIVE acknowledgement PDU, the parameter execDirAck-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

All parameters of the EXECUTE-DIRECTIVE acknowledgement PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4.

Table A-14: EXECUTE-DIRECTIVE Return Parameters

Parameters of the ExecutedDirectiveReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
execDirRet-1	performerCredentials	F4.3	M			
execDirRet-2	invokeld	F4.3	M			
execDirRet-3	result	F4.3	M			
execDirRet-4	positive	F4.5	C18		AV19	
execDirRet-5	diagnostic	F4.3	C19		AV20	
execDirRet-6	negExtension	F4.3	C19		AV21	

C18 IF execDirRet-3 = 'positive' THEN M ELSE X

C19 IF execDirRet-3 = 'negative' THEN M ELSE X

AV19 If parameters need to be added to the positive EXECUTE-DIRECTIVE return PDU, the parameter execDirRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV20 For the negative EXECUTE-DIRECTIVE return PDU the parameter `execDirRet-5` is extended by the type `ExecDirNegReturnDiagnosticExt` defined in F4.4. Therefore the parameter `execDirRet-5` may have (a) any standard value defined for the `Diagnostic` type in F4.3 except `'diagnosticExtension'`; or (b) any value defined by the extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt'` defined in F4.4 except `'execDirNegReturnDiagnosticExtExtension'`. Additional values can be introduced by the further extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt': 'execDirNegReturnDiagnosticExtExtension'`.

If the EXECUTE-DIRECTIVE return PDU is used by the Throw Event procedure, i.e., the `procedureType` element of the parameter `execDirInv-3` of the associated EXECUTE-DIRECTIVE invocation has the value `'throwEvent'`, additional values are introduced by the further extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt': 'execDirNegReturnDiagnosticExtExtension': 'teExecDirDiagExt': 'TeExecDirNegReturnDiagnosticExt'`, where the type `TeExecDirNegReturnDiagnosticExt` is specified in F4.14. Therefore the parameter `execDirRet-5` may have in this case (a) any standard value defined for the `Diagnostic` type in F4.3 except `'diagnosticExtension'`; or (b) any value defined by the extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt'` defined in F4.4 except `'execDirNegReturnDiagnosticExtExtension'`; or (c) any value defined by the extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt': 'execDirNegReturnDiagnosticExtExtension': 'teExecDirDiagExt': 'TeExecDirNegReturnDiagnosticExt'` defined in F4.14 except `'teExecDirNegReturnDiagnosticExtExtension'`. Additional values can be introduced by the further extension `'diagnosticExtension': 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt': 'execDirNegReturnDiagnosticExtExtension': 'teExecDirDiagExt': 'TeExecDirNegReturnDiagnosticExt': 'teExecDirNegReturnDiagnosticExtExtension'`, but no such extension is defined in this Recommended Standard.

- AV21 If parameters need to be added to the negative EXECUTE-DIRECTIVE return PDU, the parameter `execDirRet-6` can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to `'notUsed'`.

All parameters of the EXECUTE-DIRECTIVE return PDU are contained the complex parameter of the type `StandardReturnHeader` that is specified in F4.3. Specific extensions are, however, specified in F4.4 and F4.14.

Table A-15: GET Invocation Parameters

Parameters of the GetInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
getInv-1	invokerCredentials	F4.3	M			
getInv-2	invokeld	F4.3	M			
getInv-3	procedureInstanceId	F4.3	M		AV22	
getInv-4	listOfParameters	F4.4	M			
getInv-5	getInvocationExtension	F4.4	M		AV23	

AV22 The value of the procedureRole element of the parameter getInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

AV23 If parameters need to be added to the GET invocation PDU, the parameter getInv-5 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters getInv-1, getInv-2, and getInv-3 are contained in the complex parameter standardInvocationHeader in the GetInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-16: GET Return Parameters

Parameters of the GetReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
getRet-1	performerCredentials	F4.3	M			
getRet-2	invokeId	F4.3	M			
getRet-3	result	F4.3	M			
getRet-4	positive	F4.3	C20		AV24	
getRet-5	qualifiedParameters	F4.4	C20		AV25	
getRet-6	getPosReturnExtExtension	F4.4	C20		AV26	
getRet-7	diagnostic	F4.3	C21		AV27	
getRet-8	negExtension	F4.3	C21		AV28	

C20 IF getRet-3 = 'positive' THEN M ELSE X

C21 IF getRet-3 = 'negative' THEN M ELSE X

AV24 For the positive GET return the parameter getRet-4 is set to 'getPosReturnExt': 'GetPosReturnExt' defined in F4.4.

AV25 For the positive GET return the parameter getRet-5 is specified by 'qualifiedParameters': 'QualifiedParametersSequence'. The type QualifiedParametersSequence is defined in F4.4.

AV26 If further parameters need to be added to the positive GET return PDU, the parameter getRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV27 For the negative GET return the parameter getRet-7 is extended by the type GetDiagnosticExt defined in F4.4. Therefore the parameter getRet-7 may have (a) any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'getDiagnosticExt': 'GetDiagnosticExt' defined in F4.4 except 'getDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'getDiagnosticExt': 'GetDiagnosticExt': 'getDiagnosticExtExtension', but no such extension is specified in this Recommended Standard.
- AV28 If parameters need to be added to the negative GET return PDU, the parameter getRet-8 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

All parameters of the GET return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-17: PROCESS-DATA Invocation Parameters

Parameters of the ProcessDataInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
procDataInv-1	invokerCredentials	F4.3	M			
procDataInv-2	invokeld	F4.3	M			
procDataInv-3	procedureInstanceId	F4.3	M		AV29	
procDataInv-4	dataUnitId	F4.4	M			
procDataInv-5	data	F4.4	M			
procDataInv-6	processDataInvocationExtension	F4.4	M		AV30	
procDataInv-7	processCompletionReport	F4.8	C22			
procDataInv-8	dataProcProcDataInvocExtExtension	F4.8	C22		AV31	
procDataInv-9	earliestDataProcessingTime	F4.10	C23			
procDataInv-10	latestDataProcessingTime	F4.10	C23			
procDataInv-11	sequContrDataProcProcDataInvocExtExtension	F4.10	C23		AV32	

C22 IF procDataInv-6 = ('dpProcDataInvocExt': 'DataProcProcDataInvocExt') THEN M ELSE X

C23 IF procDataInv-8 = ('scdpProcDataInvocExt': 'SequContrDataProcProcDataInvocExt') THEN M ELSE X

AV29 The value of the procedureRole element of the parameter procDataInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

- AV30 If the `procedureType` element of the parameter `procDataInv-3` has the value `'dataProcessing'` or `'bufferedDataProcessing'` or `'sequenceControlledDataProcessing'` or if the procedure using this PDU is derived from one of these three procedure types, then the parameter `procDataInv-6` shall be set to the value `'dpProcDataInvocExt': 'DataProcProcDataInvocExt'`. Otherwise, no such extension is specified in this Recommended Standard and the value of `procDataInv-6` shall be set to `'notUsed'` except if the procedure using this PDU is mentioned above. In case of other procedure types, this parameter shall be set to `'notUsed'` except if the procedure using this PDU specifies such extension.
- AV31 If further parameters need to be added to the PROCESS-DATA invocation PDU, the parameter `procDataInv-8` can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. Except if such extension is defined by the procedure derived from the Data Processing procedure or the Buffered Data Processing procedure and using this PDU, the value of this parameter shall be set to `'notUsed'`. If the PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the `procedureType` element of the parameter `procDataInv-3` has the value `'sequenceControlledDataProcessing'`, then the parameter `procDataInv-8` shall be set to `'scdpProcDataInvocExt': 'SequContrDataProcProcDataInvocExt'`.
- AV32 If parameters need to be added to the PROCESS-DATA invocation PDU used by the Sequence-Controlled Data Processing procedure, i.e., the `procedureType` element of the parameter `procDataInv-3` has the value `'sequenceControlledDataProcessing'`, the parameter `procDataInv-11` can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, this parameter shall be set to `'notUsed'`.

The parameters `procDataInv-1`, `procDataInv-2` and `procDataInv-3` are contained in the complex parameter `standardInvocationHeader` in the `ProcessDataInvocation` type shown in F4.4. This parameter is of the type `StandardInvocationHeader` that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-18: PROCESS-DATA Return Parameters

Parameters of the ProcessDataReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
procDataRet-1	performerCredentials	F4.3	M			
procDataRet-2	invokeId	F4.3	M			
procDataRet-3	result	F4.3	M			
procDataRet-4	positive	F4.3	C24		AV33	
procDataRet-5	dataUnitId	F4.10	C25			
procDataRet-6	sequContrDataProcProcDataPosReturnExtension	F4.10	C25		AV34	
procDataRet-7	diagnostic	F4.3	C26		AV35	
procDataRet-8	negExtension	F4.3	C26		AV36	
procDataRet-9	dataUnitId	F4.10	C27			
procDataRet-10	sequContrDataProcProcDataNegReturnExtension	F4.10	C27		AV37	

C24 IF procDataRet-3 = 'positive' THEN M ELSE X

C25 IF procDataRet-3 = 'positive' AND procDataRet-4 = 'scdpProcDataPosReturnExt': 'SequContrDataProcProcDataPosReturnExt' THEN M ELSE X

C26 IF procDataRet-3 = 'negative' THEN M ELSE X

C27 IF procDataRet-3 = 'negative' AND procDataRet-8 = 'scdpProcDataNegReturnExt': 'SequContrDataProcProcDataNegReturnExt' THEN M ELSE X

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV33 If parameters need to be added to the positive PROCESS-DATA return PDU, the parameter `procDataRet-4` can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. If this PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the `procedureType` element of parameter `procDataInv-3` in the associated invocation has the value 'sequenceControlledDataProcessing', then the parameter `procDataRet-4` shall be set to 'scdpProcDataPosReturnExt': 'SequContrDataProcProcDataPosReturnExt'. If the procedure using this PDU does not specify such extension, the value of the parameter `procDataRet-4` shall be set to 'notUsed'.
- AV34 If further parameters need to be added to the positive PROCESS-DATA return PDU, the parameter `procDataRet-6` can be used to do so, but this Recommended Standard does not specify such extension. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.
- AV35 For the PROCESS-DATA return the parameter `procDataRet-7` is extended by the type `SequContrDataProcProcDataDiagnosticExt` defined in F4.10. Therefore the parameter `procDataRet-7` may have (a) any standard value defined for the `Diagnostic` type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'scdpProcDataDiagExt': 'SequContrDataProcProcDataDiagnosticExt' defined in F4.10 except 'sequContrDataProcProcDataDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'scdpProcDataDiagExt': 'SequContrDataProcProcDataDiagnosticExt': 'sequContrDataProcProcDataDiagnosticExtExtension', but no such extension is specified in this Recommended Standard.
- AV36 If parameters need to be added to the negative PROCESS-DATA return PDU, the parameter `procDataRet-8` can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. If this PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the `procedureType` element of the parameter `procDataInv-3` in the associated invocation has the value 'sequenceControlledDataProcessing', then the parameter `procDataRet-8` shall be set to 'scdpProcDataNegReturnExt': 'SequContrDataProcProcDataNegReturnExt'. The type `SequContrDataProcProcDataNegReturnExt` is defined in F4.10. Except if such extension is defined by a procedure using this PDU, the value of this parameter shall be set to 'notUsed'.
- AV37 If further parameters need to be added to the negative PROCESS-DATA return PDU, the parameter `procDataRet-10` can be used to do so, but this Recommended Standard does not specify such extension. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

This PDU is valid only in case the PROCESS-DATA operation is used by the Sequence-Controlled Data Processing procedure, i.e., the `procedureType` element of the parameter `procDataInv-3` of the associated PROCESS-DATA invocation has the value

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

‘sequenceControlledDataProcessing’. The Data Processing procedure and the Buffered Data Processing procedure use the unconfirmed variant of the PROCESS-DATA operation.

All parameters of the PROCESS-DATA return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.10.

Table A-19: START Invocation Parameters

Parameters of the StartInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
startInv-1	invokerCredentials	F4.3	M			
startInv-2	invokeld	F4.3	M			
startInv-3	procedureInstanceld	F4.3	M		AV38	
startInv-4	startInvocationExtension	F4.4	M		AV39	
startInv-5	startGenerationTime	F4.7	C28			
startInv-6	stopGenerationTime	F4.7	C28			
startInv-7	buffDataDelStartInvocExtExtension	F4.7	C28		AV40	
startInv-8	firstDataUnitId	F4.10	C29			
startInv-9	sequContrDataProcStartInvocExtExtension	F4.10	C29		AV41	
startInv-10	deliveryCycle	F4.12	C30			
startInv-11	listOfParameters	F4.12	C30			
startInv-12	cyclicReportStartInvocExtExtension	F4.12	C30		AV42	
startInv-13	listOfEvents	F4.13	C31			
startInv-14	notificationStartInvocExtExtension	F4.13	C31		AV43	

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- C28 IF startInv-4 = 'bddStartInvocExt': 'BuffDataDelStartInvocExt' THEN M ELSE X
- C29 IF startInv-4 = 'scdpStartInvocExt': 'SequContrDataProcStartInvocExt' THEN M ELSE X
- C30 IF startInv-4 = 'crStartInvocExt': 'CyclicReportStartInvocExt' THEN M ELSE X
- C31 IF startInv-4 = 'nStartInvocExt': 'NotificationStartInvocExt' THEN M ELSE X

AV38 The value of the procedureRole element of the parameter startInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

AV39 If the procedureType element of the parameter startInv-3 has the value 'bufferedDataDelivery', then the parameter startInv-4 shall be set to the value 'bddStartInvocExt': 'BuffDataDelStartInvocExt'.

If the procedureType element of the parameter startInv-3 has the value 'sequenceControlledDataProcessing', then the parameter startInv-4 shall be set to the value 'scdpStartInvocExt': 'SequContrDataProcStartInvocExt'.

If the procedureType element of the parameter startInv-3 has the value 'cyclicReport', then the parameter startInv-4 shall be set to the value 'crStartInvocExt': 'CyclicReportStartInvocExt'.

If the procedureType element of the parameter startInv-3 has the value 'notification', then the parameter startInv-4 shall be set to the value 'nStartInvocExt': 'NotificationStartInvocExt'.

Also in all other cases where parameters need to be added to the START invocation PDU, the parameter startInv-4 can be used to do so, but no such extension is defined in this Recommended Standard. Therefore this parameter shall be set to the value 'notUsed' except if the procedure using this PDU specifies such extension.

AV40 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Buffered Data Delivery procedure, the parameter startInv-7 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Buffered Data Delivery procedure specifies such extension, this parameter shall be set to 'notUsed'.

AV41 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Sequence-Controlled Data Processing procedure, the parameter startInv-9 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure specifies such extension, this parameter shall be set to 'notUsed'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV42 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Cyclic Report procedure, the parameter startInv-12 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Cyclic Report procedure specifies such extension, this parameter shall be set to 'notUsed'.
- AV43 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Notification procedure, the parameter startInv-14 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure derived from the parent Notification procedure specifies such extension, this parameter shall be set to 'notUsed'.

The parameters startInv-1, startInv-2 and startInv-3 are contained in the complex parameter standardInvocationHeader in the StartInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

Table A-20: START Return Parameters

Parameters of the StartReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
startRet-1	performerCredentials	F4.3	M			
startRet-2	invokeld	F4.3	M			
startRet-3	result	F4.3	M			
startRet-4	positive	F4.3	C32		AV44	
startRet-5	diagnostic	F4.3	C33		AV45	
startRet-6	negExtension	F4.3	C33		AV46	

C32 IF startRet-3 = 'positive' THEN M ELSE X

C33 IF startRet-3 = 'negative' THEN M ELSE X

- AV44 If parameters need to be added to the positive START return PDU, the parameter startRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

- AV45 For the START return PDU the parameter startRet-5 is extended by the type StartDiagnosticExt defined in F4.4. Therefore the parameter startRet-5 may have (a) any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value 'bufferedDataDelivery', then parameter startRet-5 is further extended by the type BuffDataDelStartDiagnosticExt defined in F4.7. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'; or (c) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension': 'bddStartDiagExt': 'BuffDataDelStartDiagnosticExt' except 'buffDataDelStartDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension': 'bddStartDiagExt': 'BuffDataDelStartDiagnosticExt': 'buffDataDelStartDiagnosticExtExtension', but no such extension is specified in this Recommended Standard.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value 'cyclicReport', then parameter startRet-5 is extended by the type CyclicReportStartDiagnosticExt defined in F4.12. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'; or (c) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension': 'crStartDiagExt': 'CyclicReportStartDiagnosticExt' defined in F4.12 except 'cyclicReportStartDiagnosticExtExtension'. Additional values can be introduced by the further extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension': 'crStartDiagExt': 'CyclicReportStartDiagnosticExt': 'cyclicReportStartDiagnosticExtExtension', but no such extension is specified in this Recommended Standard.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value 'notification', then parameter startRet-5 is extended by the type NotificationStartDiagnosticExt defined in F4.13. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'; or (b) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'; or (c) any value defined by the extension 'diagnosticExtension': 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension': 'nStartDiagExt': 'NotificationStartDiagnosticExt' defined in F4.13 except 'notificationStartDiagnosticExtExtension'. Additional

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

values can be introduced by the further extension 'diagnosticExtension':
 'startDiagnosticExt': 'StartDiagnosticExt': 'startDiagnosticExtExtension':
 'nStartDiagExt': 'NotificationStartDiagnosticExt':
 'notificationStartDiagnosticExtExtension', but no such extension is specified in this Recommended Standard.

- AV46 If parameters need to be added to the negative START return PDU, the parameter startRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

Table A-21: STOP Invocation Parameters

Parameters of the StopInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
stopInv-1	invokerCredentials	F4.3	M			
stopInv-2	invokeld	F4.3	M			
stopInv-3	procedureInstanceld	F4.3	M		AV47	
stopInv-4	stopInvocationExtension	F4.4	M		AV48	

- AV47 The value of the procedureRole element of the parameter stopInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

- AV48 If parameters need to be added to the STOP invocation PDU, the parameter stopInv-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters stopInv-1, stopInv-2 and stopInv-3 are contained in the complex parameter standardInvocationHeader in the StopInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

Table A-22: STOP Return Parameters

Parameters of the StopReturn PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
stopRet-1	performerCredentials	F4.3	M			
stopRet-2	invokeId	F4.3	M			
stopRet-3	result	F4.3	M			
stopRet-4	positive	F4.3	C34		AV49	
stopRet-5	diagnostic	F4.3	C35		AV50	
stopRet-6	negExtension	F4.3	C35		AV51	

C34 IF stopRet-3 = 'positive' THEN M ELSE X

C35 IF stopRet-3 = 'negative' THEN M ELSE X

AV49 If parameters need to be added to the positive STOP return PDU, the parameter stopRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

AV50 The parameter stopRet-5 may have any standard value defined for the Diagnostic type in F4.3 except 'diagnosticExtension'. Additional values can be introduced by the extension 'diagnosticExtension', but no such extension is specified in this Recommended Standard.

AV51 If parameters need to be added to the negative STOP return PDU, the parameter stopRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

All parameters of the STOP return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-23: NOTIFY Invocation Parameters

Parameters of the NotifyInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
notifyInv-1	invokerCredentials	F4.3	M			
notifyInv-2	invokeId	F4.3	M			
notifyInv-3	procedureInstanceId	F4.3	M		AV52	
notifyInv-4	eventTime	F4.4	M			
notifyInv-5	eventName	F4.4	M			
notifyInv-6	eventValue	F4.4	M		AV53	
notifyInv-7	notifyInvocationExtension	F4.4	M		AV54	
notifyInv-8	dataUnitIdLastProcessed	F4.8	C36			
notifyInv-9	dataUnitIdLastOk	F4.8	C36			
notifyInv-10	productionStatus	F4.8	C36		AV55	
notifyInv-11	dataProcNotifyInvocExt Extension	F4.8	C36		AV56	

C36 IF notifyInv-7 = 'dpNotifyInvocExt': 'DataProcNotifyInvocExt' THEN M ELSE X

AV52 The value of the procedureRole element of the notifyInv-3 parameter is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

AV53 The value of the notifyInv-6 parameter can be any value that can be expressed using the type SequenceOfQualifiedValues defined in F4.3 or 'empty' or any value that can be defined by means of the extension 'eventValueExtension' (see EventValue defined in F4.3), but no such extension is specified in this Recommended Standard. Except if a procedure using this PDU specifies such extension, the value of 'eventValue' must not be set to 'eventValueExtension'.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- AV54 If the `procedureType` element of the parameter `notifyInv-3` has the value ‘`dataProcessing`’, ‘`bufferedDataProcessing`’ or ‘`sequenceControlledDataProcessing`’ or a value associated with a procedure derived from the Data Processing procedure, the Buffered Data Processing procedure, or the Sequence-Controlled Data Processing procedure, then the parameter `notifyInv-7` shall be set to the value ‘`dpNotifyInvocExt`’: ‘`DataProcNotifyInvocExt`’.

Also in all other cases, if parameters need to be added to the NOTIFY invocation PDU, the parameter `notifyInv-7` can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, this parameter shall be set to ‘`notUsed`’.

- AV55 If the parameter `notifyInv-5` has the value ‘`productionStatusChange`’, the parameter `notifyInv-10` shall be set to ‘`productionStatusChange`’: ‘`NULL`’; i.e., it is absent. For all other values of the parameter `notifyInv-5`, it shall be set to ‘`anyOtherEvent`’: ‘`ProductionStatus`’.

- AV56 If parameters need to be added to the NOTIFY invocation PDU used by a procedure derived from the Data Processing procedure, the Buffered Data Processing procedure, or the Sequence-Controlled Data Processing procedure, then the parameter `notifyInv-11` can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘`notUsed`’.

The parameters `notifyInv-1`, `notifyInv-2` and `notifyInv-3` are contained in the complex parameter `standardInvocationHeader` in the `NotifyInvocation` type shown in F4.4. This parameter is of the type `StandardInvocationHeader` that is specified in F4.3.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table A-24: TRANSFER-DATA Invocation Parameters

Parameters of the TransferDataInvocation PDU						
Item	Parameter	Ref.	Status	Support	Values	
					Allowed	Supported
transferDataInv-1	invokerCredentials	F4.3	M			
transferDataInv-2	invokeId	F4.3	M			
transferDataInv-3	procedureInstanceId	F4.3	M		AV57	
transferDataInv-4	generationTime	F4.4	M			
transferDataInv-5	sequenceCounter	F4.4	M			
transferDataInv-6	data	F4.4	M		AV58	
transferDataInv-7	qualifiedParameters	F4.12	C37			
transferDataInv-8	cyclicReportTransferDataInvocDataRefExtension	F4.12	C37		AV59	
transferDataInv-9	transferDataInvocationExtension	F4.4	M		AV60	

C37 IF transferDataInv-6 = 'extendedData': 'crTransferDataInvocDataRef': 'CyclicReportTransferDataInvocDataRef' THEN M ELSE X

AV57 The value of the procedureRole element of the parameter transferDataInv-3 is constrained to one of the two values 'prime procedure' or 'secondary procedure'.

- AV58 If the procedureType element of the parameter transferDataInv-3 is 'cyclicReport', then the parameter transferDataInv-6 shall be set to the value 'extendedData': 'crTransferDataInvocDataRef': 'CyclicReportTransferDataInvocDataRef'. The type CyclicReportTransferDataInvocDataRef is defined in F4.12.

Also in all other cases where a type different from OCTET STRING is needed for the data to be transferred by means of the TRANSFER-DATA invocation PDU, the parameter transferDataInv-6 can be used to specify such type by means of the extension 'extendedData', but except for the Cyclic Report procedure no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, this parameter shall be set to 'opaqueString': 'OCTET STRING'.

- AV59 If parameters need to be added to the TRANSFER-DATA invocation PDU used by a procedure derived from the parent Cyclic Report procedure, then the parameter transferDataInv-8 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Cyclic Report procedure and using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.
- AV60 If parameters need to be added to the TRANSFER-DATA invocation PDU, the parameter transferDataInv-9 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to 'notUsed'.

The parameters transferDataInv-1, transferDataInv-2 and transferDataInv-3 are contained in the complex parameter standardInvocationHeader in the TransferDataInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

ANNEX B

PRODUCTION STATUS

(NORMATIVE)

B1 OVERVIEW

This annex defines the states and transitions of the production status and presents in tabular form the effect of the production status on the processing of data and operations. The transitions that may occur are illustrated in figure B-1.

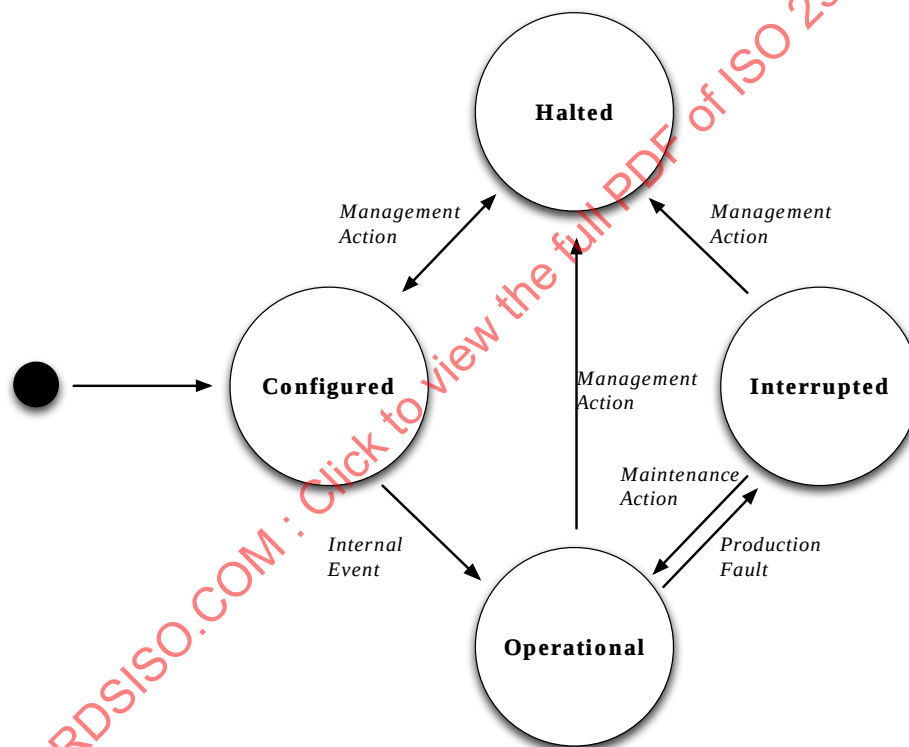


Figure B-1: Production Status Diagram

B2 PRODUCTION STATUS SPECIFICATIONS

B2.1 The production status values shall be set in accordance with the high-level semantic definition listed in table B-1.

B2.2 The Published Identifier for the production status parameter for a CSTS `svcProductionStatus` as specified in F4.17.

B2.3 The parameter reporting the value of the production status shall be named using the Functional Resource Instance representing the CSTS instance reporting the production status.

B2.4 A CSTS instance shall change the production status value in accordance with the conditions specified in table B-2. Such change of the production status shall constitute the procedure state table incoming events 'production status change', and, depending on the actual transition, 'production status change to 'operational'', 'production status change to 'interrupted'', 'production status change to 'halted'', and 'production status change to 'configured'', respectively.

Table B-1: Production Status Semantic

Production Status Value	Semantic Definition
'configured'	The configuration of the service production process has been completed.
'operational'	The service production process is ready to process data.
'interrupted'	The service production process has stopped because of an error condition that may be temporary.
'halted'	The service production process has been stopped by management action.

B2.5 The event reporting the change of the production status shall be named using the Functional Resource Instance representing the CSTS instance reporting the event (see 3.11.2.2.3).

NOTES

- 1 The production status is always a property of the CSTS itself and not of the associated production process. The CSTS may specify how the aggregate production status shall be derived for instance from the resource status and resource configuration change event reported by the Functional Resources representing the production process.
- 2 The production status always refers to the current status of the CSTS. Therefore, in case a CSTS is used to retrieve data that have been collected using a production process that completed before the CSTS was instantiated, any issues related to the production process that collected the data now being retrieved by the CSTS are not visible from the CSTS production status. However, the CSTS may specify means different from the production status for reporting events that affected the data collection.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

Table B-2: Production Status Transitions

Start Status	End Status	Cause of Status Change
'configured'	'operational'	Management action to make the production status 'operational'; this typically includes ensuring the availability of the service provider services.
'operational'	'interrupted'	Occurrence of a production fault detected by the service provider.
'interrupted'	'operational'	Maintenance action typically is required to correct the production fault (e.g., re-configuration to use a backup service production). The production status changes to 'operational' when the service provider detects that the fault is corrected.
[any]	'halted'	Direct management action is required such as an operator directive causing the service provider to halt production.
'halted'	'configured'	Direct management action is required such as an operator directive restoring the required configuration and declaring the production status to be 'configured'.

B2.6 The transition to the production status 'operational' shall only be notified by a CSTS instance, if a different production status value has been notified before and the transition to production status 'operational' has not yet been notified since the most recent successful BIND operation.

B2.7 The transition to the production status 'interrupted' shall only be notified by a CSTS instance if it is presently affected by the possibly transient production fault.

NOTE – When the production status is 'halted' the BIND operation shall be rejected (see 3.4.2.3.1). The effects of the production status parameter value on the operations other than the BIND are addressed by the procedures using the operation whenever needed.

ANNEX C

QUALIFIED PARAMETERS

(NORMATIVE)

C1 OVERVIEW

This annex defines the requirements applicable to named parameters used by the GET operation (see 3.12), the Information Query procedure (see 4.9), and the Cyclic Report procedure (see 4.10).

C2 REQUIREMENTS

C2.1 The qualified-parameters parameter shall contain for each parameter identified in the list-of-parameters the following information:

- a) the Parameter Name defined with its Functional Resource Name (see 1.6.1.6.24) and its Parameter Identifier (see 1.6.1.6.32);
- b) the parameter type (see C2.3);
- c) the parameter value(s): a parameter may be expressed as a single or as multiple values;
- d) the parameter qualifier reporting the validity of the parameter value (see C2.5).

C2.2 The Functional Resource Name (see 1.6.1.6.24) shall be defined by its Functional Resource Type (see 1.6.1.6.25) and its Functional Resource Instance Number (see 1.6.1.6.23).

C2.3 The supported parameter types shall be:

- a) integer;
- b) unsigned integer;
- c) positive integer;
- d) duration;
- e) character string;
- f) Boolean;
- g) octet string;
- h) real;
- i) time;

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- j) enumerated;
- k) Published Identifier;
- l) Object Identifier.

C2.4 All procedures shall have the possibility to extend the types with additional type definitions.

C2.5 The qualifier of a value shall be one of the following:

- a) 'valid'—the value is valid;
- b) 'unavailable'—the service provider cannot provide the value;
- c) 'undefined'—in the current service provider context, the value is undefined;
- d) 'error'—the processing of the service provider resulted in an error.

C2.6 If the value qualifier of a given parameter is 'unavailable', 'undefined', or 'error', type and value of that parameter shall not be returned.

ANNEX D**OBJECT IDENTIFIERS DEFINITION****(NORMATIVE)****D1 OVERVIEW**

This annex defines

- a) the Object Identifier tree structure that is used (a) by the procedures defined in this Recommended Standard and (b) for registering Functional Resource Types and their associated parameters, events, and directives;

NOTE – It is not intended to constrain how the data types of, e.g., parameters, are implemented or encoded. These definitions are suitable for inclusion in any type of ASN.1 based protocol that implements Cross Support Services.

- b) the procedures to be applied for the management of the Object Identifiers defined in this annex and for the creation of new Object Identifiers that need to be defined when new services are specified;
- c) the top-level Object Identifiers themselves.

NOTE – The complete set of Object Identifiers defined by this Recommended Standard is specified in F4.1, F4.16 and F4.17. An informative description of the registries relevant to this Recommended Standard and their management is provided in H2. An informative presentation of the overall OID tree structure is provided in annex L.

D2 OBJECT IDENTIFIERS REGISTRATION

D2.1 This document requests the creation of or uses registries that will be managed by the Space Assigned Numbers Authority (SANA) applying the registration rules outlined in H2. New assignments in these registries will be shown at the SANA registry Web site: <http://sanaregistry.org>. Therefore, the reader shall look at the SANA Web site for all the assignments contained in these registries.

D2.2 Already registered Object Identifiers shall be affected neither by any extension of registries as requested by this Recommended Standard nor by the definition of new CSTSes.

D2.3 Requests to add assignments to the subtrees of the OID Registry that are owned by the CSS Area beyond those initiated by the CSS Area shall be submitted to SANA and come from a Member Agency, or an Observer Agency, or a CCSDS Associate, or an industry

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

partner supported by a Member Agency. The request shall be related to a cross support activity. After evaluation of the request and approval by the CSS Area Director (AD) or CSS Area Deputy Area Directory (DAD) or a person duly authorized by the AD or DAD, a new Object Identifier will be allocated and added to the relevant subtree owned by the CSS Area and added in this way to the existing OID Registry.

D3 TREE STRUCTURE

NOTE – The overall tree structure can be found in annex L.

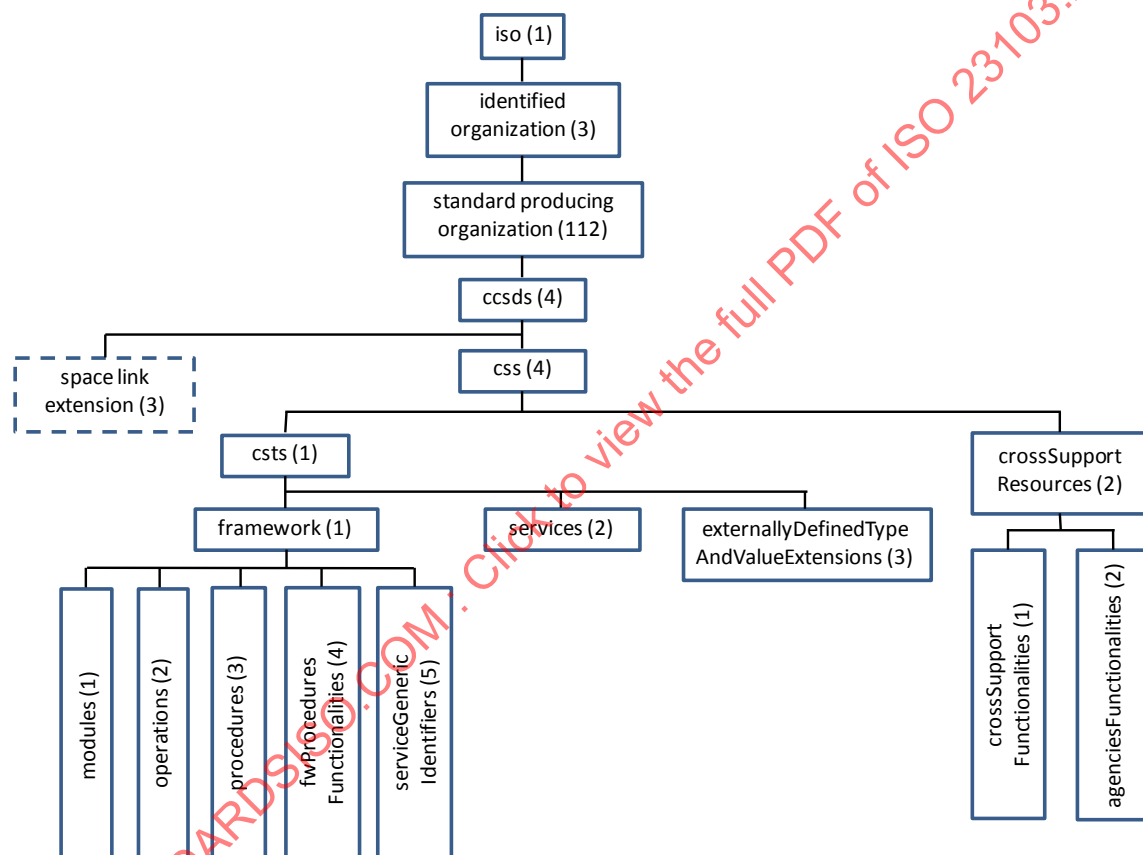


Figure D-1: CSTS and Cross Support Resources Root Object Identifier Tree

D3.1 Under the css (Cross Support Services) node one Object Identifier branch with the top-level node csts shall be allocated for all Cross Support Transfer Service information objects.

D3.2 Under the css (Cross Support Services) node one Object Identifier branch with the top-level node crossSupportResources shall be allocated for all Cross Support Resources information objects (see D6).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

D3.3 The csts Object Identifier branch shall be subdivided into the following subbranches:

- a) 'framework' which lists all Object Identifiers that are reserved for the CSTS Specification Framework definition;
- b) 'services' which lists all Object Identifiers that are relevant for CSTSes, each new service having its own subbranch;
- c) 'externallyDefinedTypeAndValueExtension' which contains the Object Identifiers of the data types defined as extension, i.e., the data types that cannot be defined using the existing ASN.1 (`valueExtension` of the `TypeAndValue` definition in F4.3). Each data type extension shall be defined in the specification of the service that uses the new data type.

D3.4 The 'framework' branch (see D4) shall be divided as follows:

- a) The 'modules' branch lists the Object Identifiers of the ASN.1 modules defined in this Recommended Standard.
- b) The 'operations' branch lists the Object Identifiers applicable to each operation defined in this Recommended Standard and specifies for each operation the Object Identifiers of the extended types defined in this Recommended Standard.
- c) The 'procedures' branch lists the Object Identifiers to be used for each procedure. Each CSTS Specification Framework procedure may be further detailed with derived procedures and with parameter extensions of the procedure.
- d) The 'fwProceduresFunctionalities' branch lists for each procedure defined in this Recommended Standard in a procedure-specific subbranch the Parameter Identifiers, the Event Identifiers and the Directive Identifiers. Under each of the procedure-specific subbranches of the 'fwProceduresFunctionalities' branch, there shall be three separate subbranches, one for Parameters, one for Events, and one for Directives, as defined in F4.16.

NOTE – The Parameter Identifiers, Event Identifiers and Directive Identifiers are used to construct the Parameter, Event, and Directive Names that are transferred via various CSTS operations. Annex E specifies the rules for the construction of names using these identifiers.

- e) The 'serviceGenericIdentifiers' branch lists those identifiers that are generic and accessible by all services using the CSTS Specification Framework. Parameters, Events, and Directives shall be accessed with the OID in this branch but shall be associated with the Functional Resource of the service using them. There shall be three separate subbranches under the 'serviceGenericIdentifiers' branch, one for Parameters, one for Events, and one for Directives, as defined in F4.17. For consistency with parameters, events and directives of Functional Resources (see D6.2), also the OIDs of parameters, events and directives registered on the 'serviceGenericIdentifiers' subbranch are extended by one digit which identifies the version of the given parameter, event, or directive (see F4.17).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – Although the ‘serviceGenericIdentifiers’ branch has a ‘directives’ subbranch, no service-generic directives have been defined as of this issue of this Recommended Standard. The ‘directives’ subbranch exists for possible use in future issues of this Recommended Standard.

D3.5 The ‘services’ branch (see D5) shall contain the service-type Object Identifiers and for each of them it may contain the extended parameters, the derived services, newly defined procedures and service type specific ASN.1 modules.

D4 CSTS SPECIFICATION FRAMEWORK OBJECT IDENTIFIERS REGISTRATION

NOTES

- 1 This section specifies some rules regarding the construction of the strings that are used to name Object Identifiers. While within this Recommended Standard these rules have been adhered to, this is not meant to impose the same rules on related documents such as CSTS specifications. If deemed more convenient, different rules for the construction of strings naming OIDs may be applied in those documents.
- 2 To better illustrate how strings used to name Object Identifiers are built, all figures in sections D4 to D6 contain such strings, but these strings are examples only; i.e., they do not name actually specified Object Identifiers of service types, procedures, parameters, events, directives, etc. As such, the figures in these sections are informative only.

D4.1 New Object Identifiers in the ‘framework’ branch shall be allocated only in the context of an update of this Recommended Standard.

D4.2 New Object Identifiers in the ‘modules’ branch shall be allocated only if new ASN.1 modules are created in this Recommended Standard.

D4.3 New Object Identifiers in the ‘operations’ branch shall be allocated only in the context of a definition of new operations and additional extensions in the definitions of the operations in this Recommended Standard.

NOTE – Strictly speaking, not the operations as such but the PDUs associated with a given operation are registered in the ‘operations’ branch. For example, different Object Identifiers are assigned to the START invocation and to the START return PDU, respectively. Likewise, extensions are registered separately for each PDU.

D4.4 New Object Identifiers in the ‘procedures’ branch (see figure D-2) shall be allocated only in the context of:

- a) definition of new procedures: in case a new procedure is created in this Recommended Standard, the newly allocated Object Identifier shall be complemented with two subbranches:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 1) '(procedure classifier)DerivedProcedures' to register any derivation of a procedure from this newly registered procedure,
 - 2) '(procedure classifier)ExtProcedureParam' to register operations parameters extensions;
- b) procedure derived from an existing procedure: the created Object Identifier shall be complemented with two subbranches:
- 1) '(derived procedure classifier)DerivedProcedures' to register the derivation of a procedure from the given parent procedure,
 - 2) '(derived procedure classifier)ExtProcedureParam' to register the operations parameters extension.

STANDARDSISO.COM : Click to view the full PDF of ISO 23103:2020

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

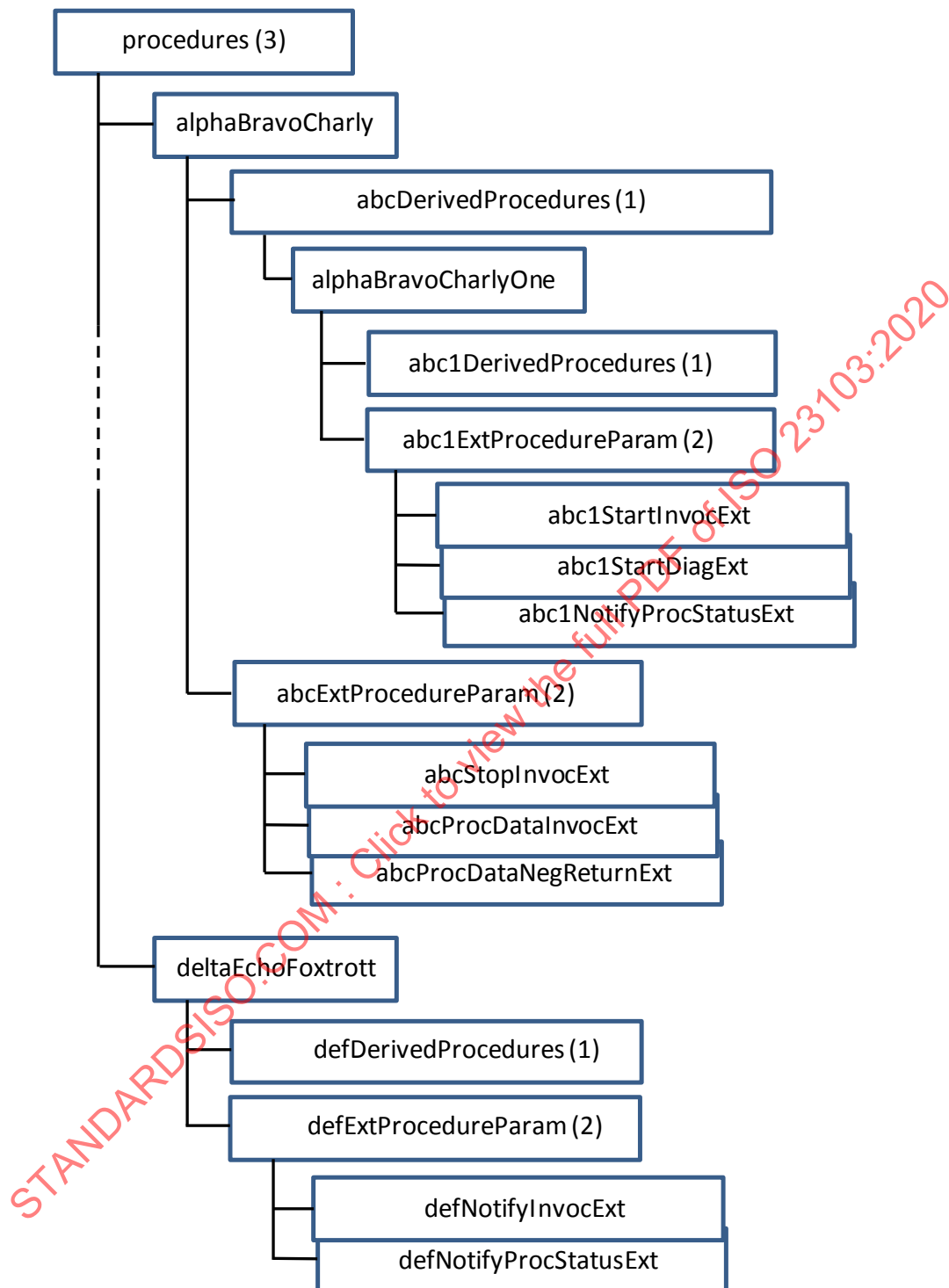


Figure D-2: 'procedures' Subtree

D4.5 New Object Identifiers in the ‘proceduresFunctionalities’ branch shall be allocated only in the context of the definition of a new procedure in this Recommended Standard. The newly allocated Object Identifier node name shall be of the form ‘proc(Procedure Long Name)’. Each such Object Identifier shall be complemented with three subbranches (see figure D-3):

- a) ‘p(PROCEDURE SHORT NAME)parametersId’ to register the procedure’s parameters;
- b) ‘p(PROCEDURE SHORT NAME)eventsId’ to register the procedure’s events;
- c) ‘p(PROCEDURE SHORT NAME)directivesId’ to register the procedure’s directives.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

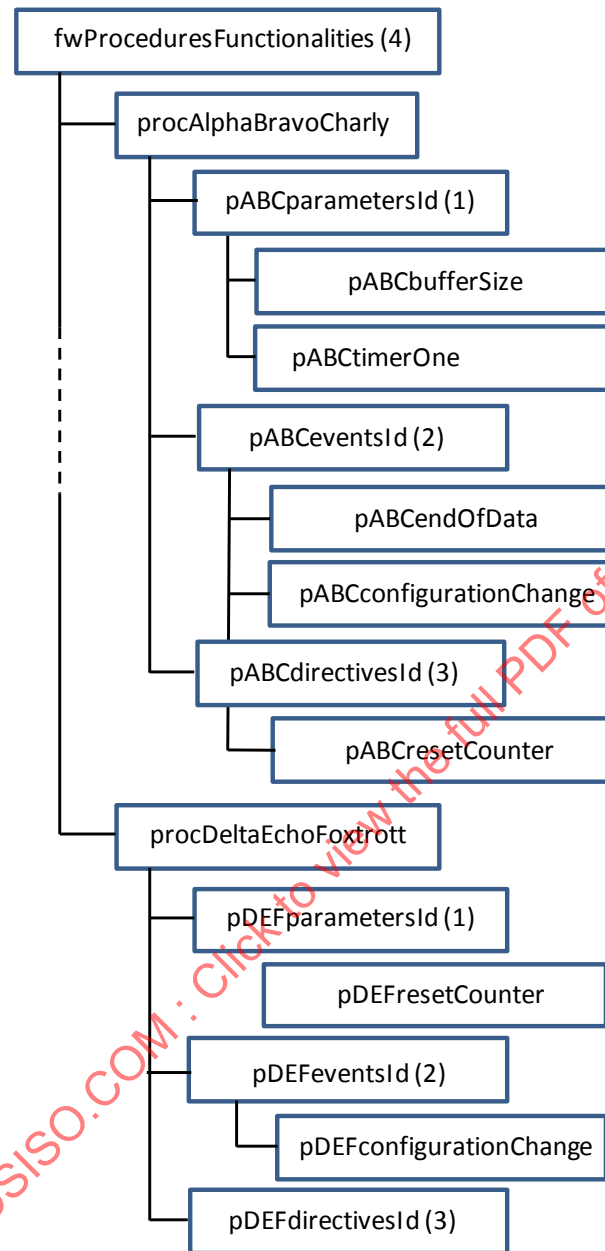


Figure D-3: 'fwProceduresFunctionalities' Subtree

NOTES

- 1 The <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in F4.16.
- 2 Figure L-4 illustrates the above specified OID tree structure for all procedures specified within this Recommended Standard.

D5 SERVICE OBJECT IDENTIFIERS REGISTRATION

D5.1 Whenever a new non-derived service is specified, a new Object Identifier shall be allocated directly under the ‘services’ node. The allocated Object Identifier shall be complemented with five subbranches (see figure D-4):

- ‘(service classifier)DerivedServices’ to register services derived from the specified service;
- ‘(service classifier)ExtendedServiceParameters’ to register service type specific parameters;
- ‘(service classifier)ServiceProcedures’ to register procedures derived for this service;
- ‘(service classifier)ServiceModules’ to register service type specific ASN.1 modules;
- ‘(service classifier)ServiceFrRef’ to register the reference to the Functional Resource Type that models the given service type.

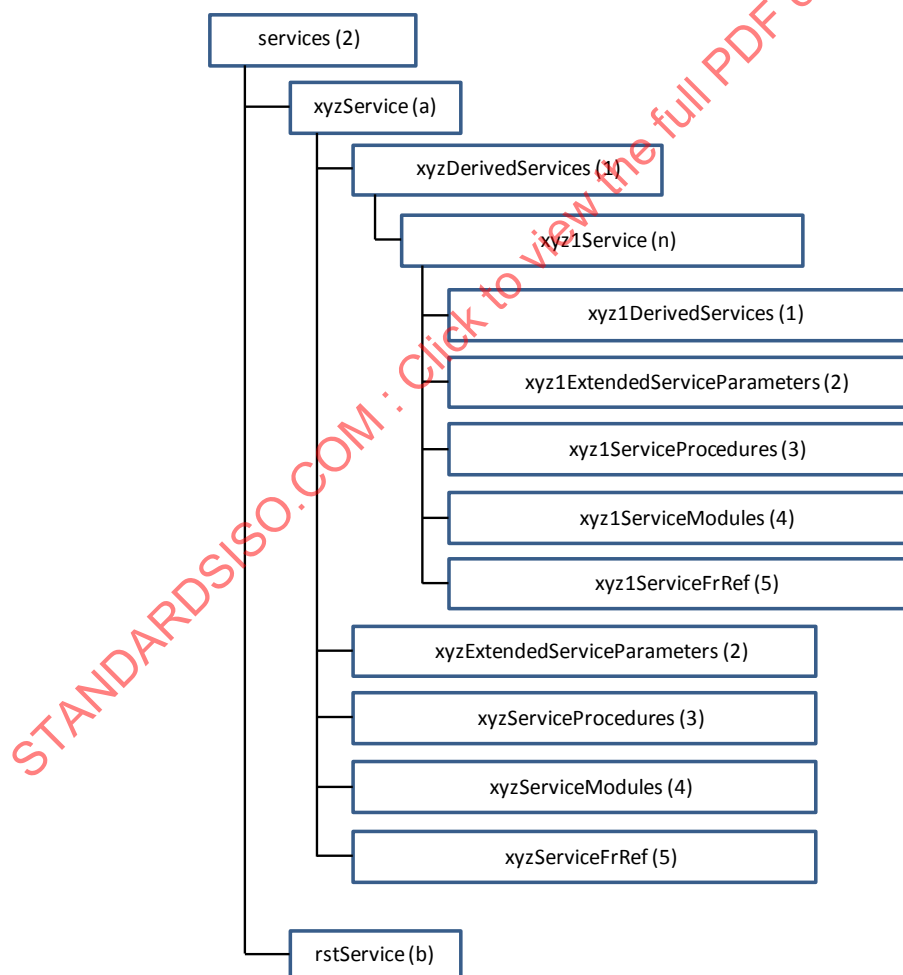


Figure D-4: ‘services’ Subtree

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

D5.2 For each procedure defined for a given service, four subbranches shall be created directly under that procedure node as follows (see figure D-5):

- ‘(service classifier)SP(service procedure classifier)ExtendedOpsParam’ to register extensions of operation parameters used by this procedure;
- ‘(service classifier)SP(service procedure classifier)ExtendedProcParam’ to register extensions of procedure specific parameters;
- ‘(service classifier)SP(service procedure classifier)EventsId’ to register procedure type specific events;
- ‘(service classifier)SP(service procedure classifier)DirectivesId’ to register procedure type specific directives.

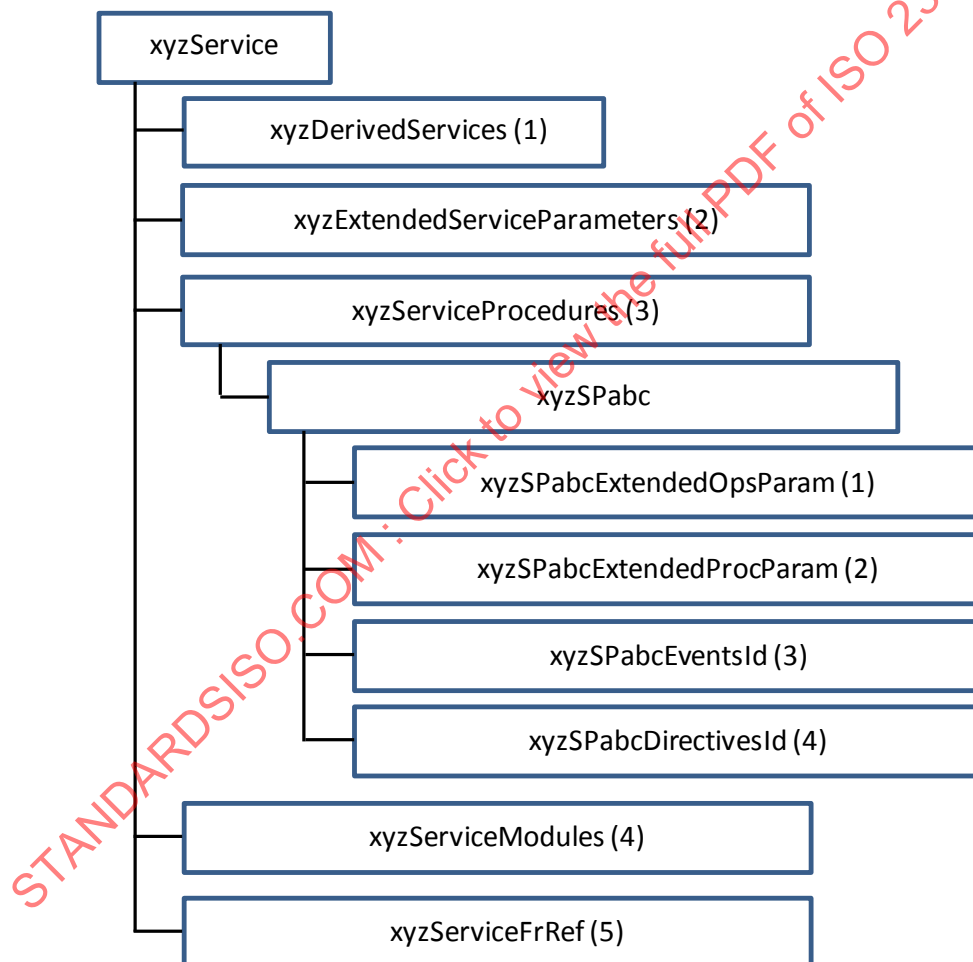


Figure D-5: ‘service procedures’ Subtree

D5.3 Whenever a new service derived from an existing service is specified, a new Object Identifier shall be allocated directly under the service it is derived from (see figure D-4). The allocated Object Identifier shall be complemented with five subbranches:

- a) '(derived service classifier)DerivedServices' to register services derived from the specified service;
- b) '(derived service classifier)ExtendedServiceParameters' to register parameters syntax;
- c) '(derived service classifier)ServiceProcedures' to register derived procedures and extended parameters for this service;
- d) '(derived service classifier)ServiceModules' to register ASN.1 modules for this service;
- e) '(derived service classifier)ServiceFrRef' to register the reference to the Functional Resource Type that models the given service type.

D6 CROSS SUPPORT RESOURCES OBJECT IDENTIFIERS REGISTRATION

D6.1 GENERAL

The Cross Support Resources branch shall be divided into two branches: 'crossSupportFunctionalities' and 'agenciesFunctionalities'.

D6.2 CROSS SUPPORT FUNCTIONALITIES BRANCH

D6.2.1 Published Identifiers in this branch shall be allocated independently of this Recommended Standard.

D6.2.2 Published Identifier registration shall ensure registration of parameters, events, and directives grouped per Functional Resource Type.

D6.2.3 Functional Resources Types, Parameter Identifiers, Event Identifiers and Directive Identifiers shall be registered as Published Identifiers (see figure D-6).

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

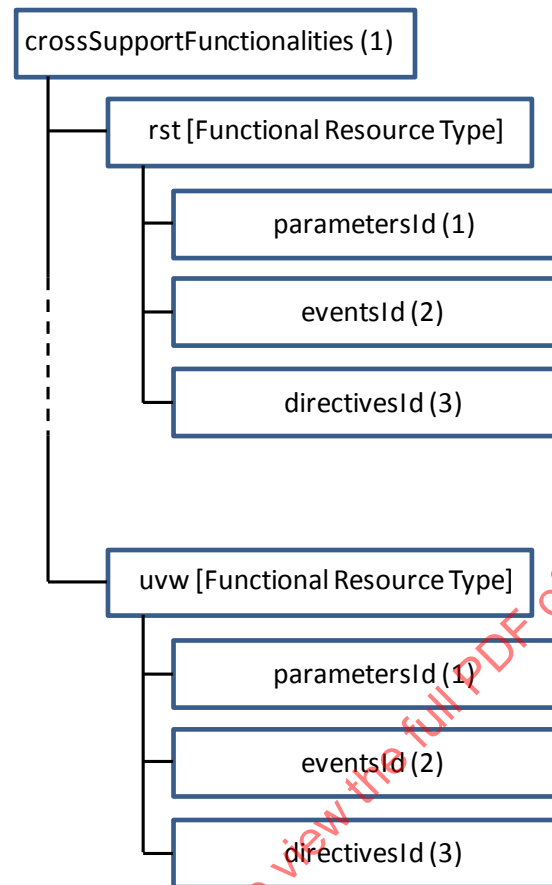


Figure D-6: 'crossSupportFunctionalities' Subtree

D6.2.4 Whenever a new Functional Resource Type is defined:

- a 'functionalResourceType' Published Identifier shall be allocated for that Functional Resource Type with three subbranches: 'parametersId', 'eventsId' and 'directivesId' as required in D6.2.3;
- Functional Resource Type specific parameters (in the 'parametersId' branch) shall be allocated reporting the specific parameters that may be defined for that Functional Resource Type;
- Functional Resource Type specific events (in the 'eventsId' branch) shall be allocated corresponding to the specific events that may be defined for that Functional Resource Type;
- Functional Resource Type specific directives (in the 'directivesId' branch) shall be allocated corresponding to the specific directives that may be defined for that Functional Resource Type.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – The Parameter Identifiers, Event Identifiers and Directive Identifiers are used to construct the Parameter, Event, and Directive Names that are transferred via various CSTS operations. Annex E specifies the rules for the construction of names using these identifiers.

D6.2.5 Whenever a new CSTS is defined, a ‘functionalResourceType’ Published Identifier shall be allocated for that CSTS with three branches: ‘parametersId’, ‘eventsId’ and ‘directivesId’ as required in D6.2.3 and populated as specified in D6.2.4.

NOTE – The provision of any CSTS is modeled by means of a service type specific Functional Resource. Therefore the definition of a new CSTS requires also the specification of the related Functional Resource and consequently the allocation of an Object Identifier to that Functional Resource Type.

D6.2.6 Whenever a new version of a Functional Resource is required, it shall be assigned a new Object Identifier. The old Functional Resource shall remain untouched, but may be deprecated.

D6.2.7 Whenever a new version of a parameter, event, or directive is required, the following steps shall be performed:

- a) the existing parameter/event/directive shall be left untouched;
- b) a new parameter/event/directive shall be created the Object Identifier of which shall be the same as the original parameter except that the appended version number shall be incremented by one;
- c) at any point in time the original parameter may be deprecated.

D6.3 AGENCIES FUNCTIONALITIES

D6.3.1 An Agency may support agency specific Functional Resources that are not covered under the ‘crossSupportFunctionalities’ branch.

D6.3.2 That Agency may request from SANA a dedicated Object Identifier that is allocated to that Agency and is to be registered under the ‘agenciesFunctionalities’ branch.

D6.3.3 The Agency may then request SANA to register new Functional Resources, parameters, events, and directives in line with the structure adopted under the ‘crossSupportFunctionalities’ branch (see figure D-7).

NOTES

- 1 It is the responsibility of the Agency to allocate and maintain the required Published Identifiers (Functional Resource Types, parameters, events, and directives).
- 2 It is the responsibility of the Agency not to duplicate already existing ‘crossSupportFunctionalities’ definitions.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- 3 The registration rules applying to the 'agenciesFunctionalities' subbranch and to the related registration of Agency-specific Functional Resources are documented in H2.4.

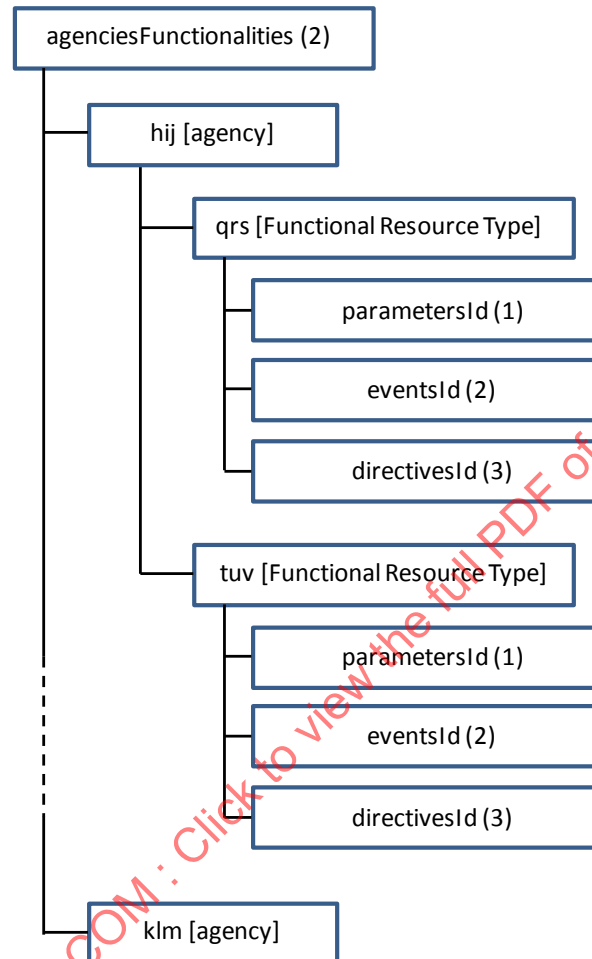


Figure D-7: 'agenciesFunctionalities' Subtree

ANNEX E

COMPOSITION OF PARAMETER, EVENT, AND DIRECTIVE NAMES
AND PARAMETER AND EVENT LISTS

(NORMATIVE)

E1 OVERVIEW

Naming Functional Resources and the observable parameters, notifiable events, and directives associated with those Functional Resources is achieved by means of Published Identifiers. Published Identifiers are Object Identifiers that are registered with the Space Assigned Numbers Authority (SANA). Use of Published Identifiers allows for the specification of CSTSes that can use parameters or events that have not been identified at the time of the writing of those CSTS specifications.

Those Published Identifiers are used in a variety of ways in the operations and procedures of the CSTS Specification Framework:

- a) to form the *Parameter Names* used (1) in the `list-of-parameters` parameter of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3), and (2) in the `qualified-parameters` parameter of the GET operation (3.12.2.2.3) and the Cyclic Report procedure TRANSFER-DATA operation (4.10.4.2.2.2);
- b) to form the *Event Names* used in the `event-name` parameter of the NOTIFY operation (3.11.2.2.3.1) and the `list-of-events` parameter of the Notification procedure START operation (4.11.4.1.2.2);
- c) to form the *Parameter Names* that might be used in the `directive-qualifier` parameter of the EXECUTE-DIRECTIVE operation (3.13.2.2.3);
- d) to form the logical records that constitute the named and default parameter lists used in the `list-of-parameters` parameters of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3);
- e) to form the logical records that constitute the named and default event lists used in the `list-of-events` parameter of the Notification procedure START operation (4.11.4.1.2.2);
- f) to form the Functional Resource Names used (1) in the `list-of-parameters` parameters of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3), and (2) in the `list-of-events` parameter of the Notification procedure START operation (4.11.4.1.2.2);

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- g) to form the procedure instance identifier used in the `list-of-parameters` parameters of the GET operation (3.12.2.2.2), the Cyclic Report procedure START operation (4.10.4.1.2.3) and the `list-of-events` parameter of the Notification procedure START operation (4.11.4.1.2.2).

This annex defines the composition of Functional Resource Names, Parameter Names, Event Names, Directive Names, Parameter Lists, and Event Lists using Published Identifiers of the appropriate types.

E2 FUNCTIONAL RESOURCE NAME

E2.1 Each Functional Resource Name shall be composed of a Functional Resource Type Published Identifier and a Functional Resource Instance Number.

E2.2 The Functional Resource Type shall be registered on one of the following CCSDS Object Identifier subtrees:

- a) {ccsds css crossSupportResources crossSupportFunctionalities} for a CCSDS-standard Functional Resource Type; or
- b) {ccsds css crossSupportResources agenciesFunctionalities <Agency X>} for an Agency-unique Functional Resource Type.

E3 PROCEDURE INSTANCE IDENTIFIER

E3.1 Each procedure instance identifier shall be composed of a Procedure Type Published Identifier and the procedure role. If the role is 'association control' or 'prime procedure', no instance number is defined, as the procedure is already unambiguously identified. If the role is 'secondary procedure', an instance number is part of the procedure instance identifier.

E3.2 The Procedure Type shall be registered on the CCSDS Object Identifier subtree {ccsds css csts framework procedures}.

E4 PARAMETER NAME

E4.1 A Parameter Name shall be composed of a Parameter Identifier and either the Functional Resource Name of the Functional Resource Instance that generates the values for that instance of the parameter or the procedure instance identifier of the procedure that generates the value for that instance of the procedure configuration parameter.

E4.2 If a Functional Resource Name is used to form the Parameter Name, then the Parameter Identifier shall be registered on one of the following CCSDS Object Identifier subtrees:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) {ccsds css csts framework serviceGenericIdentifiers svcParametersId} for a parameter that is defined as part of the CSTS Specification Framework;
- b) {ccsds css crossSupportResources crossSupportFunctionalities <functional resource type A> parametersId} for a parameter that is specified as part of a CCSDS-standard Functional Resource Type definition; or
- c) {ccsds css crossSupportResources agenciesFunctionalities <Agency X> <functional resource type A> parametersId} for a parameter that is specified as part of an Agency-unique Functional Resource Type definition or an Agency-specific extension of a CCSDS-standard Functional Resource Type.

NOTES

- 1 If an Agency uses the 'agenciesFunctionalities' subtree to register additional Agency-specific parameters for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency's 'agenciesFunctionalities' subtree and the value of the Functional Resource Type node under the 'crossSupportFunctionalities' subtree.
- 2 A Functional Resource Type that is registered under the 'crossSupportResources' subtree may generate values for parameter types that are registered under {serviceGenericIdentifiers svcParametersId}. In such cases, the Parameter Identifier component of the Parameter Name is that which is registered under the {serviceGenericIdentifiers svcParametersId} subtree. For such parameters, the reporting of the parameter by the Functional Resource Type is documented as part of the registration tree of that Functional Resource Type.

E4.3 If a procedure instance identifier is used to form the Parameter Name, then the Parameter Identifier shall be registered on the {ccsds css csts framework fwProceduresFunctionalities proc<Procedure Long Name> p<PROCEDURE SHORT NAME>parametersId} subtree for a configuration parameter that is defined for that framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in F4.16.

E5 EVENT NAME

E5.1 An Event Name shall be composed of an Event Identifier and either the Functional Resource Name of the Functional Resource Instance that generates the notifications for that instance of the event or the procedure instance identifier of the framework procedure that issues the notification.

E5.2 If a Functional Resource Name is used to form the Event Name, then the Event Identifier shall be registered on one of the following CCSDS Object Identifier subtrees:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) {ccsds css csts framework serviceGenericIdentifiers svcEventsId} for an event that is defined as part of the CSTS Specification Framework;
- b) {ccsds css crossSupportResources crossSupportFunctionalities <functional resource type A> eventsId} for an event that is specified as part of a CCSDS-standard Functional Resource Type definition; or
- c) {ccsds css crossSupportResources agenciesFunctionalities <Agency X> <functional resource type A> eventsId} for an event that is specified as part of an Agency-unique Functional Resource Type definition or an Agency-specific extension of a CCSDS-standard Functional Resource Type.

NOTES

- 1 If an Agency uses the 'agenciesFunctionalities' subtree to register additional Agency-specific events for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency's 'agenciesFunctionalities' subtree and the value of the Functional Resource Type node under the 'crossSupportFunctionalities' subtree.
- 2 A Functional Resource Type that is registered under the 'crossSupportResources' subtree may generate notifications for event types that are registered under {serviceGenericIdentifiers svcEventsId}. In such cases, the Event Identifier component of the Event Name is that which is registered under the {serviceGenericIdentifiers svcEventsId} subtree. For such events, the reporting of the event by the Functional Resource Type is documented as part of the registration tree of that Functional Resource Type.

E5.3 If a procedure instance identifier is used to form the Event Name, then the Event Identifier shall be registered on the {ccsds css csts framework fwProceduresFunctionalities proc<Procedure Long Name> p<PROCEDURE SHORT NAME>eventsId} subtree for a notification that is defined for a framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in E3.16.

E6 DIRECTIVE NAME

E6.1 A Directive Name shall be composed of a Directive Identifier and either the Functional Resource Name of the Functional Resource Instance that receives that instance of the directive or the procedure instance identifier of the framework procedure that shall be acted on by that directive.

E6.2 If a Functional Resource is used to form the Directive Name, then the Directive Identifier shall be registered on one of the following CCSDS Object Identifier subtrees:

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

- a) {ccsds css crossSupportResources crossSupportFunctionalities <functional resource type A> directivesId} for a directive that is specified as part of a CCSDS-standard Functional Resource Type definition; or
- b) {ccsds css crossSupportResources agenciesFunctionalities <Agency X> <functional resource type A> directivesId} for a directive that is specified as part of an Agency-unique Functional Resource Type definition or an Agency-specific extension of a CCSDS-standard Functional Resource Type.

NOTE – If an Agency uses the ‘agenciesFunctionalities’ subtree to register additional Agency-specific directives for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency’s ‘agenciesFunctionalities’ subtree and the value of the Functional Resource Type node under the ‘crossSupportFunctionalities’ subtree.

E6.3 If a procedure instance identifier is used to form the Directive Name, then the Directive Identifier shall be registered on the {ccsds css csts framework fwProceduresFunctionalities proc<Procedure Long Name> p<PROCEDURE SHORT NAME>directivesId} subtree for a directive that is defined for a framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in E3.16.

E7 PARAMETER LABEL

A Parameter Label shall be composed of a Parameter Identifier and either a Functional Resource Type Published Identifier or a procedure type Published Identifier.

E8 EVENT LABEL

An Event Label shall be composed of an Event Identifier and either a Functional Resource Type Published Identifier or a procedure type Published Identifier.

E9 PARAMETER LIST

E9.1 A parameter list shall contain a set of one or more Parameter Labels, each of which is composed of a Functional Resource Type or procedure type Published Identifier and a Parameter Identifier.

E9.2 Each parameter list record shall represent all instances of the parameter type represented by the Parameter Identifier for all instances of the Functional Resource Type or procedure type that are associated with the service executing the procedure that uses the parameter list.

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – For example, assume that one of the Parameter Labels of a parameter list includes the Buffered Data Delivery procedure type Published Identifier and the `return-buffer-size` Parameter Identifier. If that parameter list is put into the `list-of-parameters` parameter of the GET invocation or the Cyclic Report procedure START invocation, it signifies that the `return-buffer-size` parameter value is to be sent for every instance of the Buffered Data Delivery procedure that is active and executing within the service instance that executes the Information Query or the Cyclic Report procedure.

E10 EVENT LIST

E10.1 An event list shall logically consist of a set of one or more Event Labels, each of which is composed of a Functional Resource Type or procedure type Published Identifier and an Event Identifier.

E10.2 Each event list record shall represent all instances of the event type represented by the Event Identifier for all instances of the Functional Resource Type or procedure type that are associated with the service instance executing the Notification procedure.

NOTE – For example, assume that one of the Event Labels of an event list includes the Buffered Data Delivery procedure type Published Identifier and the configuration-change Event Identifier. If that event list is put into the `list-of-parameters` parameter of the Notification procedure START invocation, it signifies that the `pBDPconfigurationChange` notification is to be sent whenever it occurs on any of the instances of the Buffered Data Delivery procedure type that are active and being executed by the service instance that is executing the Notification procedure.

E11 PARAMETERS, EVENTS, AND DIRECTIVES DEFINITION

E11.1 A parameter, an event, and a directive shall be defined using the following definition:

- a) a classifier, i.e., a compact string in ‘camel case’ notation and using standard abbreviations (e.g., ‘fwd’ for ‘forward’) indicating the purpose of the parameter, event, or directive;
- b) the semantic definition of the parameter in the form of free text;
- c) a name in the form of an Object Identifier where the last digit indicates the version of the definition (see Parameter Name definition in 1.6.1.6.34, Event Name definition in 1.6.1.6.19, and Directive Name definition in 1.6.1.6.16);

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

NOTE – In those cases where, e.g., a suitable parameter has already been registered on the serviceGenericIdentifiers subbranch of the OID tree, such OID is used to name such parameter although the Functional Resource the parameter is associated with is registered on a different OID subbranch. An example of such parameter is svcProductionStatus which is used also for the Functional Resource type which has the classifier ‘mdServiceProductionStatus’.

- d) a syntax specification, the syntax to be used when transferring the parameter, the event, or the directive:
 - 1) the syntax shall identify one of the ASN.1 types defined by the TypeAndValueComplexQualified syntax (see F4.3);
 - 2) in the case where none of the predefined types would be suitable, the definition may use the extension capability and define a specific syntax associated with a dedicated Object Identifier referencing the extended syntax;
- e) in case of a parameter, a flag indicating if this parameter can be configured;
- f) in case of a directive acting on one or more parameters flagged as ‘configured’ a guard condition; if that guard condition does not evaluate to true, the directive must not be executed on that parameter; i.e., the parameter value must not be modified;
- g) if applicable and not implied by the data type specification, the range and other constraints (limits) shall be defined;
- h) if applicable, the engineering unit(s), preferably SI units, shall be stated;
- i) a flag indicating if the definition has been deprecated or not;

NOTE – The deprecation flag indicates that at least one more recent version of the specification of the given parameter, event, or directive exists. The deprecated version can no longer be expected to be supported by providers of CSTSes. In case one or more parameters, events, or directives of a Functional Resource shall no longer be supported at all regardless of their version, a new Functional Resource Type is to be specified.

- j) the authorizing entity (e.g., CSS Area);
- k) the creation date.

E11.2 Requests to add assignments to this registry shall be submitted to SANA and come from a member Agency, or an observer Agency, or a CCSDS Associate, or an industry partner supported by a member Agency. The request shall be related to a cross support activity. After evaluation of the request and approval by the CSS Area chair or deputy or a person duly authorized by her/him, a new Object Identifier will be allocated and added to the existing list.

ANNEX F

DATA TYPES DEFINITION

(NORMATIVE)

F1 OVERVIEW

F1.1 This annex defines the data types that are used by the procedures defined in this Recommended Standard. It is intended to provide a clear specification of these data types and to avoid ambiguity. It is not intended to constrain how these data types are implemented or encoded. These definitions are suitable for inclusion in any type of ASN.1-based protocol that implements Cross Support Services.

F1.2 The data type definitions are presented in ASN.1 modules.

F1.3 Conceptually, the CSTS Specification Framework ASN.1 definitions break into three levels (putting aside for the moment the top-level data structure that contains a Framework PDU). The lowest level consists of data types; these are used as building blocks. The middle level consists of operation messages (invocations, returns, and acknowledgements); these are generic definitions that can be extended by procedures. The highest level consists of procedure-specific information (e.g., extensions of the generic operation messages).

F1.4 The ASN.1 definitions are broken down into modules. A distinction is made between *general purpose* items (items used by multiple procedures) and *procedure-specific* items (items used by only a single procedure). General purpose building blocks are defined in a single module called 'Cross Support Transfer Service – Common Types' (F4.3). General purpose operation messages are defined in a single module called 'Common Operation PDUs' (F4.4). For each procedure, there is a dedicated module that contains procedure-specific building blocks (if any), procedure-specific operation messages (if any), and procedure-specific extensions to the generic operation messages (if any). Generally, the modules are arranged in bottom-up order:

- a) F4.1 – list of Object Identifiers for Framework operations and procedures;
- b) F4.2 – building blocks that are used only by the Bind-Invocation message (the Service-Instance-Id);
- c) F4.3 – CSTS common types;
- d) F4.4 – common operations PDUs;
- e) F4.5 – procedure-specific information for the Association Control procedure;
- f) F4.6 through F4.14 – procedure-specific information (each subsection dedicated to one procedure);

- g) F4.15 – the top-level CSTS Specification Framework PDUs;
- h) F4.16 – procedure-specific Object Identifiers associated with parameters, events and directives;
- i) F4.17 – the generic service level Object Identifiers.

F1.5 The top-level Framework PDU specifies an operation (e.g., Bind) and a specific message type within that operation (i.e., invocation, return, or acknowledgement). The combination is an operation message (e.g., Bind-Invocation). As mentioned above, if the operation is of general purpose, its messages will be defined in the ‘Common Operation PDUs’ subsection (F4.4). Otherwise, the operation’s messages will be defined within one of the subsections dedicated to specific procedures; e.g., the Bind, Unbind, and PEER-ABORT operations are defined in the subsection dedicated to the Association Control procedure (F4.5).

F2 EXTENSION

F2.1 The extension capability may or may not be used using the **Extended** parameter. If not used the **Extended** parameter shall carry a ‘null’ value, also referred to a ‘notUsed’.

F2.2 Extension is defined by means of ‘EMBEDDED PDV’. The ASN.1 EMBEDDED PDV type is a type used to include non-ASN.1 or other data within an ASN.1 encoded message. This type is described using the following ASN.1 SEQUENCE:

```
EMBEDDED PDV ::= [UNIVERSAL 11] SEQUENCE
{
  identification CHOICE
  {
    syntaxes SEQUENCE
    {
      abstract OBJECT IDENTIFIER
      ,
      transfer OBJECT IDENTIFIER
    }
    , syntax OBJECT IDENTIFIER
    , presentation-context-id INTEGER
    , context-negotiation SEQUENCE
    {
      presentation-context-id INTEGER
      , transfer-syntax OBJECT IDENTIFIER
    }
    , transfer-syntax OBJECT IDENTIFIER
    , fixed NULL
  }
  , data-value OCTET STRING
}
```

F2.3 The extension shall make use of the ‘syntax’ definition in the ‘identification’ CHOICE. The ‘syntax’ is assigned an Object Identifier (see F4.1) that is unique for all extensions and clearly indicates that all external syntaxes carried by this definition belong to the Cross Support Services.

F2.4 The syntax used for the extension (see F2.2) shall follow the requirements defined in annex D.

F3 PARAMETERS WITH ENUMERATED VALUES

Although ASN.1 has the built-in simple type ENUMERATED, this type is not used in the modules specified in annex F4 for the following reasons: (a) For a parameter of the type ENUMERATED, the permitted values must be specified; i.e., it is not possible to create a generic enumerated parameter. However, such a generic enumerated type is needed in the specification of the `TypeAndValue` construct (see F4.3). (b) A new service version adding permitted values to an enumerated type cannot interact with an older version even if the newly added values are not used in a specific cross-support scenario because the PDU decoding would fail.

Enumerated parameters are therefore represented as ‘named integers’. An example is given below.

```
EnumeratedParameter ::= INTEGER
{
  valueA      (0)
,
  valueB      (1)
,
  valueC      (2)
}
```


F4 DATA TYPE SPECIFICATION

F4.1 LIST OF OBJECT IDENTIFIERS

This module defines the Object Identifiers required for all syntaxes used for the definition of extended types.

CCSDS-CSTS-OBJECT-IDENTIFIERS

```
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) object-identifiers(1)
}
```

DEFINITIONS

IMPLICIT TAGS

```
::= BEGIN
```

```
EXPORTS acExtProcedureParam
, agenciesFunctionalities
, bddExtProcedureParam
, bdpExtProcedureParam
, crExtProcedureParam
, crossSupportFunctionalities
, dpExtProcedureParam
, executeDirectiveAcknowledge
, executeDirectiveReturn
, externallyDefinedTypeAndValueExtension
, fwProceduresFunctionalities
, getReturn
, modules
, nExtProcedureParam
, operations
, procedures
, scdpExtProcedureParam
, serviceGenericIdentifiers
, services
, startReturn
, teExtProcedureParam;
```

```
css OBJECT IDENTIFIER ::= {1 3 112 4 4}
```

```
csts OBJECT IDENTIFIER ::= {css 1}
```

```
crossSupportResources OBJECT IDENTIFIER ::= {css 2}
```

```
framework OBJECT IDENTIFIER ::= {csts 1}
```

```
services OBJECT IDENTIFIER ::= {csts 2}
```

```
externallyDefinedTypeAndValueExtension OBJECT IDENTIFIER ::= {csts 3}
```

```
-- =====
-- FRAMEWORK OBJECT IDENTIFIERS
```

```
fwProceduresFunctionalities OBJECT IDENTIFIER ::= {framework 4}
```

```
modules OBJECT IDENTIFIER ::= {framework 1}
```

```
operations OBJECT IDENTIFIER ::= {framework 2}
```

```
procedures OBJECT IDENTIFIER ::= {framework 3}
```

```
serviceGenericIdentifiers OBJECT IDENTIFIER ::= {framework 5}
```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- *****
-- FRAMEWORK OPERATIONS IDENTIFIERS:
bindInvocation          OBJECT IDENTIFIER ::= {operations 1}
bindReturn              OBJECT IDENTIFIER ::= {operations 2}
unbindInvocation        OBJECT IDENTIFIER ::= {operations 3}
unbindReturn            OBJECT IDENTIFIER ::= {operations 4}
peerAbortInvocation     OBJECT IDENTIFIER ::= {operations 5}
startInvocation         OBJECT IDENTIFIER ::= {operations 6}
startReturn             OBJECT IDENTIFIER ::= {operations 7}
stopInvocation          OBJECT IDENTIFIER ::= {operations 8}
stopReturn              OBJECT IDENTIFIER ::= {operations 9}
executedDirectiveInvocation OBJECT IDENTIFIER ::= {operations 10}
executeDirectiveAcknowledge OBJECT IDENTIFIER ::= {operations 11}
executeDirectiveReturn  OBJECT IDENTIFIER ::= {operations 12}
getInvocation           OBJECT IDENTIFIER ::= {operations 13}
getReturn               OBJECT IDENTIFIER ::= {operations 14}
notifyInvocation        OBJECT IDENTIFIER ::= {operations 15}
transferDataInvocation  OBJECT IDENTIFIER ::= {operations 16}
processDataInvocation   OBJECT IDENTIFIER ::= {operations 17}
processDataReturn       OBJECT IDENTIFIER ::= {operations 18}

-- *****
-- FRAMEWORK PROCEDURES IDENTIFIERS:
-- Identifiers to be used with the type ProcedureType
-- This branch is used to support all extension definitions required
-- for the operations extended by procedures.
associationControl      OBJECT IDENTIFIER ::= {procedures 1}
unbufferedDataDelivery OBJECT IDENTIFIER ::= {procedures 2}
bufferedDataDelivery   OBJECT IDENTIFIER ::= {procedures 3}
dataProcessing          OBJECT IDENTIFIER ::= {procedures 4}
informationQuery        OBJECT IDENTIFIER ::= {procedures 5}
notification            OBJECT IDENTIFIER ::= {procedures 6}
throwEvent             OBJECT IDENTIFIER ::= {procedures 7}

acDerivedProcedures     OBJECT IDENTIFIER ::= {associationControl 1}
acExtProcedureParam     OBJECT IDENTIFIER ::= {associationControl 2}
uddDerivedProcedures    OBJECT IDENTIFIER ::= {unbufferedDataDelivery 1}
uddExtProcedureParam    OBJECT IDENTIFIER ::= {unbufferedDataDelivery 2}
bddDerivedProcedures    OBJECT IDENTIFIER ::= {bufferedDataDelivery 1}
bddExtProcedureParam    OBJECT IDENTIFIER ::= {bufferedDataDelivery 2}
dpDerivedProcedures     OBJECT IDENTIFIER ::= {dataProcessing 1}
dpExtProcedureParam     OBJECT IDENTIFIER ::= {dataProcessing 2}
iqDerivedProcedures     OBJECT IDENTIFIER ::= {informationQuery 1}
iqExtProcedureParam     OBJECT IDENTIFIER ::= {informationQuery 2}
nDerivedProcedures      OBJECT IDENTIFIER ::= {notification 1}
nExtProcedureParam      OBJECT IDENTIFIER ::= {notification 2}
teDerivedProcedures     OBJECT IDENTIFIER ::= {throwEvent 1}
teExtProcedureParam     OBJECT IDENTIFIER ::= {throwEvent 2}
bufferedDataProcessing  OBJECT IDENTIFIER ::= {dpDerivedProcedures 1}
cyclicReport            OBJECT IDENTIFIER ::= {uddDerivedProcedures 1}
sequenceControlledDataProcessing OBJECT IDENTIFIER ::=
                                {dpDerivedProcedures 2}

crDerivedProcedures     OBJECT IDENTIFIER ::= {cyclicReport 1}
crExtProcedureParam     OBJECT IDENTIFIER ::= {cyclicReport 2}

bdpDerivedProcedures    OBJECT IDENTIFIER ::= {bufferedDataProcessing 1}
bdpExtProcedureParam    OBJECT IDENTIFIER ::= {bufferedDataProcessing 2}

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```
scdpDerivedProcedures      OBJECT IDENTIFIER ::=
                             {sequenceControlledDataProcessing 1}
scdpExtProcedureParam      OBJECT IDENTIFIER ::=
                             {sequenceControlledDataProcessing 2}

-- =====
-- CROSS SUPPORT RESOURCES
crossSupportFunctionalities OBJECT IDENTIFIER ::=
                             {crossSupportResources 1}
agenciesFunctionalities    OBJECT IDENTIFIER ::=
                             {crossSupportResources 2}

END
```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

F4.2 SERVICE-INSTANCE-ID

NOTE – This module defines the format of the Service Instance Identifier (see 3.4.2.2.7) used in the BIND operation.

```
CCSDS-CSTS-SERVICE-INSTANCE-ID
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccstds(4) css(4) csts(1) framework(1) modules(1) service-instance(2)
}
```

DEFINITIONS

IMPLICIT TAGS

```
::= BEGIN
```

```
EXPORTS ServiceInstanceIdentifier
```

```
;
```

```
IMPORTS IntUnsigned
```

```
, PublishedIdentifier
```

```
, FROM CCSDS-CSTS-COMMON-TYPES
```

```
;
```

```
ServiceInstanceIdentifier ::= SEQUENCE
{ spacecraftId          PublishedIdentifier
, facilityId           PublishedIdentifier
, serviceType          PublishedIdentifier
, serviceInstanceNumber IntUnsigned
}
```

```
END
```

F4.3 CROSS SUPPORT TRANSFER SERVICE — COMMON TYPES

CCSDS-CSTS-COMMON-TYPES

```
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccstds(4) css(4) csts(1) framework(1) modules(1) common-types(3)
}
```

DEFINITIONS

IMPLICIT TAGS

```
::= BEGIN
```

```
EXPORTS AbstractChoice
,
, AdditionalText
, AuthorityIdentifier
,
, BufferSize
,
, ConditionalTime
,
, DataTransferMode
,
, DataUnitId
,
, DeliveryLatencyLimit
,
, DeliveryMode
,
, Diagnostic
,
, Duration
,
, Embedded
,
, EventValue
,
, Extended
,
, FRorProcedureName
,
, FunctionalResourceInstanceNumber
,
, FunctionalResourceType
,
, IdentifierString
,
, IntPos
,
, IntUnsigned
,
, InvokeId
,
, Label
,
, ListOfNamesDiagnosticExt
,
, ListOfParametersEvents
,
, ListOfParamEventsDiagnostics
,
, LogicalPortName
,
, Name
,
, PortId
,
, ProcedureInstanceId
,
, ProcessingLatencyLimit
,
, ProductionStatus
,
, PublishedIdentifier
,
, QualifiedParameter
,
, ServiceUserRespTimer
,
, StandardAcknowledgeHeader
,
, StandardInvocationHeader
,
, StandardReturnHeader
,
, Time
,
, TypeAndValue
,
, TypeAndValueComplexQualified
,
, UnknownName
;
```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- This type is used by operations allowing the procedures using them to
-- select two possibilities for the definition of the data parameter:
-- 1. opaqueString: direct use, no extension required;
-- 2. extendedData: definition of a complex type using a constructed
--    syntax
AbstractChoice      ::= CHOICE
{ opaqueString      [0] OCTET STRING
, extendedData      [1] Embedded
}

-- In the event of a negative result, the value of the diagnostic
-- is complemented by the following type (see 3.2.1.6 a)):
AdditionalText      ::= VisibleString

-- Appellation is used between the service provider and the service user.
-- This appellation not being formally agreed can only be used for logging
-- or tracing.
Appellation         ::= VisibleString (SIZE (1 .. 128))

AuthorityIdentifier ::= IdentifierString (SIZE (3 .. 16))

BufferSize         ::= IntPos

ConditionalTime     ::= CHOICE
{ undefined          [0] NULL
, known              [1] Time
}

-- If credentials are used, it will be necessary that the internal
-- structure of the octet string is known to both parties. Since the
-- structure will depend on the algorithm used, it is not specified here.
-- However, the peer entities may use ASN.1 encoding to make the internal
-- structure visible.
Credentials         ::= CHOICE
{ unused             [0] NULL
, used               [1] OCTET STRING (SIZE (8 .. 256))
}

DataTransferMode    ::= INTEGER
{ undefined          (0)
, timely             (1)
, complete           (2)
}

DataUnitId         ::= IntUnsigned

DeliveryLatencyLimit ::= IntPos

DeliveryMode        ::= INTEGER
{ undefined          (0)
, realTime           (1)
, complete           (2)
}

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- The diagnostics defined here are to be used with all operation returns.
-- Note:
-- By means of the 'diagnosticExtension' CHOICE additional values of the
-- diagnostic parameter can be introduced if that is necessary for the
-- negative return or acknowledgement of an operation.
Diagnostic ::= CHOICE
{ invalidParameterValue [1] SEQUENCE
  {
    text AdditionalText
    ,
    appellation Appellation -- of the invalid parameter
  }
, conflictingValues [2] SEQUENCE
  {
    text AdditionalText
    ,
    appellations SEQUENCE OF Appellation
  }
, otherReason [3] AdditionalText
, unsupportedOption [4] AdditionalText
, diagnosticExtension [100] Embedded
}

-- The Duration maybe expressed in seconds, milliseconds, or microseconds
Duration ::= CHOICE
{ seconds [0] IntUnsigned
, milliseconds [1] IntUnsigned
, microseconds [2] IntUnsigned
}

Embedded ::= EMBEDDED PDV

EventValue ::= CHOICE
{ qualifiedValues [1] SequenceOfQualifiedValues
, empty [2] NULL
, eventValueExtension [100] Embedded
}

Extended ::= CHOICE
{ external [0] Embedded
, notUsed [1] NULL
}

FRorProcedureName ::= CHOICE
{ functionalResourceName [0] FunctionalResourceName
, procedureInstanceId [1] ProcedureInstanceId
}

FunctionalResourceName ::= SEQUENCE
{ functionalResourceType FunctionalResourceType
, functionalResourceInstanceNumber FunctionalResourceInstanceNumber
}

FunctionalResourceInstanceNumber ::= IntPos

FunctionalResourceType ::= PublishedIdentifier

IdentifierString ::= VisibleString (FROM (ALL EXCEPT " "))

-- 1 to (2^32)-1
IntPos ::= INTEGER (1 .. 4294967295)

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- 0 to (2^32)-1
IntUnsigned ::= INTEGER (0 .. 4294967295)

InvokeId ::= IntUnsigned

-- The Label structure is used to identify:
-- 1. the Label of a parameter
-- 2. the Label of an event
Label ::= SEQUENCE
{
    functionalResourceOrProcedureType CHOICE
        {
            functionalResourceType [1] FunctionalResourceType
            , procedureType [2] ProcedureType
        }
    , paramOrEventId PublishedIdentifier
}

ListOfNamesDiagnosticExt ::= CHOICE
{
    unknownNames [1] SEQUENCE OF UnknownName
    , unknownDefault [3] AdditionalText
    , diagnosticExtension [100] Embedded
}

-- The type ListOfParametersEvents is used by the service user to select
-- the parameters by means of the START of the Cyclic Report procedure and
-- by means of the GET operation. While the choices [0] to [5] relate to
-- cross support resources, the choices [6] and [7] relate to the
-- configuration parameters registered in the framework resources branch.
ListOfParametersEvents ::= CHOICE
{
    empty [0] NULL -- signifying default list
    , listName [3] VisibleString
    , functionalResourceType [5] FunctionalResourceType
    , functionalResourceName [4] FunctionalResourceName
    , procedureType [6] ProcedureType
    , procedureInstanceId [7] ProcedureInstanceId
    , paramEventLabels [2] SEQUENCE OF Label
    , paramEventNames [1] SEQUENCE OF Name
}

ListOfParamEventsDiagnostics ::= CHOICE
{
    undefinedDefault [5] AdditionalText
    , unknownListName [4] VisibleString
    , unknownFunctionalResourceType [2] FunctionalResourceType
    , unknownFunctionalResourceName [1] FunctionalResourceName
    , unknownProcedureType [6] ProcedureType
    , unknownProcedureInstanceId [7] ProcedureInstanceId
    , unknownParamEventIdentifier [3] SEQUENCE OF CHOICE
        {
            paramEventLabel [2] Label
            , paramEventName [1] Name
        }
}

LogicalPortName ::= IdentifierString (SIZE (1 .. 128))

MaxFwdBufferSize ::= IntPos

```


CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- The Name structure is used to identify:
-- 1. the Name of a parameter
-- 2. the Name of an event
-- 3. the Name of a directive
Name ::= SEQUENCE
{
  fRorProcedureName      FRorProcedureName
, paramOrEventOrDirectiveId  PublishedIdentifier
}

PortId ::= LogicalPortName

ProcedureInstanceId ::= SEQUENCE
{
  procedureType      ProcedureType
, procedureRole      CHOICE
  {
    primeProcedure      [1]      NULL
    , secondaryProcedure [2]      IntPos
    , associationControl [3]      NULL
  }
}

-- The ProcedureType is an Object Identifier the allocation of which is
-- under control of CCSDS. It is declared in the ASN.1 module
-- CCSDS-CSTS-OBJECT-IDENTIFIERS (see F1.1).
ProcedureType ::= OBJECT IDENTIFIER

ProcessingLatencyLimit ::= IntPos

ProductionStatus ::= SEQUENCE (SIZE (1)) OF INTEGER
{
  configured      (0)
, operational     (1)
, interrupted     (2)
, halted         (3)
}

-- A PublishedIdentifier is an identifier agreed between the service
-- provider and the service user. The identifier is registered in SANA
-- (See D2)
PublishedIdentifier ::= OBJECT IDENTIFIER

-- The definition of the parameters can be found in annex C2.1
QualifiedParameter ::= SEQUENCE
{
  parameterName      Name
, qualifiedValues     SequenceOfQualifiedValues
}

QualifiedValues ::= CHOICE
{
  valid      [0]      TypeAndValueComplexQualified -- Valid value
, unavailable [1]      NULL -- Unknown or unavailable value
, undefined  [2]      NULL -- Undefined in the context
, error      [3]      NULL -- Processing resulted in an error
}

SequenceOfQualifiedValues ::= SEQUENCE OF QualifiedValues

ServiceUserRespTimer ::= IntPos

StandardAcknowledgeHeader ::= StandardReturnHeader

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

StandardInvocationHeader ::= SEQUENCE
{
  invokerCredentials      Credentials
,   invokeId              InvokeId
,   procedureInstanceId   ProcedureInstanceId
}

StandardReturnHeader ::= SEQUENCE
{
  performerCredentials    Credentials
,   invokeId              InvokeId
,   result                CHOICE
  {
    positive [0] Extended -- To carry the positive results
  ,   negative [1] SEQUENCE
    {
      diagnostic          Diagnostic
    ,   negExtension      Extended
      -- The default value of the
      -- negExtension parameter is
      -- 'notUsed'.
      -- Unless a PDU that uses the
      -- StandardReturnHeader explicitly
      -- defines an extension type to be used
      -- as the value of negExtension for
      -- that PDU, the value shall be
      -- 'notUsed'.
    }
  }
}

Time ::= CHOICE
{
  ccsdsFormatMilliseconds [0] TimeCCSDSMilli
,   ccsdsFormatPicoSeconds [1] TimeCCSDSPico
}

TimeCCSDSMilli ::= OCTET STRING (SIZE(8))
-- P-field is implicit (not present, defaulted to 41 hex
-- T-field:
-- 2 octets: number of days since 1958/01/01 00:00:00;
-- 4 octets: number of milliseconds of the day;
-- 2 octets: number of microseconds of the millisecond
--           (set to 0 if not used).
-- This definition reflects exactly the format of the CCSDS defined
-- time tag as used in spacelink data units (see reference [5]).

TimeCCSDSPico ::= OCTET STRING (SIZE(10))
-- P-field is implicit (not present, defaulted to 41 hex
-- T-field:
-- 2 octets: number of days since 1958/01/01 00:00:00;
-- 4 octets: number of milliseconds of the day;
-- 2 octets: number of microseconds of the millisecond
--           (set to 0 if not used);
-- 2 octets: number of picoseconds of the microsecond
--           (set to 0 if not used).
-- This definition reflects exactly the format of the CCSDS defined
-- time tag as used in spacelink data units (see reference [5]).

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

TypeAndValue ::= CHOICE
{
  integer [0] SEQUENCE OF INTEGER
  , integerPositive [1] SEQUENCE OF IntPos
  , intUnsigned [2] SEQUENCE OF IntUnsigned
  , duration [3] SEQUENCE OF Duration
  , characterString [4] SEQUENCE OF VisibleString
  , boolean [5] SEQUENCE OF BOOLEAN
  , octetString [6] SEQUENCE OF OCTET STRING
  , float [7] SEQUENCE OF REAL
  , time [8] SEQUENCE OF Time
  , enumerated [9] SEQUENCE OF INTEGER
  , objectIdentifier [10] SEQUENCE OF OBJECT IDENTIFIER
  , publishedIdentifier [11] SEQUENCE OF PublishedIdentifier
  , typeAndValueExtension [100] Embedded
}

```

```

TypeAndValueComplexQualified ::= CHOICE
{
  typeAndValue [0] TypeAndValue
  , complexSequence [1] SEQUENCE OF TypeAndValue
  , complexSet [2] SET OF TypeAndValue
}

```

```

UnknownName ::= SEQUENCE
{
  text AdditionalText
  , name Name
}

```

END

STANDARDSISO.COM : Click to view the full PDF of ISO 23103:2020

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

F4.4 COMMON OPERATIONS PDUS

CCSDS-CSTS-COMMON-OPERATIONS-PDUS

```
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) common-operations(4)
}
```

DEFINITIONS

IMPLICIT TAGS

::= BEGIN

```
EXPORTS ExecuteDirectiveAcknowledge
, ExecuteDirectiveInvocation
, ExecuteDirectiveReturn
, GetInvocation
, GetReturn
, NotifyInvocation
, ProcessDataInvocation
, ProcessDataReturn
, StartInvocation
, StartReturn
, StopInvocation
, StopReturn
, TransferDataInvocation
;
```

```
IMPORTS AbstractChoice
, AdditionalText
, DataUnitId
, EventValue
, Extended
, Embedded
, FunctionalResourceInstanceNumber
, IntUnsigned
, ListOfParametersEvents
, ListOfParamEventsDiagnostics
, Name
, ProcedureInstanceId
, PublishedIdentifier
, QualifiedParameter
, StandardAcknowledgeHeader
, StandardInvocationHeader
, StandardReturnHeader
, Time
, TypeAndValueComplexQualified
FROM CCSDS-CSTS-COMMON-TYPES

, executeDirectiveAcknowledge
, executeDirectiveReturn
, getReturn
, startReturn
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS
;
```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- =====
-- The first part of the module is left empty as there are no PDUs
-- defined in this module.
-- =====

-- =====
-- The second part of the module defines the common operations
-- the service provider may receive.
-- =====

DirectiveQualifierValues ::= CHOICE
{
  sequenceOfParamIdsAndValues [1] SequenceOfParameterIdsAndValues
,
  parameterlessValues [2] TypeAndValueComplexQualified
,
  noQualifierValues [3] NULL
}

ExecuteDirectiveInvocation ::= SEQUENCE
{
  standardInvocationHeader StandardInvocationHeader
,
  directiveIdentifier PublishedIdentifier
,
  directiveQualifier CHOICE
  {
    localProcDirQualifier [1] DirectiveQualifierValues
  ,
    serviceProcDirQualifier [2] SEQUENCE
    {
      procedureInstanceId ProcedureInstanceId
    ,
      serviceProcDirQualifierValues DirectiveQualifierValues
    }
  ,
    functResourceDirQualifier [3] SEQUENCE
    {
      functResourceInstanceNumber FunctionalResourceInstanceNumber
    ,
      functionalResourceQualifiers DirectiveQualifierValues
    }
  ,
    directiveQualifierExtension [4] Embedded
  }
,
  executeDirectiveInvocationExtension Extended
}

GetInvocation ::= SEQUENCE
{
  standardInvocationHeader StandardInvocationHeader
,
  listOfParameters ListOfParametersEvents -- See 3.12.2.2.2
,
  getInvocationExtension Extended
}

ProcessDataInvocation ::= SEQUENCE
{
  standardInvocationHeader StandardInvocationHeader
,
  dataUnitId DataUnitId
,
  data AbstractChoice -- See 3.10.2.2.4.
,
  processDataInvocationExtension Extended
}

SequenceOfParameterIdsAndValues ::= SEQUENCE OF SEQUENCE
{
  parameterIdentifier PublishedIdentifier
,
  parameterValue TypeAndValueComplexQualified
}

StartInvocation ::= SEQUENCE
{
  standardInvocationHeader StandardInvocationHeader
,
  startInvocationExtension Extended
}

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

StopInvocation      ::= SEQUENCE
{
    standardInvocationHeader  StandardInvocationHeader
    , stopInvocationExtension  Extended
}

-- =====
-- The third part of the module defines the common operations
-- the service provider may send.
-- =====

ExecuteDirectiveAcknowledge ::= StandardAcknowledgeHeader

ExecuteDirectiveReturn      ::= StandardReturnHeader

GetReturn                   ::= StandardReturnHeader

-- The Published Identifier part of the eventName is defined by the Object
-- Identifiers svcProductionStatusChange or
-- svcProductionConfigurationChange or by procedure type
-- specific Published Identifiers (see F4.16 and F4.17).
NotifyInvocation           ::= SEQUENCE
{
    standardInvocationHeader  StandardInvocationHeader
    , eventTime               Time
    , eventName               Name
    , eventValue              EventValue
    , notifyInvocationExtension Extended
}

ProcessDataReturn          ::= StandardReturnHeader

StartReturn                ::= StandardReturnHeader

StopReturn                 ::= StandardReturnHeader

TransferDataInvocation      ::= SEQUENCE
{
    standardInvocationHeader  StandardInvocationHeader
    , generationTime          Time
    , sequenceCounter         IntUnsigned
    , data                    AbstractChoice
    , transferDataInvocationExtension Extended
}

-- =====
-- The fourth part of the module defines the extensions
-- of the common operations the service provider may send.
-- =====

-- *****
-- EXECUTE-DIRECTIVE invocation
-- The EXECUTE-DIRECTIVE invocation is not extended, i.e.,
-- 'ExecuteDirectiveInvocation': 'executeDirectiveInvocationExtension' is
-- set to 'notUsed'.

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- EXECUTE-DIRECTIVE acknowledgement
-- The EXECUTE-DIRECTIVE positive acknowledgement does not extend
-- ExecuteDirectiveAcknowledge, i.e., 'ExecuteDirectiveAcknowledge':
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'positive' shall be set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative acknowledgement does not extend
-- ExecuteDirectiveAcknowledge, i.e., 'ExecuteDirectiveAcknowledge':
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'negative': 'negExtension' shall be set to 'notUsed'.
-- The EXECUTE DIRECTIVE negative acknowledgement makes use of: (a) one of
-- the common diagnostics of the StandardReturnHeader type (see diagnostic
-- parameter defined in 3.3.2.7) except 'diagnosticExtension'; or (b) one
-- of the diagnostic values defined by 'ExecuteDirectiveAcknowledge':
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt' in F4.4 except
-- 'execDirNegAckDiagnosticExtExtension'.
ExecDirNegAckDiagnosticExt ::= CHOICE
{
    unknownDirective                [1]    NULL
  , unknownQualifier                [2]    NULL
  , invalidProcedureInstance        [3]    NULL
  , invalidFunctionalResourceInstance [4]    NULL
  , invalidFunctionalResourceParameter [5]    SET OF Name
  , invalidProcedureParameter       [6]    SET OF Name
  , parameterValueOutOfRange        [7]    SET OF Name
  , execDirNegAckDiagnosticExtExtension [100] Embedded
}

execDirAckDiagExt OBJECT IDENTIFIER ::=
    {executeDirectiveAcknowledge 1}

-- EXECUTE-DIRECTIVE return
-- The EXECUTE-DIRECTIVE positive return does not extend
-- ExecuteDirectiveReturn, i.e., 'ExecuteDirectiveReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative return does not extend
-- ExecuteDirectiveReturn, i.e., 'ExecuteDirectiveReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The EXECUTE DIRECTIVE negative return makes use of: (a) one of the
-- common diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the diagnostic values defined by
-- 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt' in F4.4
-- except 'execDirNegReturnDiagnosticExtExtension'.
ExecDirNegReturnDiagnosticExt ::= CHOICE
{
    actionNotCompleted                [0]
    ActionNotCompletedDiag
  , execDirNegReturnDiagnosticExtExtension [100] Embedded
}

execDirNegReturnDiagnosticExt OBJECT IDENTIFIER ::=
    {executeDirectiveReturn 1}

```

CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

ActionNotCompletedDiag ::= CHOICE
{
    parameterNames      [0] SET OF Name
  , noParameterNames    [1] NULL
}

-- *****
-- GET invocation
-- The GET invocation is not extended, i.e., 'GetInvocation':
-- 'getInvocationExtension' shall be set to 'notUsed'.

-- GET Return
-- The GET positive return extends the GetReturn by adding the parameters
-- 'qualifiedParameters' and 'getPosReturnExtExtension' defined by
-- 'GetReturn': 'StandardReturnHeader': 'result': 'positive':
-- 'getPosReturnExt': 'GetPosReturnExt'. This extension only defines the
-- 'qualifiedParameters' parameter. 'getPosReturnExtExtension' shall be set
-- to 'notUsed'.
GetPosReturnExt ::= SEQUENCE
{
    qualifiedParameters      QualifiedParametersSequence
  , getPosReturnExtExtension Extended
}

getPosReturnExt OBJECT IDENTIFIER ::= {getReturn 1}

-- The GET negative return does not extend GetReturn, i.e., 'GetReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The GET negative return makes use of: (a) one of the common diagnostics
-- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
-- 'Diagnostic' (see diagnostic parameter defined in 3.3.2.7 and F4.3)
-- except 'diagnosticExtension'; or (b) one of the additional diagnostic
-- values defined by 'GetReturn': 'StandardReturnHeader': 'result':
-- 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'getDiagnosticExt': 'GetDiagnosticExt' in F4.4 except
-- 'getDiagnosticExtExtension'.
GetDiagnosticExt ::= CHOICE
{
    common      [0] ListOfParamEventsDiagnostics
  , getDiagnosticExtExtension [100] Embedded
}

getDiagnosticExt OBJECT IDENTIFIER ::= {getReturn 2}

QualifiedParametersSequence ::= SEQUENCE OF QualifiedParameter

-- *****
-- START invocation
-- The START invocation is not extended, i.e., 'StartInvocation':
-- 'startInvocationExtension' shall be set to 'notUsed'.

```


CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

```

-- START return
-- The START positive return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
-- to 'notUsed'.
-- The START negative return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'negExtension' shall be set to 'notUsed'.
-- The START negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the additional values specified by
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':
-- 'startDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'.
StartDiagnosticExt ::= CHOICE
{
  unableToComply [0] AdditionalText
,
  outOfService [1] AdditionalText
,
  startDiagnosticExtExtension [100] Embedded
}

startDiagnosticExt OBJECT IDENTIFIER ::= {startReturn 1}

-- *****
-- STOP invocation
-- The STOP invocation is not extended, i.e., 'StopInvocation':
-- 'stopInvocationExtension' shall be set to 'notUsed'.

-- STOP return
-- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The STOP negative return makes use of one of the common diagnostics
-- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
-- 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

END

```