EUROPEAN COOPERATION

E CSS

FOR SPACE STANDARDIZATION

Space engineering

Ground systems and operations – Monitoring and control data definition

Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of documents.

This Standard has been prepared by the ECSS-E-70-31 Working Group, reviewed by the ECSS Executive Secretariat, and approved by the ECSS Technical Authority.

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Contents

Introduction

As described in ECSS-E-00 and ECSS-E-10, the development of a space system is an incremental task involving different entities, who can participate as customer or supplier at different levels of space system integration.

Documentation and data of different types is exchanged between supplier and customer. The purpose of this Standard is to define the data to be provided by the supplier to the customer in order to be able to monitor and control the product delivered. Formally, this data is part of the user manual for the corresponding element of the space system (see ECSS-E-70).

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1
Scope

This Standard defines the monitoring and control data that a supplier delivers together with a product in order to allow a customer to perform space system integration, testing and mission operations.

The requirements in this Standard are defined in terms of *what* data is provided by the supplier to the customer. *How* this data is provided (e.g. using spreadsheet data or XML) is outside of scope.

The Standard assumes that missions conform to the following ECSS standards:

- ECSS-E-50 and ECSS-E-70;
- ECSS-E-70-41;
- ECSS-E-70-32.

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2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-E-70B	Space engineering - Ground systems and operations - Principles and requirements
ECSS-E-70-01A [1]	Space engineering - On board control procedures
ECSS-E-70-11A	Space engineering - Ground systems and operations - Space segment operability
ECSS-E-70-32A	Space engineering -Ground systems and operations - Procedure definition language
ECSS-E-70-41A	Ground systems and operations - Telemetry and telecommand packet utilization
ECSS-M-40B	Space project management - Configuration management

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[1] To be published.

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3
Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this Standard, the definitions given in ECSS-P-001 and ECSS-E-70 apply. In particular, it should be noted that the following terms have a specific definition for use in ECSS Standards.

anomaly

assembly

availability

contingency procedure

emergency

mission

procedure

space system

subsystem

system

test

validation

verification

The following terms are specific to this Standard:

3.1.1
activity

space system monitoring and control function

3.1.2
compound parameter

record comprised of any sequence of **reporting data**, arrays of **reporting data** and sub-records that are interpreted together

Example   An anomaly report generated by the space segment comprising an anomaly report ID and a set of associated **parameters**.

3.1.3
event

occurrence of a condition or set of conditions that can arise during the course of a test session or mission phase

3.1.4
parameter

lowest level of elementary information that has a meaning for monitoring the space system

3.1.5
reporting data

data used for assessing the functioning of the space system

NOTE Reporting data can consist of a **parameter** (a simple type) or a **compound parameter** (a complex type).

3.1.6
resource

stock or supply, either depletable or shareable in nature, that can be drawn upon, or provided by, an element of the space system during operation

3.1.7
space system model

representation of the space system in terms of its decomposition into **system elements**, the **activities** that can be performed on these **system elements**, the **reporting data** that reflects the state of these **system elements** and the **events** that can be raised and handled for the control of these **system elements**, **activities** or **reporting data**

3.1.8
synthetic parameter

reporting data generated within the monitoring and control system by means of an expression which may use other **reporting data** and constants as input

3.1.9
system element

representation within the **space system model** of a functional element of the space system

3.2   Abbreviated terms

The following abbreviated terms are defined and used within this Standard.

Abbreviation	Meaning
AD	acceptance of data
AOCS	attitude and orbit control subsystem
APID	application process identifier
BD	bypass of data
CDMU	command and data management unit
CI	configuration item
COTS	commercial off-the-shelf

CPDU	command pulse distribution unit
CRC	cyclic redundancy check
EBNF	extended Backus-Naur form
EM	engineering model
EMCS	EGSE or mission control system
EXPL	expression language
FID	function identifier
FM	flight model
FTP	file transfer protocol
ID	identifier
IFL	interpretation function language
MAP	multiplexed access point
OBSM	on-board software maintenance
OBT	on-board time
PC	parameter code
PFC	parameter format code
PTC	parameter type code
PLUTO	procedure language for users in test and operations
PUS	packet utilization standard
RID	report identifier
SAU	smallest addressable unit
SE	system element
SID	structure identifier
SPEL	synthetic parameter expression language
SSM	space system model
STM	structural model
TDM	time-division multiplexed
UTC	universal time coordinated
VAL	value definition language
VC	virtual channel

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4

Background and context

4.1   The space system model

Throughout the space system lifecycle, suppliers deliver "Products" to customers. A product consists of hardware component, software component, or both, together with associated documentation containing all the knowledge required by the customer during the complete lifecycle of the product (design, development, integration, testing and operation) and across all domains of expertise (quality, management and engineering).

> NOTE   A prime contractor can deliver a product (e.g. documentation) to a subcontractor. In this context, the prime contractor is the supplier and the subcontractor is the customer.

To facilitate the sharing and reuse of the product knowledge by the customer, the documentation shall be organised according to a formal structure.

For this purpose, this Standard introduces the concept of a space system model (SSM) that is structured so as to be able to capture the space system knowledge. This structure reflects the structure of the space system itself. The SSM is hierarchically broken down into system elements (SE) mirroring the functional breakdown of the space system. A system element is a data structure whose properties are the means to capture the space system knowledge.

System elements correspond to the elements of the space system resulting from the functional decomposition defined in ECSS-E-00. From the highest level downwards, these are progressively: system, subsystem, set, equipment or software product, assembly, part (hardware) or module (software).

An example of the SSM corresponding to a product delivery (an attitude and orbit control subsystem) is shown in Figure 1.
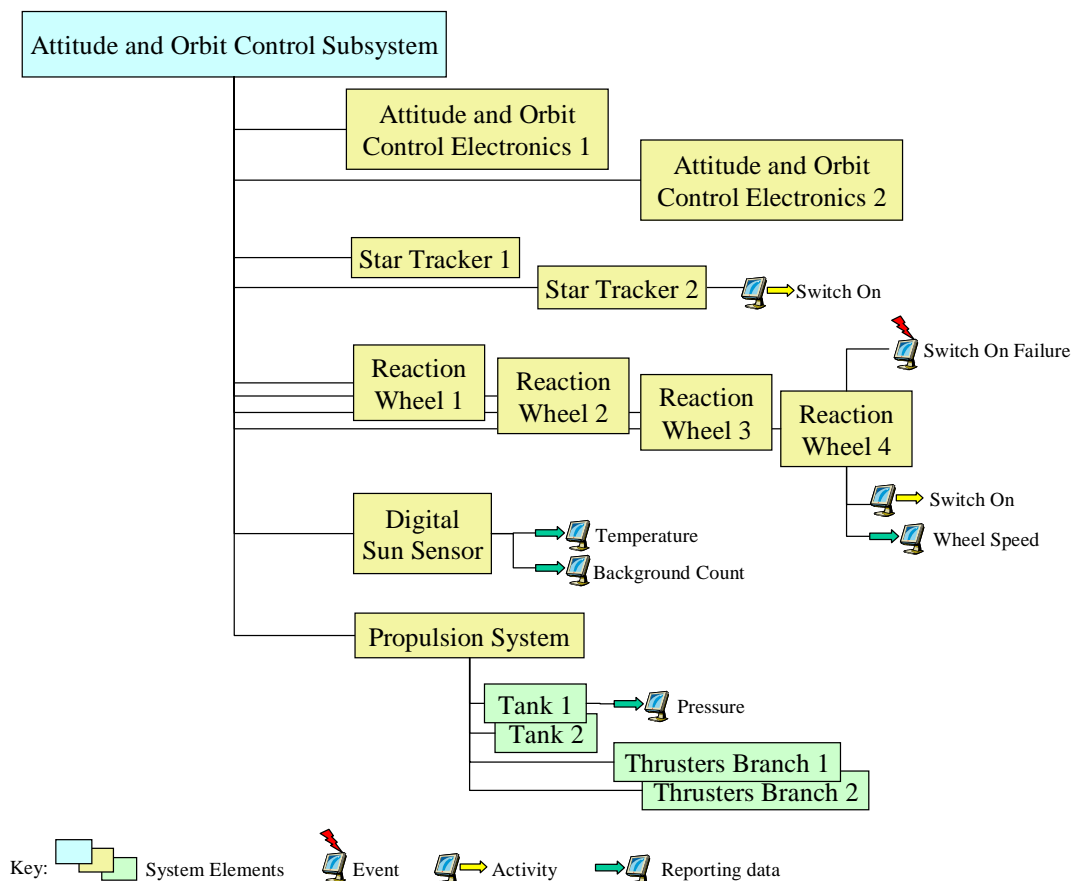
Figure 1   Example product delivery system element hierarchy

4.2   Monitoring and control view of the SSM

4.2.1   Introduction

According to the utilisation of the product, actors in different domains will require different "domain-specific views" of the SSM, where a view is the corresponding SE hierarchy (or hierarchies) and the sub-set of SE characteristics relevant to the domain.

The SSM consists of:

• "entity" types e.g. system element is an entity type.

• "value" types e.g. APID is a value type.

4.2.2   Standard SSM definitions

The SSM types that are relevant for monitoring and control purposes are system elements and their associated activities, reporting data, events and constituent system elements.

• An activity is a space system monitoring and control function implemented within the EGSE or mission control system (EMCS). An activity can be implemented as a telecommand either to the space segment or to the ground segment, a procedure, an operating system command (e.g. a printer request, sending an email, transferring a file using FTP) or any other command type that is specific to a given implementation of the space

system (e.g. a command to a special check-out system (SCOE) or to a ground station using a proprietary protocol).

- Reporting data is information that a system element provides, irrespective of how this information is used. Reporting data can comprise measurements which reflect the state of the associated system element or an output product whose purpose is to be used by another system element (e.g. manoeuvre parameters provided by the flight dynamics system). Reporting data comprises parameters and compound parameters. A parameter is the lowest level of elementary information that has a meaning for monitoring and control of the space system. A compound parameter is a record comprised of any sequence of parameters, arrays of parameters and sub-records (see also ECSS-E-70-41A). For example, a complete telemetry packet, or part thereof, may be represented as a compound parameter. The parameters within a compound parameter are normally interpreted together (e.g. when interpreting the contents of an anomaly report). Reporting data can have different representations depending on its life cycle within the space system (e.g. an on-board measurement has a raw value in telemetry and an engineering value when presented on a ground segment display).

- An event is an occurrence of a condition or group of conditions of operational significance. Events are widely used within the space system to trigger the execution of functions (e.g. acquisition of signal can initiate telemetry processing tasks at the ground station). Users can define mission-specific events, associated with a system element, for example for use within procedures.

In turn, activities, reporting data and events may have their own value and entity types e.g. an activity has a name (value type) and arguments (entity type).
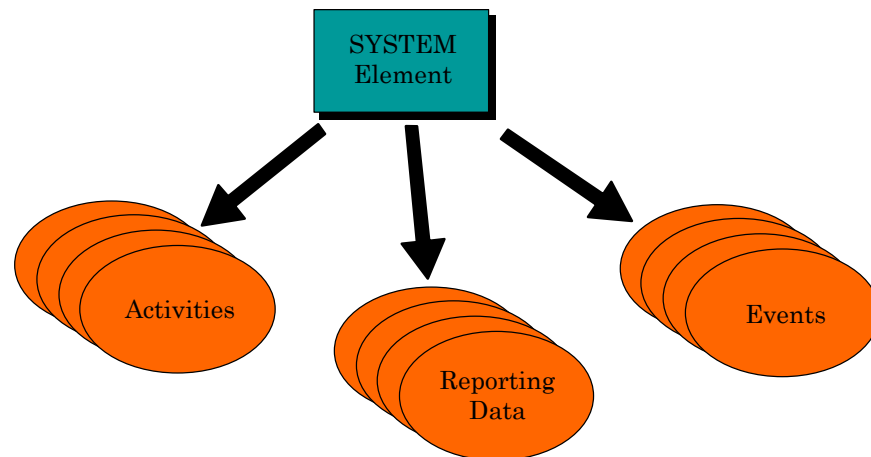
Figure 2   Monitoring and control knowledge associated with a system element

Each actor in the overall space system development life cycle has its own view of the SSM hierarchy, which corresponds to its needs and which is comprised of:

- one or more root system elements (a root system element corresponds to a node of the overall SSM hierarchy), and

- one or more corresponding system element hierarchies i.e. for each root system element, a view of the decomposition of this system element which is limited in scope to its level of interest.

> Example   A payload manufacturer only knows about the hierarchy of system elements that correspond to its payload and its EGSE.

The concepts of system elements and their characteristics introduced above enable a complete, high-level description of the space system model independent of any specific space system configuration and, as such, can be reused at any level of integration, test and mission operations. For example, the name and description of an activity always remain the same, although it may be implemented as a simulated command during testing and a procedure during mission operations.

4.2.3   Product-specific SSM tailoring

A tailoring process is required to define the SSM that corresponds to a given product. This implies selecting the applicable subset of the entity and value types identified in this Standard and adding product-specific additional types.

> Example 1   Adding types corresponding to a 1553 bus-specific protocol.

> Example 2   Tailoring of standard PUS (packet utilization standard, ECSS-E-70-41) services for a mission and adding mission-specific services and extensions to the standard PUS services.

> Example 3   Accommodating an existing proprietary protocol for monitoring and controlling an antenna front-end controller.

5

Conventions

5.1   Data definition

This Standard defines the SSM data model (consisting of entity types and value types) that a supplier uses to provide the monitoring and control data for a delivered product.

The SSM data model is specified as a set of requirements in a tabular form. Each table corresponds to an entity type which is uniquely identified by the name of the table.

Tables are comprised of three columns (see Table 1 for an example):

- Each row corresponds to a value type.

- The first column identifies a value type by means of a name that is unique within the context of the current table.

- The second column contains the definition of the type i.e. a description and any applicable constraints.

- The third column identifies the data type of the type.

Where the arity of a value type (or a set of value types) is greater than one, the first column also specifies the corresponding lower-level entity type i.e. an ordered list ("Ordered list of…") or an unordered list ("List of…").

NOTE 1   Where a condition is expressed for the provision of a given type, the corollary is that the type is NOT provided if the condition is not TRUE.

NOTE 2   Enumerated values and keywords are shown in bold in the tables.

Table 1   Example data requirement table

Name		Definition	Data Type
Type		The type of array. The set of values is {"**fixed**", "**variable**"}.	Enumerated
Minimum Number of Repetitions		The minimum number of repetitions of the array component	Unsigned Integer
Maximum Number of Repetitions		The maximum number of repetitions of the array component	Unsigned Integer
Ordered list of	Reporting Data	The reporting data that comprises the component	Reporting Data Reference

Within this Standard, a reference to the SSM indicates both the data model as defined by the data requirements and the corresponding mission data provided by a supplier to a customer. The term "SSM object" is used to refer to any object of the populated database that is uniquely identified by a name e.g. a system element, a reporting data, an activity or an event.

5.2   Railroad diagrams

A graphical convention is used to define the syntax of language-based data type constructs within the remainder of this Standard. This convention is known as a "railroad" diagram, so-called because of the similarity to a railway network. An example railroad diagram is shown in Figure 3. The elements of this graphical convention are as follows:

- the name at the top of the diagram is that of the item being defined, also referred to as a "non-terminal symbol";

- a non-terminal symbol is a combination of zero or more non-terminal symbols and "terminal symbols", where a terminal symbol is a sequence of one or more characters forming an irreducible element (i.e. it cannot be decomposed further);

- non-terminal symbols are enclosed in rectangles;

- terminal symbols are enclosed in round-cornered boxes (in the limit, a circle);

- the main line corresponds to mandatory elements of the data type or construct;

- branch lines correspond to optional elements;

- "return" lines correspond to optional repetitions of one or more elements.

Integer Constant =
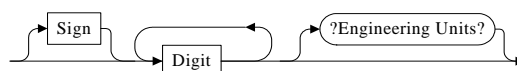
Figure 3   Example railroad diagram

Figure 3 defines that an integer constant starts with an optional sign followed by one or more digits, followed by optional engineering units.

NOTE   The "?" is a special-sequence-symbol which indicates the start and end of a special sequence (see ISO/IEC 14977); in this case a standalone syntax for Engineering Units.

5.3 Case sensitivity

All words used in expressing the data requirements in this Standard are case-insensitive.

5.4 Names

As a result of the distributed approach employed for space system development, the uniqueness of names assigned by a given supplier cannot be guaranteed at a higher-level of integration. For this reason, this Standard introduces the concepts of relative names and reference paths.

A relative name is a name which is unique within a local context. When the context changes and that uniqueness is compromised, the relative name is rendered unique by attaching a reference path.

A relative name is an identifier comprised of one or more identifier words separated by spaces. An identifier word is a sequence of letters (in upper or lower case) and digits.

> Example   Star Tracker

A reference path is also a name comprised of one or more identifier words separated by spaces. A reference path itself can be comprised of a relative name, unique within a lower-level context, and a reference path rendering it unique. The keyword "**of**" is used to separate the left-hand part of the name (i.e. the relative name) from the right-hand part of the name (i.e. the reference path).

> Example   X Thruster of Branch 1

For entities that are associated with a parent entity (e.g. reporting data are associated with system elements, activity arguments are associated with activities) the uniqueness of the name can be achieved in two ways: either by assigning a name that is unique at the level of the child entity (e.g. a reporting data) or by using the parent entity in a reference path.

> Example 1   XGyro temperature
>
> Example 2   Temperature of XGyro

There are no constraints in the use of the keyword "**of**" in naming entities, except the need to maintain the uniqueness of names with a given product. This implies, for example, that "Temperature of XGyro" can either represent an absolute name of a reporting data or a relative name of a reporting data using "of XGyro" as the reference path.

The syntax for defining names is the following:

Name =
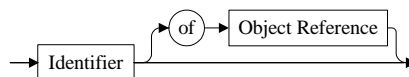
Identifier =
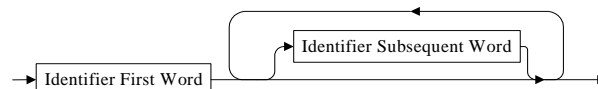
Identifier First Word =
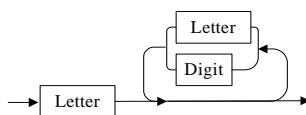
Identifier Subsequent Word =
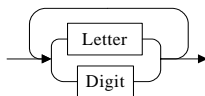
Object Reference =
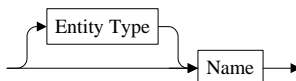
where:

- Letter is an upper-case or lower-case letter of the alphabet.

- Digit is one of the decimal characters from 0 to 9.

- Identifiers are case-insensitive.

- Entity Type includes one of "system element", "activity", "reporting data", "parameter" or "event". The naming convention defined in this subclause is also used within this Standard to uniquely identify entity types, value types and data types within the SSM data model. This facilitates direct references from supplied data to elements of the SSM data model, e.g. reference to a data type when declaring variables in a test procedure script. For this purpose, Entity Type also includes any entity type referenced within the SSM data model.

Examples of SSM data model names are:

- "System Element" which uniquely identifies an entity type within the data model.

- "Severity of Event" which uniquely identifies the value type "Severity" of the entity type "Event".

- "Data Type **of current parameter**" which uniquely identifies the data type of the parameter in whose context it is defined.

5.5   Data types

5.5.1   General

The data types used within this Standard are classified as "simple" or "complex".

- The "simple" types include:
  - o   the conventional types "**Boolean**", "**integer**", "**unsigned integer**", "**real**", "**bit string**", "**octet string**", "**character string**", "**absolute time**" and "**relative time**";
  - o   the types for packet fields identified in ECSS-E-70-41A (the PUS) by the parameter code "PC" comprising the parameter type code "PTC" and the parameter format code "PFC". These PUS types correspond to

conventional types, however their representation and scope is constrained by the associated PFC definition (e.g. the type PTC 1 PFC 0 corresponds to Boolean, with the characteristic that TRUE = 1 and FALSE = 0);

o   the enumerated types either defined within this Standard and identified by the keyword "Enumerated", or user-defined using the "user-defined enumerated type" construct specified in subclause 5.5.2.3. An enumerated type is defined by a set of values that can either be:

➢   "absolute" i.e. this Standard identifies all values. Such enumerated sets are indicated with "The set of values is {"**a**", "**b**", "**c**"}", or

➢   "extensible" i.e. a system compliant with this Standard can add implementation-specific values. Such enumerated sets are indicated with "The set of values includes {"**a**", "**b**", "**c**"}", or

➢   "mission-specific" i.e. the enumerated set is comprised of mission-specific data;

o   an enumerated set comprising all populated values (or a subset of these values) of a given data item. Since a data item corresponds to a value type of an SSM object, these types are called "value type sets";

o   a data type which is inherited from a data item which is itself a data type. These types are called "value type data types".

•   A "complex" type is identified by the name of a language and is defined by the language grammar. Data items of complex type are assigned a character string value whose syntax complies with the language grammar.

5.5.2   Simple Data Types

5.5.2.1   Conventional data types

5.5.2.1.1   Boolean

This type comprises the set of truth values, which can be involved in logical operations.

The syntax used for referring to the Boolean type is the following:
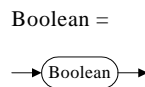
Boolean =

The syntax for defining constants of type Boolean is the following:

Boolean Constant =
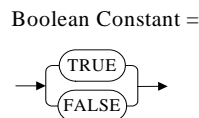
5.5.2.1.2   Integer

This type comprises a subset of whole numbers which can be involved in arithmetical, relational and comparative expressions.

The minimum and maximum values are mission-dependent.

The type can have associated engineering units. The engineering units supported by the ECSS-E-70 series of standards are specified in Annex B of ECSS-E-70-32A.

The syntax used for referring to the integer type is the following:

Integer =
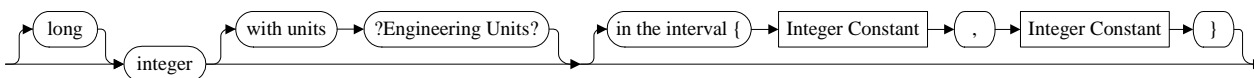
The syntax for defining constants of type integer is the following:

Integer Constant =
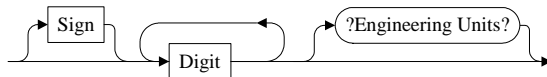
where:

- Sign is one of the character symbols "+" or "-".

- Digit is one of the decimal characters from 0 to 9 and ?Engineering Units? is one of the engineering units defined in Annex B of ECSS-E-70-32A.

When providing data of type "integer with associated engineering units", the value is expressed together with its corresponding units.

Examples   23, 2056, 5 **A** (i.e. 5 amps), 65536 **B** (i.e. 65536 bytes)

5.5.2.1.3   Unsigned Integer

This type comprises a subset of whole positive numbers which can be involved in arithmetical, relational and comparative expressions.

The minimum value is 0 and the maximum value is mission-dependent.

The type can have associated engineering units.

When providing data of type unsigned integer, the value can be given in decimal or in hexadecimal.

The syntax used for referring to the unsigned integer type is the following:

Unsigned Integer =
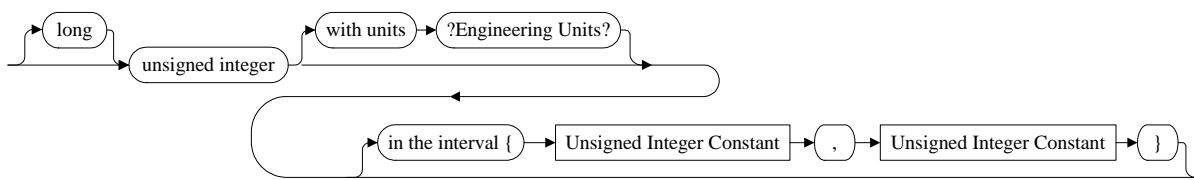
The syntax for defining constants of type unsigned integer is the following:

Unsigned Integer Constant =
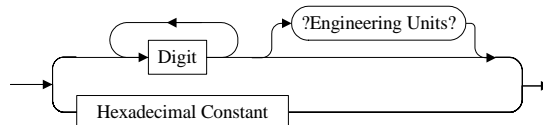
where:

- Digit is one of the decimal characters from 0 to 9.

- Hexadecimal Constant is a Hexadecimal Symbol followed by one or more Hexadecimal Digits.

- Hexadecimal Symbol is the character pair symbol "0x".

- Hexadecimal Digit is a decimal character from 0 to 9 or a letter from A to F.

> Examples 2056, **0x**2056, **0x**FFFF

When providing data of type "unsigned integer with associated engineering units", the value is expressed together with its corresponding units.

5.5.2.1.4   Real

This type comprises a set of numbers that can be represented with a floating point notation and which can be involved in arithmetical, relational and comparative expressions.

The minimum and the maximum values and the precision are mission-dependent.

The syntax used for referring to the real type is the following:
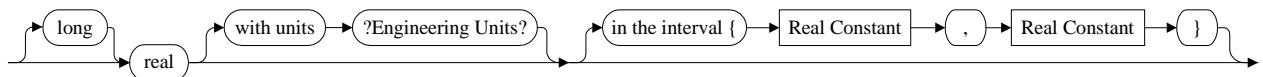
Real =

The syntax for defining constants of type real is the following:

Real Constant =
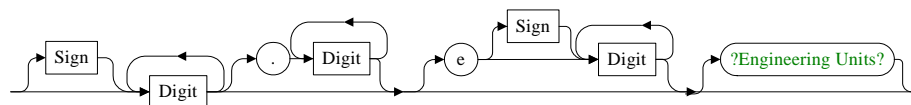
> Examples 123, 56e12, 0.1, 23E6

When providing data of type real with associated engineering units, the value is expressed together with its corresponding units.

5.5.2.1.5   Bit String

This type comprises a sequence of binary characters i.e. "1"s and "0"s.

The syntax used for referring to the bit string type is the following:
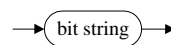
Bit String =

The syntax for defining constants of type bit string is the following:

Bit String Constant =
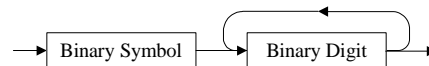
where:

- Binary Symbol is the character pair symbol "0b".

- Binary Digit is a binary character i.e. 0 or 1.

> Example **0b**11001

5.5.2.1.6   Octet String

This type comprises a sequence of octets, each octet being an ordered sequence of eight bits.

The syntax used for referring to the octet string type is the following:

Octet String =
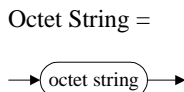
→→(octet string)→→

The syntax for defining constants of type octet string is the following:

Octet String Constant =

→→| Hexadecimal Symbol |→(Hexadecimal Digit)→(Hexadecimal Digit)→→
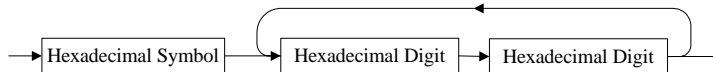
where:

- Hexadecimal Symbol is the character pair symbol "0x".

- Hexadecimal Digit is a decimal character from 0 to 9 or a letter from A to F.

Example   **0x**12AB

5.5.2.1.7   Character String

This type comprises any visible character string composed of allowable characters. Character strings can be involved in comparative expressions.

The syntax used for referring to the character string type is the following:

Character String =
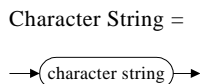
→→(character string)→→

The syntax for defining constants of type character string is the following:

Character String Constant =
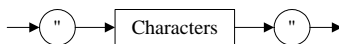
→→(")→| Characters |→(")→→

where Characters is any sequence of letters or digits or one of the following characters:

space ! " # $ % & ' ( ) * + , - . / :

; < = > ? @ [\ ] ^ _ ` { | } ~

Example   "This is a string."

NOTE In order to enter a double-quote character (") or a reverse solidus (backslash) character (\), a reverse solidus is used as an "escape" character i.e. (\") or (\\).

5.5.2.1.8   Absolute Time

This type comprises a set of values that represents an absolute date which can be involved in arithmetical, relational and comparative expressions.

The syntax used for referring to the absolute time type is the following:

Absolute Time =
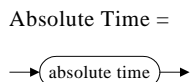
→→(absolute time)→→

The syntax for defining constants of type absolute time conforms to the following rule:

Absolute Time Constant =
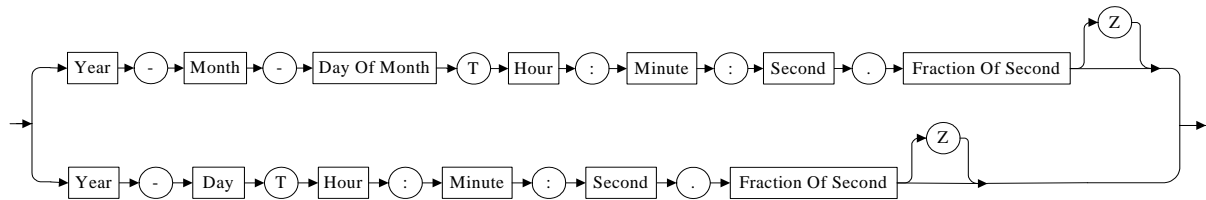
a. Month/day of month calendar variation

Year-Month-Day Of MonthTHour:Minute:Second.Fraction Of Second(Z)

where:

*   Year = four digits with a value in the range 0001-9999;

*   Month = two digits with a value in the range 01-12;

*   Day Of Month = two digits with a value in the range 01-28, 01-29, 01-30, or 01-31;

*   "T" = calendar-time separator;

*   Hour = two digits with a value in the range 00-23;

*   Minute = two digits with a value in the range 00-59;

*   Second = two digits with a value in the range 00-59 (00-58 or 00-60 during leap seconds);

*   Fraction Of Second = one to n digits. To obtain a given precision, the appropriate number of digits to the right of the period is used;

*   "Z" = optional terminator.

    Example   2001-08-18T21:07:43.137468Z

b. Year/day of year calendar variation

Year-DayTHour:Minute:Second.Fraction Of Second(Z)

where:

*   Year, "T", Hour, Minute, Second, Fraction Of Second, "Z": are as defined in a. above;

*   Day = three digits with a value in the range 001-365 or 001-366.

    Example   2001-033T13:21:32.226

    NOTE 1 Leading zeros are included to make up the specified number of digits.

    NOTE 2 Elements shown in brackets are optional.

5.5.2.1.9   Relative Time

This type comprises a set of values that represents an interval of time which can be involved in arithmetical, relational and comparative expressions.

The syntax used for referring to the relative time type is the following:

Relative Time =
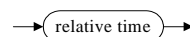
The syntax for defining constants of type relative time conforms to the following rule:

Relative Time Constant =
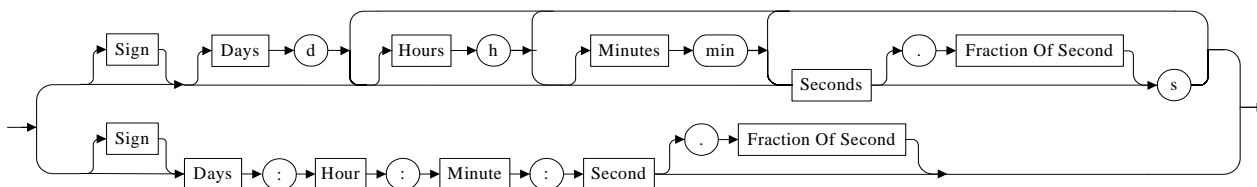
where:

- Days, Hours, Minutes and Seconds are unsigned integers;

- Hour, Minute, Second and Fraction Of Second are as defined in 5.5.2.1.8 above.

  Example 1   30 h 10 min

  Example 2   200 s

  Example 3   -0:00:10:00

5.5.2.2   PUS Data Types

5.5.2.2.1   Service data types

PUS packets defined within ECSS-E-70-41A are associated with services and each packet is assigned a "Service Type" and a "Service Subtype".

The syntax used to refer to the service type data type is the following:

Service Type =
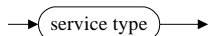
The syntax for defining constants of type service type is:

Service Type Constant =

The standard service types are defined in ECSS-E-70-41A and lie in the range 0 to 127. Mission-specific service types can be defined and lie in the range 128 to 255.

The syntax used to refer to the service subtype data type is the following:

Service Subtype =
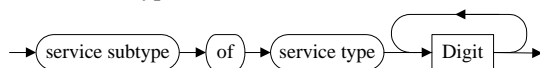
The syntax for defining constants of type service subtype is:

Service Subtype Constant =

The standard service subtypes for a given service are defined in ECSS-E-70-41A and lie in the range 0 to 127. Mission-specific service subtypes

can be defined for standard services and lie in the range 128 to 255 or in the range 0 to 255 for mission-specific services.

5.5.2.2.2   Parameter data types

Data within PUS packets are encoded according to a "Parameter Code (PC)" which is a combination of a "Parameter Type Code (PTC)" and a "Parameter Format Code (PFC)". The PTC identifies the data type (e.g. Boolean, Integer). The PFC identifies the encoding format and hence constrains the values that the data may take.

The standard PUS data types are defined within ECSS-E-70-41A and are as shown in Table 2:

Table 2   PUS data types

PTC	Data Type	PFC
PTC 1	Boolean	PFC 0
PTC 2	Enumerated	PFC 1 to PFC 16, PFC 24, PFC 32
PTC 3	Unsigned integer	PFC 0 to PFC 16
PTC 4	Signed integer	PFC 0 to PFC 16
PTC 5	Real	PFC 1 to PFC 4
PTC 6	Bit-string	PFC 0 to PFC any
PTC 7	Octet-string	PFC 0 to PFC any
PTC 8	Character-string	PFC 0 to PFC any
PTC 9	Absolute time	PFC 0 to PFC 18
PTC 10	Relative time	PFC 0 to PFC 16
PTC 11	Deduced	PFC 0

NOTE 1   Within ECSS-E-70-41, the PFC is used to define the size of the encoded value in a packet. In this Standard, the PFC is used to express the possible range of values. For example, PTC 3 PFC 0 implies an integer value between 0 and 15. PTC 8 PFC 12 implies a fixed-length character string of 12 characters length.

NOTE 2   When a Boolean value is used within a telecommand or a telemetry packet, the raw value 0 is used to express a false value, 1 is used to express a truth value.

Within this Standard, three derived data types are used, depending on whether the data type corresponds to the complete Parameter Code or to only a sub-set of the Parameter Code i.e. the PTC alone or the PFC alone.

The syntax used for referring to these data types is one of the following:

PC =

PTC =
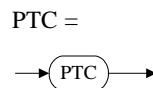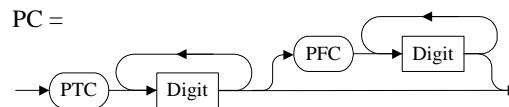
PFC =
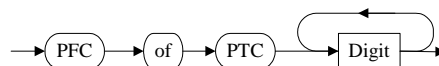
The syntax for defining constants of type PC depends on the corresponding PTC and PFC values:

- PTC 1, PTC 2 and PTC 3 constants are unsigned integers as specified in subclause 5.5.2.1.3.

- PTC 4 constants are integers as specified in subclause 5.5.2.1.2.

- PTC 5 constants are reals as specified in subclause 5.5.2.1.4.

- PTC 6 constants are Binary Constants consisting of a Binary Symbol (the character pair symbol "**0b**") followed by one or more Binary Digits (0 or 1).

- PTC 7 constants are hexadecimal constants as specified in subclause 5.5.2.1.3.

- PTC 8 constants are character strings as specified in subclause 5.5.2.1.7.

- PTC 9 constants are absolute times as specified in subclause 5.5.2.1.8.

- PTC 10 constants are relative times as specified in subclause 5.5.2.1.9.

In each case, if the PFC is specified, the range of possible values is constrained in accordance with ECSS-E-70-41A.

> NOTE PTC 11 is not used in this Standard because all parameters of deduced type are instantiated to one of the other PUS data types identified above.

The syntax for defining constants of type PTC is:

PTC Constant =

The syntax for defining constants of type PFC is:

PFC Constant =
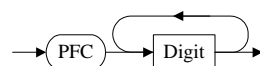
5.5.2.3   User-defined enumerated types

5.5.2.3.1

As introduced in subclause 5.5.1, enumerated sets can be specified by end-users. These enumerated sets are simple data types that can be used when specifying, for example, activity arguments (see subclause 6.7.1.2) and parameters (see subclause 6.6.3.1).

For each user-defined enumerated type, the data specified in Table 3 shall be provided.

Table 3   User defined enumerated type data

Name		Definition	Data Type
Name		The name of the enumerated set	Name
List of	Value	A value of the enumerated set	Character String

5.5.2.3.2

When the data items associated with these types correspond to parameters whose values are sampled within packets, the raw representation of a given value in the packet can differ from the textual representation given in Table 3. When this is the case, the correspondence between the textual representation and its raw representation shall be defined for each element of the set, as follows.

a.   When the enumerated set is used for decoding values within telemetry packets which have a one-to-one correspondence between their raw and textual representations or for encoding telecommand arguments within telecommand packets, the data in Table 4 shall be provided for each element of the set.

Table 4   Raw correspondence data

Name	Definition	Data Type
Raw Value	The raw value of the set element.	PTC 2

Example   The Battery Charge Status enumerated set is comprised of a list of 3 elements, each one having a raw and textual representation as follows:

Value	Raw Value
"**trickle charge**"	0
"**full charge**"	1
"**discharge**"	2

b.   When the enumerated set is used for decoding values within telemetry packets or for encoding telecommand arguments within telecommand packets and where there is a many-to-one correspondence between raw and textual representations:

1.   For each user-defined enumerated type with a many-to-one correspondence between raw and textual representations, the additional data specified in Table 5 shall be provided.

Table 5   Raw data type data

Name	Definition	Data Type
PTC	The PTC of the raw data type. The set of values is {PTC 3, PTC 4, PTC 5}	PTC

2. For each element of the set, the data specified in Table 6 shall be provided.

Table 6   Raw correspondence data

Name		Definition	Data Type
List of Raw Value Intervals	Minimum Raw Value	The raw value of the low boundary of the raw value interval of the set element	PTC **of** Raw Data Type
	Maximum Raw Value	The raw value of the upper boundary of the raw interval of the set element	PTC **of** Raw Data Type

Example   The position readout of a telescope filter wheel could be interpreted as follows:

Value	Minimum Raw Value	Maximum Raw Value	Default Raw Value
"non-operational"	0	4	0
	13	15	
"red"	5	6	5
"green"	7	8	7
"blue"	9	10	9
"UV"	11	12	11

c. When an enumerated set is used for encoding telecommand arguments within telecommand packets and where there is a many-to-one correspondence between raw and textual representations, the additional data specified in Table 7 shall be provided:

Table 7   Telecommand argument encoding data

Name	Definition	Data Type
Default Raw Value	The default value to be used for the argument encoding	PTC **of** Raw Data Type

5.5.2.3.3

The syntax used for referring to user-defined enumerated types is the following:

User Defined Enumerated Type =
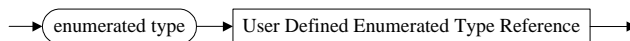
where User Defined Enumerated Type Reference is a name of a user-defined enumerated type as specified in 5.5.2.3.1.

5.5.2.4   Value Type Set

When a data item is of data type "the enumerated set comprising all populated values (or a subset of these values) of another data item", this data type is of type value type set. The syntax used for referring to a value type set is the following:

Value Type Set =
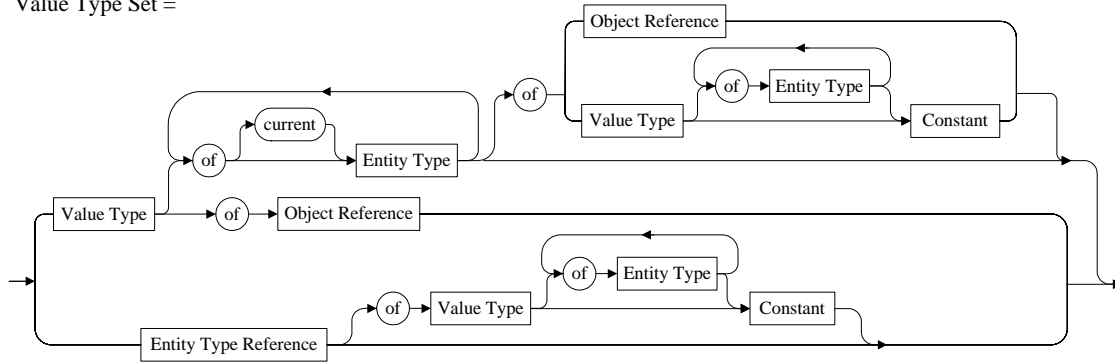
where:

- Value Type is an Identifier corresponding to a value type of the SSM data model.

- Entity Type is an Identifier corresponding to an entity type of the SSM data model.

- Entity Type Reference is one of {"**System Element Reference**", "**Reporting Data Reference**", "**Activity Reference**", "**Event Reference**", "**Activity Argument Reference**"}. The value that a corresponding data item can take is one of the names associated with the specified entity type.

  Example 1   The enumerated set identified by "Name **of** Output Line **of current system element**". This set comprises all output line names defined for the current CPDU as specified in Table 76, data item "Name **of** Output Line".

  Example 2   The enumerated set identified by "ID of system element **of** Type "**application process**"". This set comprises all application process IDs defined for the mission as specified in Table 21, data item "ID".

  Example 3   The enumerated set identified by "Name **of** reporting data **of** Power Subsystem of Cluster1". This set comprises all names of reporting data as specified in Table 80, data item "Name", restricted to those belonging to the Power Subsystem system element of the Cluster 1 system element.

  Example 4   The enumerated set identified by "system element reference **of** Type "**application process**"". This set comprises all names of application processes as specified in Table 15, data item "Name".

5.5.2.5   Value Type Data Type

When the type of a data item is inherited from a data item which is itself a data type, this type is of type value type data type. The syntax used for referring to a value type data type is the following:

Value Type Data Type =
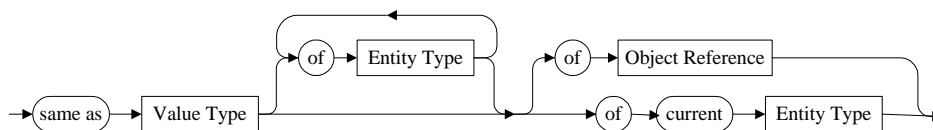
Example   The data type of the data item Engineering Value of linear interpolation data of reporting data as specified in Table 85 is "**same as** Data Type **of current parameter**".

5.5.3   Complex Data Types

A complex data type is identified by the name of a language and defined by a grammar. Data items of complex type are assigned a character string value whose syntax complies with the corresponding language grammar. Within this Standard, the following complex data types are used:

- "**Activity Call**" to define an instantiation of an activity,

- "**EXPL**" to define expressions,

- "**IFL**" to define interpretation functions,

- "**PLUTO**" to define procedures,

- "**SPEL**" to define synthetic parameters,

- "**VAL**" to define values.

6

Monitoring and control data requirements

6.1   Data exchange

a.   This Standard specifies which data shall be delivered by a supplier for the purposes of monitoring and control of the delivered product(s). According to the nature of the product, the product data schema corresponds to:

- a subset of the data model identified in this Standard, supplemented by

- product-specific entity and value types.

b.   The product data schema to be used for exchange of data shall be specified.

c.   The product data schema shall be suitable for communication, interpretation and processing by computers.

d.   Formal languages are used within this Standard for the definition of data types and constants. Data delivered by suppliers to customers at any point in the overall space system development and operation lifecycle should comply with these languages. Such compliance is encouraged to optimize the process of sharing and reuse of product data.

e.   If other languages are used, these languages shall be formally specified using the extended Backus-Naur form (EBNF), see ISO/IEC 14977.

f.   The product data schema shall ensure the integrity of the data, i.e. it shall be possible to re-import data, extracted in accordance with the schema, without any loss of information.

g.   The electronic database used to transfer the product data shall be subject to configuration management.

h.   The configuration identification data for the electronic database specified in Table 8 shall be provided.

Table 8   Electronic database configuration identification data

Name		Definition	Data Type
ID		The Configuration Item (CI) identifier of the electronic database. NOTE: To ensure the system-wide uniqueness of this identifier, a common practice is to prefix the filename with an enterprise identifier.	Enumerated
Version Number		The version number of the electronic database Example: Revision 1 of Version 2	Name
Date		The date of generation	Absolute Time
ID of Supplier		The supplier identifier	Enumerated
List of Digital Files	Name	The name of a digital file within the electronic database	Name
	Type	The type of the digital file. The set of values is product-specific.	Enumerated
	Type of Checksum	The type of the checksum. The set of values is product-specific.	Enumerated
	Value of Checksum	The checksum of the file	Unsigned Integer

    i.   Furthermore, the following requirements apply to any constituting digital file.

        1.   Each digital file shall be uniquely identified.

        2.   Each digital file shall be compressed using a standard compression tool (e.g. zip, tar).

6.2   Specification of complex data types

6.2.1   General

It shall be possible to include comments at any location in the script of a complex data type.

6.2.2   Activity call

a.   It shall be possible to define the data relating to the instantiation of an activity namely, the activity reference, the values of the activity argument or a reference to a predefined set of argument values and any directives that apply for the instantiation of the activity.

    Example 1   To define corrective actions to be taken in specific circumstances (limit violations, activity failures etc.).

    Example 2   To define arguments of activities (e.g. a PUS service 11 subtype 4 request which inserts telecommand packets in the on-board schedule).

    Example 3   Telecommand directives can include for example: the MAP ID to be used; whether the telecommand is to be sent in AD or BD mode; the specification of the telecommand verification packets to be generated in response to this telecommand.

b. The syntax for defining data of type Activity Call should conform to that specified in Annex A.3.9.28 of ECSS-E-70-32A.

6.2.3   Expression

a. It shall be possible to specify data values by means of an expression.

> Example   Validity or selection conditions for reporting data or pre-conditions and post-conditions for an activity.

b. Expressions shall be able to operate on constants and space system parameters acquired from the EMCS.

c. Mathematical, time and string functions shall be supported.

d. Engineering units shall be supported.

e. The capability to assign engineering units to constants shall be supported.

f. The capability to mix compatible units freely within an expression shall be supported

g. The automatic conversion between different, but compatible, units shall be supported.

h. The syntax for defining data of type EXPL should conform to that specified in Annex B.5.

6.2.4   Interpretation function

a. It shall be possible to specify the interpretation function for a reporting data by means of an expression.

b. Interpretation function expressions shall be able to operate on constants and space system parameters acquired from the EMCS.

c. Mathematical, time and string functions shall be supported.

d. Engineering units shall be supported.

e. The capability to assign engineering units to constants shall be supported.

f. The capability to mix compatible units freely within an expression shall be supported.

g. The automatic conversion between different, but compatible, units shall be supported.

h. The syntax for defining data of type IFL should conform to that specified in Annex B.6.

6.2.5   Procedure

The requirements in ECSS-E-70-32A clause 5 shall apply.

6.2.6   Synthetic parameter

a. It shall be possible to synthesize reporting data within the EMCS from other reporting data and constants.

b. It shall be possible to synthesize a parameter or one or more components of a compound parameter.

c. The evaluation function shall return the engineering value of the synthetic parameter i.e. no subsequent interpretation (e.g. calibration) shall be required.

d. It shall be possible to specify the condition(s) under which a new value of a synthetic parameter is evaluated (i.e. triggered).

e. The possible conditions shall include:

1. upon update of any reporting data (usually a "contributing" reporting data i.e. one whose value itself is used in the synthetic parameter evaluation).

    NOTE Update, in this context, means the arrival of a new occurrence of the reporting data, not a change of value of the reporting data.

2. upon the occurrence of a specified event;

3. any combination of the above.

f. It shall be possible to define the context in which a synthetic parameter is evaluated i.e. a system element or reporting data context.

g. The capability shall be provided to perform the following execution flow controls within a synthetic parameter evaluation:

1. simple conditional branching (i.e. if … then … else …);

2. multiple conditional branching where the path taken is dependent on the value of a specified parameter (or local variable, see h below);

h. Local variables used within a synthetic parameter evaluation shall be declared and their type explicitly stated.

i. The capability shall be provided to assign a value to a local variable.

j. Persistent variables shall be supported.

    NOTE A persistent variable is one whose value is maintained (memorized) from one evaluation of a synthetic parameter to the next.

    Example A synthetic parameter that uses the delta between the current value and the previous value of a given parameter.

k. It shall be possible to define an expression when assigning a value to a local variable or to a synthetic parameter.

l. Synthetic parameter expressions shall be able to operate on constants, space system parameters acquired from the EMCS and local variables.

m. Mathematical, time and string functions shall be supported.

n. Engineering units shall be supported.

o. The capability to assign engineering units to constants shall be supported.

p. The capability to mix compatible units freely within an expression shall be supported

q. The automatic conversion between different, but compatible, units shall be supported.

r. The syntax for defining data of type SPEL should conform to that specified in Annex B.7.

6.2.7   Value set

a. It shall be possible to specify fixed values or value sets for data items.

    Example   Default values.

b. It shall be possible to specify a simple value, a record value or an array value for a single value or a component of a value set.

c. The syntax for defining data of type VAL should conform to that specified

in Annex B.9.

6.3 Product data

6.3.1 Introduction

Product data corresponds to the data that is provided, together with a given product delivery, by a supplier to a customer and comprises:

- Product configuration data;

- Product monitoring and control data (i.e. the SSM).

6.3.2 Product configuration data

6.3.2.1

According to ECSS-M-40, product configuration data is provided to enable traceability from a product to its defining documentation.

Depending on the configuration management requirements associated with a given product, different types of product configuration data are provided.

6.3.2.2

For each product identified within the electronic database, the data specified in Table 9 shall be provided.

Table 9   Product configuration data

Name	Definition	Data Type
Name of Product	The name of the product which is unique within this delivery	Name
Nature	The nature of the product. The set of values is {"**specification**", "**realization**"}. NOTE: "**specification**" corresponds to the specification of the product (i.e. a theoretical product); "**realization**" corresponds to a developed product (i.e. a real product).	Enumerated
Type	The type of product. The set of values includes {"**developed hardware CI**", "**developed software CI**", "**COTS and standard product**","**non CI product**"}.	Enumerated

6.3.2.3

For products of type "**developed hardware CI**", the additional data specified in Table 10 shall be provided.

Table 10   Developed hardware CI configuration data

Name	Definition	Data Type
ID	The Configuration Item identifier	Enumerated
Part Number	The part number of the product	Character String
Serial Number	The serial number of the product	Character String
Lot Number	The lot number of the product	Character String
Model	The model of the space system to which the product is applicable e.g. EM, STM, FM	Enumerated
ID of Manufacturer	The identifier of the manufacturer (i.e. the original supplier)	Enumerated

6.3.2.4

For products of type "**developed software CI**", the additional data specified in Table 11 shall be provided.

Table 11   Developed software CI configuration data

Name	Definition	Data Type
ID	The Configuration Item identifier	Enumerated
Software Identifier	The identifier of the software	Enumerated
Version Number	The version number of the software	Name
Release Date	The date of release of this version of the software	Absolute Time
ID of Manufacturer	The identifier of the manufacturer (i.e. the original supplier)	Enumerated

6.3.2.5

For products of type "**COTS and standard product**", the additional data specified in Table 12 shall be provided.

Table 12   COTS and standard product configuration data

Name	Definition	Data Type
Part Number	The part number of the product	Character String
Serial Number	The serial number of the product	Character String
Lot Number	The lot number of the product	Character String
ID of Manufacturer	The identifier of the manufacturer (i.e. the original supplier)	Enumerated

6.3.2.6

For products of type "**non CI product**" (i.e. not defined as a configuration item), the additional data specified in Table 13 shall be provided.

Table 13   Non CI product configuration data

Name	Definition	Data Type
Part Number	The part number of the product	Character String
Serial Number	The serial number of the product	Character String
Lot Number	The lot number of the product	Character String
ID of Manufacturer	The identifier of the manufacturer (i.e. the original supplier)	Enumerated

6.3.2.7

The SSM corresponds to one or more elements of the overall space system.

The product configuration data also contains configuration data for each constituent system element, activity, reporting data and event of the SSM according to the following requirements:

a.   When one (or more) property of a system element has changed between successive deliveries of the same product or when one (or more) activities, reporting data, events or constituent system elements has been created or deleted, a new version shall be defined for this system element.

b.   When one (or more) property of an activity has changed between successive product deliveries, a new version shall be defined for this activity.

c.   When one (or more) property of a reporting data has changed between successive product deliveries or when one (or more) sub reporting data of a reporting data (i.e. of record type) has been created or deleted, a new version shall be defined for this reporting data.

d.   When one (or more) property of an event has changed between successive product deliveries, a new version shall be defined for this event.

6.3.2.8

For each system element, activity, reporting data and event of the SSM, the data specified in Table 14 shall be provided.

Table 14   Version data

Data	Definition	Data Type
Number	The version number of the configuration data	Name
Date	The date when this configuration item version was produced	Absolute Time
Originator	The name of the organization or person responsible of having produced this configuration item version	Character String
Reason	The reason(s) for the change, with respect to the previous version	Character String
Status	Information relating to the validation testing status of this configuration item. The set of values includes {"**not validated**", "**validated by review**", "**validated by simulation** ", "**validated by testing**"}.	Enumerated

6.3.2.9

Products are the result of procurement and integration activities at lower-levels and earlier phases in the overall space system lifecycle.

To allow the traceability of information supplied at these lower-levels (or earlier phases):

a. The data specified in Table 9, Table 10, Table 11, Table 12 or Table 13 shall be provided for each constituent product, according to the product type.

b. The data specified in Table 14 shall be provided for each object (i.e. system elements, reporting data, activities and events) of the SSM associated with each constituent product.

6.4 Data population

6.4.1

All monitoring and control data shall be provided using the English language.

6.4.2

All monitoring and control data shall be considered as case-insensitive, with the exception of engineering units (as defined in ECSS-E-70-32A).

6.4.3

If the name of an SSM object (i.e. system elements, reporting data, activities or events) is changed during integration of lower-level products, the former name(s) of this object shall be retained within the integrated product for traceability purposes.

6.4.4

The data supplied with the delivered product shall be fully consistent with the product documentation (e.g. ICD, user manual).

6.4.5

Uniqueness of SSM objects names within a given product delivery shall be ensured.

6.4.6

Some elements of the space system are qualified for a maximum number of operational cycles or a maximum operational life. For these elements, the accumulated number of operational cycles or the accumulated operational life shall be provided with each product delivery.

6.4.7

Sufficient information shall be provided by the sub-suppliers such that the data required by the customer is fully populated.

6.4.8

The principal customers of the monitoring and control data are "Software" (i.e. on-board and ground software development teams), "AIV" and "Operations".

a. Data specific to a domain (e.g. Software, AIV or Operations) shall be identified as such.

b. Data required to monitor and control the space system in all operational and testing modes shall be fully populated.

c. For the SSM, fully populated means:

1. All system elements that correspond to the delivered product shall be provided.

2. All monitoring and control characteristics of the system elements shall be provided. In the case of ECSS-E-70-41 services (and other on-board software), this includes all service configuration data required on ground for monitoring and control of the service.

d. For reporting data, fully populated means:

1. All reporting data defined within the product documentation shall be provided. This includes all data that can be downlinked, for example, software tables and memory dumps.

2. When more than one reporting data conveys the same information, the redundancy link between them shall be provided.

3. All interpretation functions (required to calibrate raw values) shall be provided together with the conditions under which they are applied.

4. When the validity of a reporting data depends on specific conditions, the validity conditions shall be provided.

5. Ground monitoring checks shall be provided for all reporting data together with the conditions under which they are applied.

   NOTE The only exceptions are reporting data that can take any possible value.

6. When the value that a reporting data may take depends on the execution of a given activity or the occurrence of a given event, status consistency checks shall be provided accordingly.

7. The corrective actions to be taken whenever a reporting data violates a given check shall be provided.

e. For activities, fully populated means:

1. All activities defined within the product documentation (e.g. operation procedures contained in the space segment user manual) shall be provided.

2. All atomic activities used to control elements of the space system shall be provided.

3. Arguments of activities shall be provided in engineering values together with (where applicable) the deinterpretation function used to produce the raw values.

4. Pre-conditions and post-conditions for activities shall be provided.

5. When the start, progress and completion of execution of activities can be deduced from low-level reporting data, the corresponding verification conditions shall be provided (regardless of whether the ECSS-E-70-41 telecommand verification service is used).

6. When activities are "redundant" i.e. they have the same effect, the redundancy link between these activities shall be provided.

7. When activities have the opposite effect, the reverse link between these activities shall be provided.

8. The criticality level of each activity shall be provided (e.g. non-critical, mission-critical).

9. The corrective actions to be taken whenever the start, progress and

completion of execution of an activity are unsuccessful shall be provided.

10. The execution profile of activities (i.e. expected duration, minimum and maximum duration) shall be provided.

11. The resources utilised during the execution of an activity shall be provided.

f. For events, fully populated means:

1. All events defined within the product documentation shall be provided.

2. The corrective actions to be taken whenever an event occurs shall be provided.

g. All data contained within the product delivery shall be validated (e.g. by review, by test with simulators, by test with real hardware).

NOTE Some data, such as descriptions, can only be validated by review.

h. For operational use, all data shall be validated with real hardware wherever possible.

NOTE The exceptions are those activities that cannot be executed on ground for safety or environmental reasons.

6.5 System element data

6.5.1 Introduction

From the monitoring and control viewpoint there is data that is generic to all system elements and data that is specific to the type of the system element. This Standard identifies a number of specialised types, for example application process, service and multiplexed access point (MAP).

6.5.2 System element generic data

6.5.2.1

For each system element associated with a product or a sub-product, the data specified in Table 15 shall be provided.

Table 15   System element data

Name	Definition	Data Type
Name	The name of the system element which is unique within the context of the product	Name
Description	The description of the system element	Character String
Type	The type of the system element. The set of values includes { "**system**", "**subsystem**", "**set**", "**equipment**", "**software product**", "**assembly**", "**part**" (hardware), "**module**" (software), "**element**", "**facility**" (ground segment)**,** "**application process**", "**MAP**", "**VC**", any Service, "**function**", "**memory block**", "**memory subblock**", "**store**", "**CPDU**", "**OnOff device**", "**register load device**", "**sensor**"}.	Enumerated
Nature	The nature of the definition. The set of values is {"**specification**", "**realization**"}	Enumerated

Table 15 System element data (cont.)

Name		Definition	Data Type
List of References	Name of Product	The name of a sub-product that has been integrated in the current product (see subclause 6.3.2)	Product Reference
	Name of System Element	The name of the system element within the sub-product	System Element Reference
List of	Name of Redundant System Element	A system element that is redundant with the system element i.e. has the identical function and is provided for the purposes of increasing the availability of the function	System Element Reference

6.5.2.2

For system elements which can be the source of telecommand packets or the destination of telemetry packets, the data specified in Table 16 shall be provided.

Table 16 Packet address data

Name	Definition	Data Type
ID	The unique identifier of the source or destination as defined in ECSS-E-70-41A	PTC 2

6.5.2.3

For system elements which have limitation on their number of operation cycles and/or duration, the operation control data specified in Table 17 shall be provided.

Table 17 Operation control data

Name		Definition	Data Type
Maximum Cycles		The maximum number of operational cycles permitted for this system element	Unsigned Integer
Maximum Duration		The maximum cumulative operational life permitted for this system element	Relative Time
List of Operations	Date	A date on which the system element has been operated	Absolute Time
	Duration	The duration of the corresponding operation	Relative Time
Cumulative Cycles		The accumulated number of operational cycles for this system element	Unsigned Integer
Cumulative Duration		The accumulated operational life for this system element	Relative Time

6.5.3   System data

6.5.3.1   General

For system elements of type "**system**", the additional data specified in Table 18 shall be provided.

Table 18   System data

Name	Definition	Data Type
ID	The unique identifier of the system	PTC 2
Type	The type of the system. The set of values is { "**ground segment**", "**space segment**"}.	Enumerated

6.5.3.2   Telecommand packet tailoring data

For system elements of type "**system**" that utilise ECSS-E-70-41, the additional data specified in Table 19 shall be provided.

Table 19   System level telecommand packet tailoring data

Name		Definition	Data Type
To be provided where the packet data field contains a Source ID field			
	PFC of Source ID	The PFC of the Source ID field in the packet data field header	PFC **of** PTC 2
List of	Source	A possible telecommand source	System Element Reference
Presence of CPDU DFH		The definition of whether or not a data field header is used for CPDU telecommands	Boolean
Maximum Length of TC Packet		The maximum length of a telecommand packet	Unsigned Integer **with units B**

6.5.3.3   Telemetry packet tailoring data

For system elements of type "**system**" that utilise ECSS-E-70-41, the additional data specified in Table 20 shall be provided for tailoring of telemetry packets.

Table 20   System level telemetry packet tailoring data

Name		Definition	Data Type
To be provided where the packet data field contains a Destination ID field			
	PFC of Destination ID	The PFC of the Destination ID field in the packet data field header	PFC **of** PTC 2
List of	Destination	A possible destination	System Element Reference
Presence of Spacecraft Time Source Packet DFH		The definition of whether or not a data field header is used for the "spacecraft time source packet".	Boolean
Maximum Length of TM Packet		The maximum length of a telemetry packet	Unsigned Integer **with units B**

6.5.4 Application process data
6.5.4.1 General

For system elements of type "**application process**", the additional data specified in Table 21 shall be provided.

Table 21 Application process data

Name			Definition	Data Type
ID			The identifier of the application process (APID) which is unique within a system element of type system	PTC 2 PFC 11
List of Service Accesses	Type		The type of the service access to other system elements. The set of values includes {"**commanding path**", "**monitoring path**", "**memory management**", "**store management**", "**store access**", "**event report access**"}. Examples: Commanding path is used to identify those system elements to which telecommands can be routed. This can be system elements of type device (in the case of the device commanding service) or application process (in the case of the on-board scheduling service). Monitoring path is used to identify those system elements from which monitoring data can be acquired (e.g. for the housekeeping service, parameter statistics service, on-board monitoring service). Memory/store management is used to define which memories and stores are managed by this application process. Store access is used to identify which store can be used by this application process for on-board storage. Event report access is used to identify those application processes from which event reports can be received by this application process (for the event/action service).	Enumerated
	List of	Name of System Element	A system element accessible for this service access type	System Element Reference
Word Length			The word length used by the application process, where spare bits are used to pad the data field header and the overall packet length to be an integral number of words. The set of values includes {"**8 bits**", "**16 bits**", "**24 bits**", "**32 bits**", "**64 bits**"}.	Enumerated
PFC of Variable Bit String			The PFC used for the length field of variable-length bit-string parameters (PTC 6)	PFC **of** PTC 3
PFC of Variable Octet String			The PFC used for the length field of variable-length octet-string parameters (PTC 7)	PFC **of** PTC 3
PFC of Variable Character String			The PFC used for the length field of variable-length character-string parameters (PTC 8)	PFC **of** PTC 3

6.5.4.2   Telecommand packet tailoring data

For system elements of type "**application process**", the additional data specified in Table 22 shall be provided.

Table 22   Application process level telecommand packet tailoring data

Name	Definition	Data Type
Type of TC Checksum	The type of the checksum. The set of values is {"**ISO**", "**CRC**"}.	Enumerated

6.5.4.3   Telemetry packet tailoring data

For system elements of type "**application process**", the additional data specified in Table 23 shall be provided.

Table 23   Application process level telemetry packet tailoring data

Name	Definition	Data Type
To be provided where the packet data field contains a Time Field		
PFC of Time Field	The PFC of the Time Field	PFC **of** PTC 9
Packet Subcounter	Whether or not there is a packet sub-counter for this application process	Boolean
Type of TM Checksum	The type of checksum used for checking the integrity of telemetry packets from the application process. The set of values is {"**ISO**", "**CRC**"}.	Enumerated

6.5.5   Service data

6.5.5.1   Introduction

Application processes are the entities that provide services. This Standard assumes that application processes and services are also used within the ground segment. Therefore, to this extent, the ground segment and the space segment are modelled within the SSM in an analogous manner.

The data to be provided for each standard ECSS-E-70-41A service in the following subclauses is structured as follows:

- The specification of how the service has been tailored for the mission is provided in the form of a set of tailoring variables. The need to provide specific additional service data depends strongly on how the service has been tailored for a given mission. Annex A contains, for each service, its tailoring algorithm expressed in the form of a flowchart showing the successive tailoring choices available for the service and the tailoring variables associated with these choices. The presence of a given tailoring variable may depend on the decision path taken through this flowchart. This conditionality is also expressed in the tailoring variable tables in this subclause.

- The data types of the different fields of the service requests (telecommand packets) and service reports (telemetry packets). Again, depending on the tailoring choices made, some of the fields shown in ECSS-E-70-41A may not be present. Annex A shows the standard ECSS-E-70-41A packet structures and any conditionality associated with them.

- The service-specific configuration data i.e. the data required by the ground to model the ECSS-E-70-41A service for monitoring and control purposes.

NOTE Service data is defined separately for each distinct application process.

6.5.5.2 Telecommand verification service

6.5.5.2.1 Tailoring data

For the definition of the tailoring of the telecommand verification service, the additional data shown in Table 24 shall be provided.

Table 24   Telecommand verification service tailoring data

Name	Definition	Data Type
S1 ST3 and ST4 Provider	Whether this service verifies start of telecommand execution	Boolean
S1 ST5 and ST6 Provider	Whether this service verifies progress of telecommand execution	Boolean
S1 ST7 and ST8 Provider	Whether this service verifies completion of telecommand execution.	Boolean

6.5.5.2.2 Packet field data types data

For the data types of the packet fields of the telecommand verification service, the additional data shown in Table 25 shall be provided.

Table 25   Telecommand verification service data types data

Name	Definition	Data Type
S1 Code	The PFC of the Code fields	PFC **of** PTC 2
To be provided if S1 ST5 and ST6 Provider = TRUE		
S1 Step Number	The PFC of the Step Number fields	PFC **of** PTC 2

6.5.5.2.3 Service data

For the telecommand verification service, the additional data specified in Table 26 shall be provided (see subclause 6.7.4.9 for related command execution check data).

Table 26   Telecommand verification service data

Name			Definition	Data Type
List of Command Failures	Name		The name of a specific command verification failure applicable to all commands	Name
	Code		The corresponding failure code value. NOTE: Values 0 through 5 have a special meaning in ECSS-E-70-41A.	PTC 2
	Applicability		The stage(s) to which the command failure code is applicable. The set of values is {"**all**", "**start**", "**progress**", "**completion**"}.	Enumerated
	Description		The description of the command failure	Character String
	Ordered list of	Component	A component of the parameters field associated with the code value	Reporting Data Reference

6.5.5.3   Device command distribution service

6.5.5.3.1   Tailoring data

For the definition of the tailoring of the device command distribution service, the additional data shown in Table 27 shall be provided.

Table 27   Device command distribution service tailoring data

Name	Definition	Data Type
S2 ST3 Provider	Whether this service distributes CPDU commands	Boolean
To be provided if S2 ST3 Provider = FALSE		
S2 ST1 Provider	Whether this service distributes On/Off commands	Boolean
To be provided if S2 ST1 Provider = TRUE		
S2 Multiple OnOff Distribution	Whether this service can distribute multiple On/Off commands in a single telecommand	Boolean
S2 ST2 Provider	Whether this service distributes Register Load commands	Boolean
To be provided if S2 ST2 Provider = TRUE[a]		
S2 Multiple Register Load Distribution	Whether this service can distribute multiple Register Load commands in a single telecommand	Boolean
[a]S2 ST2 Provider = TRUE if S2 ST3 Provider = FALSE AND S2 ST1 Provider = FALSE		

6.5.5.3.2   Packet field data types data

For the data types of the packet fields of the device command distribution service, the additional data shown in Table 28 shall be provided.

Table 28   Device command distribution service data types data

Name	Definition	Data Type
To be provided if S2 Multiple OnOff Distribution = FALSE OR S2 Multiple Register Load Distribution = FALSE		
S2 N	The PFC of the number of repetitions fields	PFC **of** PTC 3
To be provided if S2 ST1 Provider = TRUE		
S2 OnOff Address	The PFC of the On/Off Address fields	PFC **of** PTC 2
To be provided if S2 ST2 Provider = TRUE		
S2 Register Load Address	The PFC of the Register Load Address fields	PFC **of** PTC 2

See subclauses 6.5.12, 6.5.13 and 6.5.14 for the related CPDU, On/Off and register load device data.

6.5.5.3.3   Service data

There is no additional service-specific data for the device command distribution service.

6.5.5.4 Housekeeping and diagnostic data reporting service

6.5.5.4.1 Tailoring data

For the definition of the tailoring of the housekeeping and diagnostic data reporting service, the additional data shown in Table 29 shall be provided.

Table 29   Housekeeping and diagnostic data reporting service tailoring data

Name	Definition	Data Type
S3 HK Provider	Whether this service reports housekeeping data	Boolean
To be provided if S3 HK Provider = TRUE		
S3 ST1 ST3 ST5 and ST6 Provider	Whether control of housekeeping reports is provided	Boolean
To be provided if S3 ST1 ST3 ST5 and ST6 Provider = TRUE		
S3 HK Implicit Collection Interval	Whether an implicit housekeeping packet collection interval is used	Boolean
S3 HK Multiple Clear SID	Whether multiple housekeeping reporting definitions can be cleared	Boolean
S3 HK Multiple Control SID	Whether multiple housekeeping reporting definitions can be controlled	Boolean
S3 ST9 and ST10 Provider	Whether this service can report housekeeping parameter definitions	Boolean
To be provided if S3 ST9 and ST10 Provider = TRUE		
S3 HK Multiple Report SID	Whether this service can report multiple housekeeping parameter definitions	Boolean
S3 ST13 and ST15 Provider	Whether this service can report housekeeping parameter sampling time offsets	Boolean
S3 ST17 and ST19 Provider	Whether this service supports housekeeping filtered mode	Boolean
To be provided if S3 ST17 and ST19 Provider = TRUE		
S3 HK Default Timeout	Whether a housekeeping default timeout is used	Boolean
S3 HK Default Threshold	Whether a housekeeping default threshold is used	Boolean
S3 HK Default Threshold Type	Whether a housekeeping default threshold type is used	Boolean
S3 HK Filtered Parameters	Whether filtering of housekeeping parameters is supported	Boolean
To be provided if S3 HK Filtered Parameters = TRUE		
S3 HK Implicit Filter	Whether there is implicit knowledge of which housekeeping parameters are filtered	Boolean
To be provided if S3 HK Implicit Filter = FALSE		
S3 ST21 and ST23 Provider	Whether the unfiltered housekeeping parameters can be reported	Boolean

Table 29   Housekeeping and diagnostic data reporting service tailoring data (cont.)

Name	Definition	Data Type
S3 Diagnostic Provider	Whether this service reports diagnostic data	Boolean
To be provided if S3 Diagnostic Provider = TRUE		
S3 Diagnostic Implicit Collection Interval	Whether an implicit diagnostic packet collection interval is used	Boolean
S3 Diagnostic Multiple Clear SID	Whether multiple diagnostic reporting definitions can be cleared	Boolean
S3 Diagnostic Multiple Control SID	Whether multiple diagnostic reporting definitions can be controlled	Boolean
S3 ST11 and ST12 Provider	Whether this service can report diagnostic parameter definitions	Boolean
To be provided if S3 ST11 and ST12 Provider = TRUE		
S3 Diagnostic Multiple Report SID	Whether this service can report multiple diagnostic parameter definitions	Boolean
S3 ST14 and ST16 Provider	Whether this service can report diagnostic parameter sampling time offsets	Boolean
S3 ST18 and ST20 Provider	Whether this service supports diagnostic filtered mode	Boolean
To be provided if S3 ST18 and ST20 Provider = TRUE		
S3 Diagnostic Default Timeout	Whether a diagnostic default timeout is used	Boolean
S3 Diagnostic Default Threshold	Whether a diagnostic default threshold is used	Boolean
S3 Diagnostic Default Threshold Type	Whether a diagnostic default threshold type is used	Boolean
S3 Diagnostic Filtered Parameters	Whether filtering of diagnostic parameters is supported	Boolean
To be provided if S3 Diagnostic Filtered Parameters = TRUE		
S3 Diagnostic Implicit Filter	Whether there is implicit knowledge of which diagnostic parameters are filtered	Boolean
To be provided if S3 Diagnostic Implicit Filter = FALSE		
S3 ST22 and ST24 Provider	Whether the unfiltered diagnostic parameters can be reported	Boolean

6.5.5.4.2   Packet field data types data

For the data types of the packet fields of the housekeeping and diagnostic data reporting service, the additional data shown in Table 30 shall be provided.

Table 30   Housekeeping and diagnostic data reporting service data types data

Name	Definition	Data Type
S3 SID	The PFC of the report identifier field	PFC **of** PTC 2
To be provided if S3 HK Implicit Collection Interval = TRUE OR S3 Diagnostic Implicit Collection Interval= TRUE		
S3 Collection Interval	The PFC of the Collection Interval field	PFC **of** PTC 3
To be provided if S3 ST1 ST3 ST5 and ST6 Provider = TRUE OR S3 ST9 and ST10 Provider = TRUE OR S3 Diagnostic Provider = TRUE		
S3 NPAR1	The PFC of the number of repetitions field for parameters	PFC **of** PTC 3
S3 NFA	The PFC of the number of repetitions field for supercommutated parameter definitions	PFC **of** PTC 3
S3 NREP	The PFC of the number of parameter repetitions field	PFC **of** PTC 3
S3 NPAR2	The PFC of the number of repetitions field for parameters	PFC **of** PTC 3
To be provided if S3 ST1 ST3 ST5 and ST6 Provider = TRUE OR S3 ST9 and ST10 Provider = TRUE OR S3 ST13 and ST15 Provider = TRUE OR S3 ST17 and ST19 Provider = TRUE OR S3 Diagnostic Provider = TRUE		
S3 Parameter Number	The PFC of the Parameter# field	PFC **of** PTC 2
To be provided if S3 HK Multiple Clear SID = TRUE OR S3 HK Multiple Control SID = TRUE OR S3 HK Multiple Report SID = TRUE OR S3 Diagnostic Multiple Clear SID = TRUE OR S3 Diagnostic Multiple Control SID = TRUE OR S3 Diagnostic Multiple Report SID		
S3 NSID	The PFC of the number of repetitions field for report identifiers	PFC **of** PTC 3
To be provided if S3 ST13 and ST15 Provider = TRUE OR S3 ST14 and ST16 Provider = TRUE		
S3 Time Offset	The PFC of the Time Offset field	PFC **of** PTC 10
To be provided if S3 HK Default Timeout = TRUE OR S3 Diagnostic Default Timeout = TRUE		
S3 Timeout	The PFC of the Timeout field	PFC **of** PTC 3
To be provided if (S3 HK Filtered Parameters = TRUE AND S3 HK Implicit Filter =FALSE) OR (S3 Diagnostic Filtered Parameters = TRUE AND S3 Diagnostic Implicit Filter = FALSE)		
S3 N	The PFC of the number of repetitions field for parameter threshold definitions	PFC **of** PTC 3
To be provided if S3 HK Default Threshold Type = FALSE OR S3 Diagnostic Default Threshold Type = FALSE		
S3 Threshold Type	The PFC of the Threshold Type field	PFC **of** PTC 2
To be provided if S3 HK Default Threshold =FALSE OR S3 Diagnostic Default Threshold =FALSE		
S3 Threshold	The PFC of the Threshold field	PFC **of** PTC 3
To be provided if S3 ST17 and ST19 Provider = TRUE OR S3 ST18 and ST20 Provider = TRUE		
S3 Mode	The PFC of the Mode field	PFC **of** PTC 3

6.5.5.4.3   Service data

For the housekeeping and diagnostic data reporting service, the additional data specified in Table 31 shall be provided.

Table 31   Housekeeping and diagnostic data reporting service data

Name	Definition	Data Type
Minimum Sampling Interval	The minimum sampling interval at which parameters can be sampled on-board in diagnostic mode. This sampling interval is used as a time unit for the specification of several other time parameters e.g. the collection interval for a housekeeping or diagnostic report. NOTE: This corresponds to the PUS mission constant `<DIAG_MIN_INTERV>`.	Relative Time
Absolute Sampling Accuracy	The accuracy with which the absolute on-board sampling of parameters is known. This corresponds to the PUS mission constant `<PARAM_ABS_SAMPL_TIME>`.	Relative Time
Relative Sampling Accuracy	The accuracy with which the relative on-board sampling of parameters is known. NOTE: This corresponds to the PUS mission constant `<PARAM_REL_SAMPL_TIME>`.	Relative Time
To be provided if S3 HK Implicit Collection Interval = TRUE		
Default HK Collection Interval	The default value for the collection interval for housekeeping report packets	Relative Time
To be provided if S3 HK Default Timeout = TRUE		
Default HK Timeout	The default value for the timeout for the generation of a one-shot housekeeping packet when the packets are being generated in filtered mode	Relative Time
To be provided if S3 HK Default Threshold Type = TRUE		
Type of Default HK Threshold	The default value for the type of threshold used for filtering parameter values when packets are being generated in filtered mode. The set of values is {"**percentage change**","**absolute delta**"}.	Enumerated
To be provided if S3 HK Default Threshold = TRUE		
Value of Default HK Threshold	The default value for the threshold used for filtering parameter values when packets are being generated in filtered mode	Unsigned Integer
To be provided if S3 Diagnostic Implicit Collection Interval = TRUE		
Default Diagnostic Collection Interval	The default value for the collection interval for diagnostic report packets	Relative Time
To be provided if S3 Diagnostic Default Timeout = TRUE		
Default Diagnostic Timeout	The default value for the timeout for the generation of a one-shot diagnostic packet when the packets are being generated in filtered mode	Relative Time

Table 31   Housekeeping and diagnostic data reporting service data (cont.)

Name		Definition	Data Type
To be provided if S3 Diagnostic Default Threshold Type = TRUE			
	Type of Default Diagnostic Threshold	The default value for the type of threshold used for filtering parameter values when packets are being generated in filtered mode. The set of values is {"**percentage change**","**absolute delta**"}.	Enumerated
To be provided if S3 Diagnostic Default Threshold = TRUE			
	Value of Default Diagnostic Threshold	The default value for the threshold used for filtering parameter values when packets are being generated in filtered mode	Unsigned Integer

6.5.5.4.4   SID data

a.   For each reporting data that represents a housekeeping report, the additional data specified in Table 32 shall be provided.

Table 32   Housekeeping report definition data

Name		Definition	Data Type
SID		The unique identifier of the housekeeping report within the service	PTC 2
Ordered list of Components	Reporting Data	A reporting data component of this SID	Reporting Data Reference
	Time Offset	The time offset of the sampling time of the reporting data from the packet time	Relative Time
Predefined Onboard		The definition of whether the corresponding reporting data definition is predefined on-board	Boolean
To be provided if S3 HK Implicit Collection Interval = FALSE			
	Collection Interval	The interval of time used for collecting the parameters contained in this report	PTC 3
To be provided if S3 HK Implicit Filter = TRUE			
List of	Parameter	A filtered parameter when this report is generated in filtered mode	Reporting Data Reference

b. For each reporting data that represents a diagnostic report, the additional data specified in Table 33 shall be provided.

Table 33   Diagnostic report definition data

Name		Definition	Data Type
SID		The unique identifier of the diagnostic report within the service	PTC 2
Ordered list of Components	Reporting Data	A reporting data component of this SID	Reporting Data Reference
	Time Offset	The time offset of the sampling time of the reporting data from the packet time	Relative Time
Predefined Onboard		The definition of whether the corresponding reporting data definition is predefined on-board	Boolean
To be provided if S3 Diagnostic Implicit Collection Interval = FALSE			
	Collection Interval	The interval of time used for collecting the parameters contained in this report	PTC 3
To be provided if S3 Diagnostic Implicit Filter = TRUE			
	List of Parameter	A filtered parameter when this report is generated in filtered mode	Reporting Data Reference

6.5.5.5   Parameter statistics reporting service

6.5.5.5.1   Tailoring data

For the definition of the tailoring of the parameter statistics reporting service, the additional data shown in Table 34 shall be provided.

Table 34   Parameter statistics reporting service tailoring data

Name		Definition	Data Type
S4 ST4 and ST5 Provider		Whether the concept of periodic reporting is supported	Boolean
To be provided if S4 ST4 and ST5 Provider = TRUE			
	S4 Default Reporting Interval	Whether a default value is used for the reporting interval	Boolean
S4 Add Parameters		Whether parameters can be added to the reporting list	Boolean
To be provided if S4 Add Parameters = TRUE			
	S4 Default Sampling Interval	Whether a default value is used for the parameter sampling interval	Boolean
	S4 Multiple Parameters	Whether multiple parameters can be loaded at once	Boolean
	S4 ST6 and ST7 Provider	Whether parameters can be deleted from the reporting list	Boolean
	To be provided if S4 ST6 and ST7 Provider = TRUE		
	S4 ST6 and ST10 Provider[a]	Whether the reporting list can be cleared	Boolean
S4 ST8 and ST9 Provider		Whether the parameter statistics list can be reported	Boolean
S4 Always Reset		Whether the evaluation of parameter statistics is	Boolean

Table 34 Parameter statistics reporting service tailoring data (cont.)

Name	Definition	Data Type
	always reset	
S4 Standard Deviation	Whether the standard deviation of parameters can be evaluated	Boolean
[a]S4 ST6 and ST10 Provider is always TRUE if S4 Add Parameters = TRUE AND S4 ST6 and ST7 Provider = FALSE		

6.5.5.5.2 Packet field data types data

For the data types of the packet fields of the parameter statistics reporting service, the additional data shown in Table 35 shall be provided.

Table 35 Parameter statistics reporting service data types data

Name	Definition	Data Type
To be provided if S4 Always Reset = FALSE		
S4 Reset Flag	The PFC of the Reset Flag field	PFC **of** PTC 2
S4 Time	The PFC of the Time fields	PFC **of** PTC 9
S4 NPAR	The PFC of the number of repetitions field for parameters	PFC **of** PTC 3
S4 Parameter Number	The PFC of the Parameter# field	PFC **of** PTC 2
To be provided if S4 Default Reporting Interval = FALSE OR S4 Default Sampling Interval = FALSE		
S4 Relative Time	The PFC of the Relative Time fields	PFC **of** PTC 10

6.5.5.5.3 Service data

For the parameter statistics reporting service, the additional data specified in Table 36 shall be provided.

Table 36 Parameter statistics reporting service data

Name	Definition	Data Type
Maximum Parameters	The maximum number of parameters whose statistical results can be evaluated at a given time. NOTE: This corresponds to the PUS mission constant `<PSLIST_MAX_PARAMS>`.	Unsigned Integer
To be provided if S4 Default Reporting Interval = TRUE		
Default Reporting Interval	The default value for the periodic reporting interval for the parameter statistics results	Relative Time
To be provided if S4 Default Sampling Interval = TRUE		
Default Sampling Interval	The default value for the sampling interval for all parameters in the list	Relative Time

6.5.5.6   Event reporting service

6.5.5.6.1   Tailoring data

For the definition of the tailoring of the parameter statistics reporting service, the additional data shown in Table 37 shall be provided.

Table 37   Event reporting service tailoring data

Name	Definition	Data Type
S5 ST5 and ST6 Provider	Whether event reports can be enabled and disabled	Boolean
To be provided if S5 ST5 and ST6 Provider = TRUE		
S5 Multiple RIDs	Whether multiple event reports can be enabled and disabled	Boolean

6.5.5.6.2   Packet field data types data

For the data types of the packet fields of the event reporting service, the additional data shown in Table 38 shall be provided.

Table 38   Event reporting service data types data

Name	Definition	Data Type
S5 RID	The PFC of the report identifier field	PFC **of** PTC 2
To be provided if S5 Multiple RIDs = TRUE		
S5 NRID	The PFC of the number of repetitions field for report identifiers	PFC **of** PTC 3

6.5.5.6.3   On-board event data

For each event raised by this service, the additional data specified in Table 39 shall be provided.

Table 39   Event data

Name	Definition	Data Type
RID	The unique identifier of the corresponding event report	PTC 2

6.5.5.7   Memory management service

6.5.5.7.1   Tailoring data

For the definition of the tailoring of the memory management service, the additional data shown in Table 40 shall be provided.

Table 40   Memory management service tailoring data

Name	Definition	Data Type
S6 ST1 ST3 and ST4 Provider	Whether a managed memory uses the base plus offset addressing technique	Boolean
To be provided if S6 ST1 ST3 and ST4 Provider = TRUE		
S6 Symbolic Base References	Whether symbolic base references are supported	Boolean
S6 Base Multiple Memory Blocks	Whether multiple memory blocks are supported	Boolean
S6 Base Data Level Checksum	Whether checksums at data level are supported	Boolean
S6 Base Scatter Load	Whether scatter loading is supported	Boolean
S6 Base Scatter Dump	Whether scatter dumping is supported	Boolean
S6 ST7 and ST8 Provider	Whether on-board checking of memory is supported	Boolean
To be provided if S6 ST7 and ST8 Provider = TRUE		
S6 Base Scatter Check	Whether scatter checking is supported	Boolean
S6 ST2 ST5 and ST6 Provider	Whether a managed memory uses the absolute addressing technique	Boolean
To be provided if S6 ST2 ST5 and ST6 Provider = TRUE[a]		
S6 Absolute Multiple Memory Blocks	Whether multiple memory blocks are supported	Boolean
S6 Absolute Data Level Checksum	Whether checksums at data level are supported	Boolean
S6 Absolute Scatter Load	Whether scatter loading is supported	Boolean
S6 Absolute Scatter Dump	Whether scatter dumping is supported	Boolean
S6 ST9 and ST10 Provider	Whether on-board checking of memory is supported	Boolean
To be provided if S6 ST9 and ST10 Provider = TRUE		
S6 Absolute Scatter Check	Whether scatter checking is supported	Boolean
[a]S6 ST2 ST5 and ST6 Provider is always TRUE if S6 ST1 ST3 and ST4 Provider = FALSE		

6.5.5.7.2   Packet field data types data

For the data types of the packet fields of the memory management service, the additional data shown in Table 41 shall be provided.

Table 41   Memory management service data types data

Name	Definition	Data Type
To be provided if S6 Base Multiple Memory Blocks = TRUE OR S6 Absolute Multiple Memory Blocks = TRUE		
S6 Memory ID	The PFC of the Memory Identifier field	PFC **of** PTC 7, PFC > 0
To be provided if S6 Base Scatter Load = TRUE OR S6 Base Scatter Dump = TRUE OR S6 Base Scatter Check = TRUE OR S6 Absolute Scatter Load = TRUE OR S6 Absolute Scatter Dump = TRUE OR S6 Absolute Scatter Check = TRUE		
S6 N	The PFC of the number of repetitions field	PFC **of** PTC 3
To be provided if S6 ST1 ST3 and ST4 Provider = TRUE		
S6 Offset	The PFC of the Offset field	PFC **of** PTC 4
S6 Length	The PFC of the Length field	PFC **of** PTC 3
To be provided if S6 ST2 ST5 and ST6 Provider = TRUE		
S6 Start Address	The PFC of the Start Address field	PFC **of** PTC 3

Where a symbolic base reference is used (S6 Symbolic Base References = TRUE), the additional data specified in Table 42 shall be provided.

Table 42   Symbolic base reference data

Name	Definition	Data Type
S6 Base	The PFC of the Symbolic Base Reference field	PFC **of** PTC 8, PFC > 0

Where an unsigned integer base is used (S6 Symbolic Base References = FALSE), the additional data specified in Table 43 shall be provided.

Table 43   Unsigned integer base data

Name	Definition	Data Type
S6 Base	The PFC of the Unsigned Integer Base field	PFC **of** PTC 3

See subclauses 6.5.9 and 6.5.10 for the related memory block and memory sub-block data.

6.5.5.7.3   Service data

There is no additional service-specific data for the memory management service.

6.5.5.8 Function management service

6.5.5.8.1 Tailoring data

For the definition of the tailoring of the function management service, the additional data shown in Table 44 shall be provided.

Table 44 Function management service tailoring data

Name	Definition	Data Type
S8 Parameter Subset	Whether a sub-set of function parameters can be loaded	Boolean

6.5.5.8.2 Packet field data types data

For the data types of the packet fields of the function management service, the additional data shown in Table 45 shall be provided.

Table 45 Function management service data types data

Name		Definition	Data Type
S8 Function ID		The PFC of the Function Identifier field	PFC **of** PTC 8, PFC > 0
To be provided if S8 Parameter Subset = TRUE			
	S8 N	The PFC of the number of repetitions field for parameters and their values	PFC **of** PTC 3
	S8 Parameter Number	The PFC of the Parameter# field	PFC **of** PTC 2

See subclause 6.5.8 for the related function definition data.

6.5.5.8.3 Service data

There is no additional service-specific data for the function management service.

6.5.5.9 Time management service

6.5.5.9.1 Tailoring data

For the definition of the tailoring of the time management service, the additional data shown in Table 46 shall be provided.

Table 46 Time management service tailoring data

Name		Definition	Data Type
S9 ST1 Provider		Whether this service supports control of the rate of the time packet	Boolean
S9 ST2 Provider		Whether this service provides the spacecraft time source packet	Boolean
To be provided if S9 ST2 Provider = TRUE			
	S9 Basic Report	Whether only a basic time reporting service is provided	Boolean

6.5.5.9.2 Packet field data types data

For the data types of the packet fields of the time management service, the additional data shown in Table 47 shall be provided.

Table 47   Time management service data types data

Name	Definition	Data Type
To be provided if S9 ST2 Provider = TRUE		
S9 Satellite Time	The PFC of the Satellite Time field	PFC **of** PTC 9
To be provided if S9 Basic Report = FALSE		
	PTC of S9 Status	The parameter type code of the Status field (i.e. the PTC of ECSS-E-70-41A)	PTC
	PFC of S9 Status	The parameter format code of the Status field (i.e. the PFC of ECSS-E-70-41A)	PFC **of** PTC of S9 Status

6.5.5.9.3   Service data

For the time management service, the additional data specified in Table 48 shall be provided.

Table 48   Time management service data

Name	Definition	Data Type
To be provided if this is not contained explicitly in the Satellite Time field		
Mission Time Code	The value of the P-field for the time report packet (subtype 2). NOTE: This corresponds to the PUS mission constant `<MISSION_TIME_CODE>`.	Enumerated
To be provided if S9 Basic Report = FALSE		
List of Statuses	Value	A status value identified for the service	**same as** S9 Status
	Description	The interpretation of the status	Character String

6.5.5.10   On-board operations scheduling service

6.5.5.10.1   Tailoring data

For the definition of the tailoring of the on-board operations scheduling service, the additional data shown in Table 49 shall be provided.

Table 49   Onboard scheduling service tailoring data

Name	Definition	Data Type
S11 Subschedule Support	Whether the concept of sub-schedules is supported	Boolean
To be provided if S11 Subschedule Support = TRUE		
S11 Subschedule Selection	Whether the concept of selection of telecommands at sub-schedule level is supported	Boolean
S11 Relative Time Support	Whether the concept of relative time is supported	Boolean
S11 Interlock Support	Whether the concept of command interlocking is supported	Boolean
S11 Application Selection	Whether the concept of command selection at Application Process level is supported	Boolean
S11 Multiple Insert	Whether insertion of multiple commands is supported	Boolean
S11 ST5 Provider	Whether deletion of commands from the schedule is	Boolean

Table 49   Onboard scheduling service tailoring data (cont.)

Name	Definition	Data Type
	supported	
To be provided if S11 ST5 Provider = TRUE		
S11 ST6 Provider	Whether deletion of commands over a time period is supported	Boolean
S11 ST15 Provider	Whether time-shifting of commands in the schedule is supported	Boolean
To be provided if S11 ST15 Provider = TRUE		
S11 ST7 Provider	Whether time-shifting of selected commands is supported	Boolean
To be provided if S11 ST7 Provider = TRUE		
S11 ST8 Provider	Whether time-shifting of commands over a time period is supported	Boolean
S11 ST16 and ST10 Provider	Whether reporting of the schedule in detailed form is supported	Boolean
To be provided if S11 ST16 and ST10 Provider = TRUE		
S11 ST9 Provider	Whether detailed reporting of selected commands is supported	Boolean
To be provided if S11 ST9 Provider = TRUE		
S11 ST11 Provider	Whether detailed reporting over a time period is supported	Boolean
S11 ST17 and ST13 Provider	Whether reporting of the schedule in summary form is supported	Boolean
To be provided if S11 ST17 and ST13 Provider = TRUE		
S11 ST12 Provider	Whether summary reporting of selected commands is supported	Boolean
To be provided if S11 ST12 Provider = TRUE		
S11 ST14 Provider	Whether summary reporting over a time period is supported	Boolean
To be provided if S11 ST5 Provider = TRUE OR S11 ST15 Provider = TRUE OR S11 ST16 and ST10 Provider = TRUE		
S11 Scattering Support	Whether scatter (delete, time-shifting or detailed reporting) support is provided	Boolean
S11 ST18 and ST19 Provider	Whether reporting of the status of the schedule is supported	Boolean

6.5.5.10.2   Packet field data types data

For the data types of the packet fields of the on-board operations scheduling service, the additional data shown in Table 50 shall be provided.

Table 50   Onboard operations scheduling service data types data

Name	Definition	Data Type
To be provided if S11 Subschedule Support = TRUE		
S11 N1	The PFC of the number of repetitions field for telecommand sets	PFC **of** PTC 3
S11 Subschedule ID	The PFC of the Sub-schedule Identifier field	PFC **of** PTC 2
To be provided if S11 Application Selection = TRUE		
S11 N2	The PFC of the number of repetitions field for Application Process Identifiers	PFC **of** PTC 3
S11 APID	The PFC of the Application Process Identifier field	PFC **of** PTC 2
To be provided if S11 Multiple Insert = TRUE OR S11 Scattering Support = TRUE		
S11 N	The PFC of the number of repetitions field for telecommands	PFC **of** PTC 3
To be provided if S11 Interlock Support = TRUE		
S11 Interlock ID	The PFC of the Interlock Identifier field	PFC **of** PTC 2
S11 Assessment Type	The PFC of the Assessment Type field	PFC **of** PTC 2
To be provided if S11 Relative Time Support = TRUE		
S11 Scheduling Event	The PFC of the Scheduling Event field	PFC **of** PTC 2
S11 Relative CUC Time	The PFC of relative CUC time fields. NOTE: The same representation of CUC time is used as applies for S11 Absolute CUC Time.	PFC **of** PTC 10
To be provided if S11 ST5 Provider = TRUE OR S11 ST7 Provider = TRUE OR S11 ST9 Provider = TRUE		
S11 Sequence Count	The PFC of the Sequence Count field	PFC **of** PTC 3
S11 Number of TCs	The PFC of the Number of Telecommands field	PFC **of** PTC 3
To be provided if S11 ST6 Provider = TRUE OR S11 ST8 Provider = TRUE OR S11 ST11 Provider = TRUE		
S11 Range	The PFC of the Range field	PFC **of** PTC 2
S11 Absolute CUC Time	The PFC of absolute CUC time fields	PFC **of** PTC 9
To be provided if S11 ST18 and ST 19 Provider = TRUE		
S11 Status	The PFC of the Status field	PFC **of** PTC 2

6.5.5.10.3   Service data

a.   For the on-board operations scheduling service, the additional data specified in Table 51 shall be provided.

Table 51   Onboard operations scheduling service data

Name	Definition	Data Type
Maximum Size of Schedule	The maximum size of the buffer allocated for scheduled telecommands	Unsigned Integer **with units B**
To be provided if S11 Subschedule Support = TRUE		
Maximum Number of Subschedules	The maximum number of sub-schedules that can be supported	Unsigned Integer
To be provided if S11 Interlock Support = TRUE		
Maximum Number of Interlocks	The maximum number of interlocks (per sub-schedule) that can be supported	Unsigned Integer

b.   For each event of type "scheduling event", the additional data specified in Table 52 shall be provided.

Table 52   Scheduling event data

Name	Definition	Data Type
Name	A mission-specific event that can be used as the base to which the relative time of a loaded telecommand is referenced	Event Reference
ID	The identifier of the event. The values 0, 1, 2 and 3 are reserved for standard use by the PUS	PTC 2

6.5.5.11   On-board monitoring service

6.5.5.11.1   Tailoring data

For the definition of the tailoring of the opn-board monitoring service, the additional data shown in Table 53 shall be provided.

Table 53   Onboard monitoring service tailoring data

Name	Definition	Data Type
S12 Multiple Enable and Disable	Whether multiple parameters can be enabled and disabled	Boolean
S12 ST3 Provider	Whether the maximum reporting delay can be changed	Boolean
S12 ST5 Provider	Whether parameters can be added to the monitoring list	Boolean
S12 ST7 Provider	Whether parameter checking information can be modified	Boolean
To be provided if S12 ST5 Provider = TRUE		
S12 Default Monitoring Interval	Whether there is a default monitoring interval	Boolean
S12 ST4 Provider	Whether the monitoring list can be cleared	Boolean
To be provided if S12 ST4 Provider = TRUE		
S12 ST6 Provider[a]	Whether parameters can be deleted from the monitoring list	Boolean

Table 53   Onboard monitoring service tailoring data (cont.)

Name	Definition	Data Type
To be provided if S12 ST5 Provider = TRUE OR S12 ST7 Provider = TRUE		
S12 ST8 and ST9 Provider	Whether the current monitoring list can be reported	Boolean
S12 Multiple Parameters	Whether multiple parameters can be added, deleted or modified	Boolean
S12 Parameter Validity Support	Whether the concept of parameter validity is supported	Boolean
S12 Event Reports	Whether event reports can be linked to monitoring violations	Boolean
S12 Expected Value Check	Whether expected value checking is supported	Boolean
To be provided if S12 Expected Value Check = TRUE		
To be provided if S12 ST5 Provider = TRUE OR S12 ST8 and ST9 Provider = TRUE		
S12 Default Value Repetitions	Whether there is a default value for the number of successive samples required to establish a new checking status	Boolean
S12 Multiple Expected Value Checks	Whether multiple expected value checks can be defined per parameter	Boolean
S12 Limit Check	Whether limit checking is supported	Boolean
To be provided if S12 Limit Check = TRUE		
To be provided if S12 Expected Value Check = FALSE AND S12 ST5 Provider = TRUE OR S12 ST8 and ST9 Provider = TRUE		
S12 Default Value Repetitions	Whether there is a default value for the number of successive samples required to establish a new checking status	Boolean
S12 Multiple Limit Checks	Whether multiple limit checks can be defined per parameter	Boolean
To be provided if S12 Expected Value Check = TRUE OR S12 Limit Check = TRUE		
S12 Delta Check	Whether delta checking is supported	Boolean
To be provided if S12 Delta Check = TRUE		
To be provided if S12 ST5 Provider = TRUE OR S12 ST8 and ST9 Provider = TRUE		
S12 Default Delta Repetitions	Whether there is a default value for the number of successive samples required to establish a new checking status	
S12 Multiple Delta Checks	Whether multiple delta checks can be defined per parameter	Boolean
S12 ST10 and ST11 Provider	Whether the current parameters out-of-limits list can be reported	Boolean
S12 Transition Time	Whether transition time is required in the check transition report	Boolean
[a]S12 ST6 Provider is always TRUE if S12 ST4 Provider = FALSE		

6.5.5.11.2   Packet field data types data

For the data types of the packet fields of the on-board monitoring service, the additional data shown in Table 54 shall be provided.

Table 54   Onboard monitoring service data types data

Name	Definition	Data Type
S12 N	The PFC of the number of repetitions field for parameters (and monitoring attributes)	PFC **of** PTC 3
S12 Parameter Number	The PFC of the Parameter# field	PFC **of** PTC 2
To be provided if S12 ST3 Provider = TRUE		
S12 Maximum Reporting Delay	The PFC of the Maximum Reporting Delay field	PFC **of** PTC 3
To be provided if S12 Default Monitoring Interval = TRUE		
S12 Parameter Monitoring Interval	The PFC of the Parameter Monitoring Interval field	PFC **of** PTC 3
To be provided if S12 Default Value Repetitions = FALSE OR S12 Default Delta Repetitions =FALSE		
S12 Repetitions	The PFC of the number of repetition fields	PFC **of** PTC 3
To be provided if S12 Multiple Limit Checks = TRUE		
S12 NOL	The PFC of the number of repetitions field for limit checks	PFC **of** PTC 3
To be provided if S12 Multiple Delta Checks = TRUE		
S12 NOD	The PFC of the number of repetitions field for delta checks	PFC **of** PTC 3
To be provided if S12 Multiple Expected Value Checks = TRUE		
S12 NOE	The PFC of the number of repetitions field for expected value checks	PFC **of** PTC 3
To be provided if S12 Event Reports = TRUE		
S12 RID	The PFC of the report identifier field	PFC **of** PTC 2
To be provided if S12 ST7 Provider = TRUE AND (S12 Multiple Limit Checks = TRUE OR S12 Multiple Delta Checks = TRUE OR S12 Multiple Expected Value Checks = TRUE)		
S12 Check Position	The PFC of the Check Position field	PFC **of** PTC 4
To be provided if S12 ST8 and ST9 Provider = TRUE		
S12 Monitoring Status	The PFC of the monitoring status fields	PFC **of** PTC 2
S12 Checking Status	The PFC of the checking status fields	PFC **of** PTC 2
To be provided if S12 ST10 and ST11 Provider = TRUE OR S12 Transition Time = TRUE		
S12 Time	The PFC of the Transition Time field	PFC **of** PTC 9

6.5.5.11.3   Service data

For the on-board monitoring service, the additional data specified in Table 55 shall be provided.

Table 55   Onboard monitoring service data

Name		Definition	Data Type
To be provided if S12 ST5 Provider = TRUE			
	Maximum Number of Parameters	The maximum number of parameters that can be loaded in the on-board monitoring list. NOTE: This corresponds to the PUS mission constant <MONLIST_MAX_PARAMS>.	Unsigned Integer
	Maximum Number of Checks	The maximum number of checks that can be defined per parameter. NOTE: This corresponds to the PUS mission constant <MONLIST_MAX_CHECKS>.	Unsigned Integer
To be provided if S12 Default Value Repetitions = TRUE			
	Default Number of Limit or Status Transitions	The number of successive times that a limit or expected status check transition is registered before a new checking status is declared for the corresponding parameter	Unsigned Integer
To be provided if S12 Default Delta Repetitions = TRUE			
	Default Number of Delta Transitions	The number of successive times that a delta check transition is registered before a new checking status is declared for the corresponding parameter	Unsigned Integer
To be provided if S12 Default Monitoring Interval = TRUE			
	Default Monitoring Interval	The default value used for the interval between successive samples of parameters for the purposes of the on-board monitoring	Relative Time

6.5.5.12   Large data transfer service

6.5.5.12.1   Tailoring data

For the definition of the tailoring of the large data transfer service, the additional data shown in Table 56 shall be provided.

Table 56   Large data transfer service tailoring data

Name	Definition	Data Type
S13 Large Downlink Provider	Whether this service supports the downlink of large data units	Boolean
To be provided if S13 Large Downlink Provider = TRUE		
S13 Downlink Multiple Data Units	Whether multiple data units can be downlinked in parallel	Boolean
S13 ST6 and ST7 Provider	Whether the concept of re-sending lost or erroneous parts is supported	Boolean
To be provided if S13 ST6 and ST7 Provider = TRUE		
S13 Downlink Sliding Window	Whether the concept of a sliding window is supported	Boolean
S13 ST4 Reason Code	Whether the ground requires the use of a Reason Code when the downlink transfer is aborted by the on-board service	Boolean
S13 ST8 Reason Code	Whether the on-board service can process a Reason Code when the downlink transfer is aborted by the ground	Boolean
S13 Large Uplink Provider	Whether this service supports the uplink of large data units	Boolean
To be provided if S13 Large Uplink Provider = TRUE		
S13 Uplink Multiple Data Units	Whether multiple data units can be uplinked in parallel	Boolean
S13 ST12 and ST15 Provider	Whether the concept of re-sending lost or erroneous parts is supported	Boolean
To be provided if S13 ST12 and ST15 Provider = TRUE		
S13 Uplink Sliding Window	Whether the concept of a sliding window is supported	Boolean
S13 ST13 Reason Code	Whether the on-board service can process a Reason Code when the uplink transfer is aborted by the ground	Boolean
S13 ST16 Reason Code	Whether the ground requires the use of a Reason Code when the uplink transfer is aborted by the on-board service	Boolean

6.5.5.12.2   Packet field data types data

For the data types of the packet fields of the large data transfer service, the additional data shown in Table 57 shall be provided.

Table 57   Large data transfer service data types data

Name	Definition	Data Type
To be provided if S13 Downlink Multiple Data Units = TRUE OR S13 Uplink Multiple Data Units = TRUE		
S13 Large Data Unit ID	The PFC of the Large Data Unit Identifier field	PFC of PTC 2
S13 Sequence Number	The PFC of the Sequence Number field	PFC of PTC 3
To be provided if S13 ST6 and ST7 Provider = TRUE OR S13 ST12 and ST15 Provider = TRUE		
S13 N	The PFC of the number of repetitions field for sequence numbers	PFC of PTC 3
To be provided if S13 ST4 Reason Code = TRUE OR S13 ST8 Reason Code = TRUE OR S13 ST13 Reason Code = TRUE OR S13 ST16 Reason Code = TRUE		
S13 Reason Code	The PFC of the Reason Code field	PFC of PTC 2

6.5.5.12.3   Service data

a.   Sending sub-service

For a sending sub-service (S13 Large Downlink Provider = TRUE), the additional data specified in Table 58 shall be provided.

Table 58 Large data transfer sending subservice data

Name		Definition	Data Type
Size of Part		The size of the parts into which the large service data unit is split. This part size is equal to or smaller than the maximum telemetry source packet size defined for the mission.	Unsigned Integer **with units B**
To be provided if S13 Downlink Sliding Window = TRUE			
List of Sliding Windows	Size	The size of the sliding window expressed as the maximum number of parts that can be in transmission at any given time for which no reception acknowledgement has been received	Unsigned Integer
	Name of System Element	The application process or service from which the original large service data unit originates	System Element Reference **of** Type "**application process**" or System Element Reference **of** Type "**service**"
Acknowledgement Timeout Interval		The time interval for the acknowledgement timer after which the transfer is aborted if no reception acknowledgement is received from the ground	Relative Time
List of Reasons	Code	A service-wide reason code for aborting the transfer at the receiving end i.e. by the ground	PTC 2
	Description	The interpretation of the reason for aborting	Character String

b. Receiving sub-service

For a receiving sub-service (S13 Large Uplink Provider = TRUE), the additional data specified in Table 59 shall be provided.

Table 59 Large data transfer receiving subservice data

Name		Definition	Data Type
Size of Part		The size of the parts into which the large service data unit is split. This part size is equal to or smaller than the maximum telecommand packet size defined for the mission.	Unsigned Integer **with units B**
List of Reasons	Code	A service-wide reason code for aborting the transfer at the receiving end i.e. by the on-board service	PTC 2
	Description	The interpretation of the reason for aborting	Character String
Reception Timeout Interval		The time interval for the reception timer after which the reception activity is locally aborted if no subsequent parts are received	Relative Time

6.5.5.13   Packet forwarding control service

6.5.5.13.1   Tailoring data

For the definition of the tailoring of the packet forwarding control service, the additional data shown in Table 60 shall be provided.

Table 60   Packet forwarding control service tailoring data

Name	Definition	Data Type
S14 Centralised	Whether this is a centralised service	Boolean
S14 ST3 and ST4 Provider	Whether the list of enabled telemetry packets can be reported	Boolean
S14 ST5 and ST6 Provider	Whether specified housekeeping packets can be controlled	Boolean
To be provided if S14 ST5 and ST6 Provider = TRUE		
S14 ST7 and ST8 Provider	Whether the list of enabled housekeeping packets can be reported	Boolean
S14 ST9 and ST10 Provider	Whether specified diagnostic packets can be controlled	Boolean
To be provided if S14 ST9 and ST10 Provider = TRUE		
S14 ST11 and ST12 Provider	Whether the list of enabled diagnostic packets can be reported	Boolean
S14 ST13 and ST14 Provider	Whether specified event packets can be controlled	Boolean
To be provided if S14 ST13 and ST14 Provider = TRUE		
S14 ST15 and ST16 Provider	Whether the list of enabled event packets can be reported	Boolean
To be provided if S14 ST5 and ST6 Provider = TRUE OR S14 ST9 and ST10 Provider = TRUE OR S14 ST13 and ST14 Provider = TRUE		
S14 Multiple Packet Control	Whether multiple packets can be controlled	Boolean

6.5.5.13.2   Packet field data types data

For the data types of the packet fields of the packet forwarding control service, the additional data shown in Table 61 shall be provided.

Table 61   Packet forwarding control service data types data

Name	Definition	Data Type
S14 N	The PFC of the number of repetitions fields	PFC of PTC 3
To be provided if S14 Centralised = TRUE		
S14 APID	The PFC of the Application Process Identifier field	PFC of PTC 2
S14 Type	The PFC of the (service) Type and Subtype fields	PFC of PTC 2
To be provided if S14 ST5 and ST6 Provider = TRUE OR S14 ST9 and ST10 Provider = TRUE		
S14 SID	The PFC of the structure identifier field	PFC of PTC 2
To be provided if S14 ST13 and ST14 Provider = TRUE		
S14 RID	The PFC of the report identifier field	PFC of PTC 2

6.5.5.13.3   Service data

There is no additional service-specific data for the packet forwarding control service.

6.5.5.14   On-board storage and retrieval service

6.5.5.14.1   Tailoring data

For the definition of the tailoring of the on-board storage and retrieval service, the additional data shown in Table 62 shall be provided.

Table 62   Onboard storage and retrieval service tailoring data

Name	Definition	Data Type
S15 Multiple Packet Store	Whether multiple packet stores are supported	Boolean
S15 Packet Selection Provider	Whether this service provides a packet selection sub-service	Boolean
To be provided if S15 Packet Selection Provider = TRUE		
S15 ST3 and ST4 Provider	Whether the storage selection definition can be changed	Boolean
To be provided if S15 ST3 and ST4 Provider = TRUE		
S15 ST5 and ST6 Provider	Whether the storage selection definition can be reported	Boolean
S15 Storage and Retrieval Provider	Whether this service provides a storage and retrieval sub-service	Boolean
To be provided if S15 Storage and Retrieval Provider = TRUE		
S15 Centralised	Whether the service is centralised	Boolean
To be provided if S15 Storage and Retrieval Provider = TRUE[a]		
S15 Circular Packet Store	Whether circular packet stores are supported	Boolean
To be provided if S15 Circular Packet Store = TRUE AND S15 Multiple Packet Store = TRUE		
S15 Bounded Packet Store[b]	Whether bounded packet stores are supported	Boolean
S15 ST8 Provider	Whether packets are downlinked in the same virtual channel as real-time packets	Boolean
S15 ST7 Provider	Whether packets can be downlinked for a specified packet range	Boolean
To be provided if S15 ST7 Provider = TRUE[c]		
S15 ST7 All Criterion	Whether "all" packet set criterion can be used to request downlink of a packet store	Boolean
S15 ST7 Between Criterion	Whether "between" packet set criterion can be used to request downlink of a packet store	Boolean
S15 ST7 Before Criterion	Whether "before" packet set criterion can be used to request downlink of a packet store	Boolean
To be provided if S15 ST7 All Criterion = TRUE OR S15 ST7 Between Criterion = TRUE OR S15 ST7 Before Criterion = TRUE		
S15 ST7	Whether "after" packet set criterion can be used to	Boolean

Table 62   Onboard storage and retrieval service tailoring data (cont.)

Name			Definition	Data Type
		After Criterion	request downlink of a packet store	
	To be provided if S15 Bounded Packet Store = TRUE			
		S15 ST10 Provider	Whether packet store contents can be deleted up to specified packets	Boolean
		S15 ST10 All Criterion	Whether "all" packet set criterion can be used to request deletion from a packet store	Boolean
		To be provided if S15 ST10 All Criterion = TRUE		
			S15 ST10 Before Criterion	Whether "before" packet set criterion can be used to request deletion from a packet store	Boolean
	S15 Time Stamping		Whether packets are time-stamped at the time of storage	Boolean
	To be provided if S15 Time Stamping = TRUE			
		S15 ST9 Provider	Whether packets can be downlinked for a specified time period	Boolean
		To be provided if S15 ST9 Provider = TRUE[d]		
			S15 ST9 All Criterion	Whether "all" packet set criterion can be used to request downlink of a packet store	Boolean
			S15 ST9 Between Criterion	Whether "between" packet set criterion can be used to request downlink of a packet store	Boolean
			S15 ST9 Before Criterion	Whether "before" packet set criterion can be used to request downlink of a packet store	Boolean
			To be provided if S15 ST9 All Criterion = TRUE OR S15 ST9 Between Criterion= TRUE OR S15 ST9 Before Criterion = TRUE		
				S15 ST9 After Criterion	Whether "after" packet set criterion can be used to request downlink of a packet store	Boolean
	To be provided if S15 Bounded Packet Store = TRUE			
		S15 ST11 Provider	Whether packet store contents can be deleted up to a specified time	Boolean
	S15 ST12 and ST13 Provider		Whether reporting of store catalogues is supported	Boolean

[a]S15 Storage and Retrieval Provider is always TRUE if S15 Packet Selection Provider = FALSE

[b]S15 Bounded Packet Store is always TRUE if S15 Circular Packet Store = FALSE AND S15 Storage and Retrieval Provider = TRUE

[c]S15 ST7 After Criterion is always TRUE if S15 ST7 All Criterion = FALSE AND S15 ST7 Between Criterion = FALSE AND S15 ST7 Before Criterion = FALSE

[d]S15 ST9 After Criterion is always TRUE if S15 ST9 All Criterion = FALSE AND S15 ST9 Between Criterion = FALSE AND S15 ST9 Before Criterion = FALSE

6.5.5.14.2   Packet field data types data

For the data types of the packet fields of the on-board storage and retrieval service, the additional data shown in Table 63 shall be provided.

Table 63   Onboard storage and retrieval service data types data

Name	Definition	Data Type
S15 N	The PFC of the number of repetitions fields	PFC **of** PTC 3
To be provided if S15 Multiple Packet Store = TRUE		
S15 Store ID	The PFC of the Store Identifier field	PFC of PTC 8, PFC > 0
To be provided if S15 ST3 and ST4 Provider = TRUE OR S15 ST12 and ST13 Provider = TRUE		
S15 Type	The PFC of the (service) Type and Subtype fields	PFC **of** PTC 2
To be provided if at least two of the following are true: {S15 ST7 All Criterion, S15 ST7 Between Criterion, S15 ST7 Before Criterion, S15 ST7 After Criterion} OR {S15 ST10 All Criterion = TRUE AND S15 ST10 Before Criterion = TRUE}		
S15 Packet Set	The PFC of the Packet Set field	PFC **of** PTC 2
To be provided if S15 Centralised = TRUE		
S15 APID	The PFC of the Application Process Identifier field	PFC **of** PTC 2
To be provided if S15 ST7 Between Criterion = TRUE OR S15 ST7 Before Criterion = TRUE OR S15 ST7 After Criterion = TRUE OR S15 ST10 Before Criterion = TRUE OR S15 ST12 and ST13 Provider = TRUE		
S15 Source Sequence Count	The PFC of the Source Sequence Count field	PFC **of** PTC 3
To be provided if at least two of the following are true: {S15 ST9 All Criterion, S15 ST9 Between Criterion, S15 ST9 Before Criterion, S15 ST9 After Criterion}		
S15 Time Span	The PFC of the Time Span field	PFC **of** PTC 2
To be provided if S15 ST9 Between Criterion = TRUE OR S15 ST9 Before Criterion = TRUE OR S15 ST9 After Criterion = TRUE OR S15 ST11 Provider = TRUE OR {S15 ST12 and ST13 Provider = TRUE AND S15 Time Stamping = TRUE}		
S15 Time	The PFC of the Storage Time fields	PFC **of** PTC 9
To be provided if S15 ST12 and ST13 Provider = TRUE AND Packet Subcounter **of current system element of** Type "**application process**" = TRUE		
S15 Packet Subcounter	The PFC of the Packet Sub-counter field	PFC **of** PTC 3
To be provided if S15 ST12 and ST13 Provider = TRUE		
S15 Percent	The PFC of the percentage fields	PFC **of** PTC 3
S15 No Of Packets	The PFC of the number of packets fields	PFC **of** PTC 3

6.5.5.14.3   Service data

There is no additional service-specific data for the on-board storage and retrieval service.

See subclause 6.5.11 for the related store definition data.

6.5.5.15   Test service

6.5.5.15.1   Tailoring data

There is no tailoring data for the test service.

6.5.5.15.2   Packet field data types data

There are no packet field data types for the test service.

6.5.5.15.3   Service data

There is no additional service-specific data for the test service.

6.5.5.16   On-board operations procedure service

6.5.5.16.1   Tailoring data

For the definition of the tailoring of the on-board operations procedure service, the additional data shown in Table 64 shall be provided.

Table 64   Onboard operations procedure service tailoring data

Name	Definition	Data Type
S18 ST7 Provider	Whether parameters can be communicated to a procedure when running	Boolean
S18 Parameter Subset	Whether a sub-set of parameters can be used when starting a procedure or communicating with a procedure	Boolean
S18 ST8 and ST9 Provider	Whether the list of on-board procedures can be reported	Boolean
S18 ST10 and ST11 Provider	Whether the list of active on-board procedures can be reported	Boolean

6.5.5.16.2   Packet field data types data

For the data types of the packet fields of the on-board operations procedure service, the additional data shown in Table 65 shall be provided.

Table 65   Onboard operations procedure service data types data

Name	Definition	Data Type
S18 Procedure ID	The PFC of the Procedure Identifier field	PFC **of** PTC 8, PFC > 0
To be provided if S18 Parameter Subset = TRUE		
S18 N	The PFC of the number of repetitions field for parameters and their values	PFC **of** PTC 3
S18 Parameter Number	The PFC of the Parameter# field	PFC **of** PTC 2
S18 Step ID	The PFC of the Step Identifier field	PFC **of** PTC 2
To be provided if S18 ST8 and ST9 Provider = TRUE OR S18 ST10 and ST11 Provider = TRUE		
S18 NProc	The PFC of the number of repetitions fields for procedures (and their statuses)	PFC **of** PTC 3
To be provided if S18 ST10 and ST11 Provider = TRUE		
S18 Status	The PFC of the Status field	PFC **of** PTC 2

6.5.5.16.3 Service data

For the on-board operations procedure service, the additional data specified in Table 66 shall be provided.

Table 66   Onboard operations procedure service data

Name	Definition	Data Type
Maximum Number of Procedures	The maximum number of procedures that can be simultaneously managed by the service	Unsigned Integer

6.5.5.17   Event/action service

6.5.5.17.1 Tailoring data

For the definition of the tailoring of the event/action service, the additional data shown in Table 67 shall be provided.

Table 67   Event action service tailoring data

Name	Definition	Data Type
S19 Multiple APIDs	Whether event reports can be received from more than one application process	Boolean
S19 ST2 Provider	Whether events can be deleted from the event/action list	Boolean
To be provided if S19 ST2 Provider = TRUE		
S19 ST3 Provider[a]	Whether the event/action list can be cleared	Boolean
S19 Multiple Events	Whether multiple event/actions can be added to or deleted from the event/action list	Boolean
S19 Multiple Actions	Whether more than one action can be controlled at a time	Boolean
S19 ST6 and ST7 Provider	Whether the event/action list can be reported	Boolean
[a]S19 ST3 Provider is always TRUE if S19 ST2 Provider = FALSE		

6.5.5.17.2 Packet field data types data

For the data types of the packet fields of the event/action service, the additional data shown in Table 68 shall be provided.

Table 68   Event action service data types data

Name	Definition	Data Type
To be provided if S19 Multiple Events = TRUE OR S19 Multiple Actions = TRUE		
S19 N	The PFC of the number of repetitions fields	PFC **of** PTC 3
To be provided if S19 Multiple APIDs = TRUE		
S19 APID	The PFC of the Application Process Identifier field	PFC **of** PTC 2
S19 RID	The PFC of the report identifier field	PFC **of** PTC 2
To be provided if S19 ST6 and ST7 Provider= TRUE		
S19 Status	The PFC of the Action Status field	PFC **of** PTC 2

6.5.5.17.3   Service data

For each event/action couplet which is pre-loaded on-board, the additional data specified in Table 69 shall be provided.

Table 69   Preloaded event action couplet data

Name	Definition	Data Type
Name of Trigger Event	The on-board event which triggers an action	Event Reference
Action	The action to be taken when this event occurs	Activity Call
Status	The status of the action. The set of values is {"**enabled**", "**disabled**"}	Enumerated

6.5.6   MAP data

For system elements of type "**MAP**", the additional data specified in Table 70 shall be provided.

Table 70   MAP data

Name		Definition	Data Type
ID		The unique identifier of the MAP. The set of values is in the range {0, 63}.	PTC 2
Priority		The priority assigned to the MAP. The set of values is mission-specific covering the priority range from "Lowest" to "Highest".	Enumerated
List of Application Processes	Name of Application Process	An application process that can be accessed via the MAP	System Element Reference **of** Type "**application process**"
	Default MAP Flag	The definition of whether this is the default MAP for telecommands to this application process	Boolean

6.5.7   VC data

For system elements of type "**VC**", the additional data specified in Table 71 shall be provided.

Table 71   VC data

Name		Definition	Data Type
ID		The unique identifier of the virtual channel	PTC 2
Type		The type of the link to which the virtual channel belongs. The set of values is {"**downlink**", "**uplink**"}.	Enumerated
List of Packets	Name of Application Process	The application process of a telemetry (or telecommand) packet that can be downlinked (or uplinked) via the virtual channel	System Element Reference **of** Type "**application process**"
	Service Type	The service type of the telemetry or telecommand packet	Service Type
	Service Subtype	The service subtype of the telemetry or telecommand packet	Service Subtype **of** Service Type

6.5.8 Functions

6.5.8.1

For system elements of type "**function**" (see subclause 6.5.5.8 for the related PUS function management service), the additional data specified in Table 72 shall be provided.

Table 72 Function data

Name		Definition	Data Type
ID		The identifier of the function. Function ID (FID) is unique within a given service implementation, but the same FID may be used in different application processes.	PTC 8 PFC > 0
Ordered List of Arguments	Name	The relative name of an argument used in the context of the function	Name
	ID	The identification of the argument used in the telecommand packet when the argument is supplied to the function (corresponds to Parameter# of the PUS)	PTC 2
	Description	The description that unambiguously describes the argument	Character String
	Type	The type of argument. The set of values is {any Simple Data Type, "**record**"}.	Enumerated
	Arity	The arity of the argument. The set of values is {"**array**","**single value**"}.	Enumerated
	Default Value	The default value of the argument	VAL

NOTE A function command can load a sub-set of the function arguments. This subset is identified by using the same names for the arguments that are defined for the corresponding command.

6.5.8.2

For each argument component of type value type data type or value type set, the data specified in Table 97 shall be provided.

6.5.8.3

For each argument component of arity array, the data specified in Table 98 shall be provided.

6.5.9 Memory data

For system elements of type "**memory block**" (see subclause 6.5.5.7 for the related memory management service), the additional data specified in Table 73 shall be provided.

Table 73 Memory block data

Name	Definition	Data Type
ID	The identifier of the memory block. The Memory ID is unique at system level (e.g. spacecraft).	PTC 7 PFC > 0
Accessibility	The definition of whether the memory block is read-only, or whether it can also be loaded from ground. The set of values includes {"**read-only**", "**read and write**"}.	Enumerated
Smallest Addressable Unit	The smallest unit that can be addressed for the memory block. The base reference, block length, sub-block length and offset are expressed in multiples of this smallest addressable unit (SAU). NOTE: This corresponds to the PUS mission constant `<SMALLEST_ADDRESSABLE_UNIT>`. The set of values includes {"**1 B**", "**2 B**", "**3 B**", "**4 B**", "**8 B**"}.	Enumerated
Addressing Technique	The addressing technique used when addressing the memory block. The set of values is {"**base reference (unsigned integer) plus offset**", "**symbolic reference plus offset**", "**absolute address**"}.	Enumerated
Size	The size of the memory block	Unsigned Integer **with units B**

6.5.10   Memory sub-block data

For system elements of type "**memory subblock**" (see subclause 6.5.5.7 for the related PUS memory management service), the additional data specified in Table 74 shall be provided.

Table 74 Memory subblock data

Name	Definition	Data Type
Symbolic Base Reference	The (fixed length) character string used as the symbolic reference for this sub-block in load and/or dump packets. See subclause 0 for the length of this field.	PTC 8
Offset	The offset from the zero reference of the start of the memory sub-block from its parent (which can be either a memory block or sub-block)	Unsigned Integer **with units B**
Size	The size of the memory sub-block	Unsigned Integer **with units B**
Accessibility	The definition of whether the memory block is read-only, or whether it can also be loaded from ground. The set of values includes {"**read-only**", "**read and write**"}.	Enumerated
Loading Instruction	The definition of whether this memory subblock is to be completely reloaded if any part of it is changed, or whether it can be "patched". The set of values is {"**reload**", "**patch**"}.	Enumerated
Type	The type of reporting data that is contained in this memory subblock The set of values includes {"**object code**", "**dynamic data**","**data pool**","**static data**"}.	Enumerated
Reporting Data	The reporting data that maps to the memory sub-block	Reporting Data Reference

6.5.11 Store data

For system elements of type "**store**" (see subclause 6.5.5.13.3 for the related PUS on-board storage and retrieval service), the additional data specified in Table 75 shall be provided.

Table 75   Store data

Name	Definition	Data Type
ID	The identifier of the store. The store ID is unique at system level (e.g. spacecraft). See subclause 6.5.5.14.2 for the length of this field.	PTC 8
Type	The type of the store. The set of values is {"**circular**", "**bounded**"}.	Enumerated
Size	The maximum capacity of the store	Unsigned Integer **with units B**

6.5.12 CPDU data

For system elements of type "**CPDU**" (see subclause 6.5.5.3 for the related PUS device command distribution service), the additional data specified in Table 76 shall be provided.

Table 76   CPDU data

Name		Definition	Data Type
List of Output Lines	Name	The name of an output line of the CPDU	Name
	Number	The corresponding number of the output line	PTC 2 PFC 8
	Description	The description of the output line function	Character String
Duration Unit		The unit of time used by the CPDU as the basis for defining the duration of the command pulse that is to be issued (it is expressed as a multiple of this unit). NOTE: This corresponds to the PUS mission constant `<CPDU_DURATION_UNIT>`.	Real **with units ms in the interval {**10 **ms**, 15 **ms}**
Maximum Number of Instructions		The maximum number of CPDU instructions that can be contained within a single packet. NOTE: This corresponds to the PUS mission constant `<CPDU_MAX_INSTR>`.	Unsigned Integer **in the interval {**12, 120**}**

6.5.13 On/Off device data

For system elements of type "**OnOff device**" (see subclause 6.5.5.3 for the related PUS device command distribution service), the additional data specified in Table 77 shall be provided.

Table 77   OnOff device data

Name		Definition	Data Type
List of Addresses	Address	An on-board hardware address associated with the On/Off device	PTC 2
	Name of System Element	The system element to which the On/Off address is associated	System Element Reference
	Type	The type of the address. Possible types are {"**ON**", "**OFF**"}.	Enumerated

6.5.14   Register load device data

For system elements of type "**register load device**" (see subclause 6.5.5.3 for the related PUS device command distribution service), the additional data specified in Table 78 shall be provided.

Table 78   Register load device data

Name		Definition	Data Type
Address		The on-board hardware address of the register load device	PTC 2
List of Components	Name	The name of an independently commandable component of the register.	Name
	Current Value	The reporting data that reflects the current value of the register component.	Reporting Data Reference

NOTE   A register load device command can load a sub-set of the register components. This subset is identified by using the same names for the arguments that are defined for the corresponding command. The values to be uplinked for components that are not accessed by a given register load command are acquired from the current value of the register component.

6.5.15   Sensor data

For system elements of type "**sensor**", the additional data specified in Table 79 shall be provided.

Table 79   Sensor data

Name	Definition	Data Type
Type	The type of the sensor. Possible types include {"**bi-level**" (digital), "**analogue SE**", "**analogue DE**", "**relay**", "**thermistor**"}.	Enumerated
Address	The on-board address of the sensor (e.g. RTU address)	PTC 2
Connector Number	The connector number of the sensor	Enumerated

6.6   Reporting data

6.6.1   Introduction

Two types of reporting data are distinguished: parameters and compound parameters.

Parameters are of simple type e.g. the temperature of a battery (its engineering value) is of type real.

Compound parameters are complex in nature. A compound parameter is a set of data used as a single entity (e.g. a planned manoeuvre produced by the flight dynamics system is a compound parameter consisting of a record of parameters defining the start time, the slew axis, the slew rate and the slew duration). A component of a compound parameter is either a parameter or another compound parameter.

Reporting data are associated with system elements. When a reporting data is a component of a higher level reporting data, the association with the system element is inherited from its parent.

6.6.2   General

For each reporting data, the data specified in Table 80 shall be provided.

Table 80   Reporting data

Name		Definition	Data Type
Name of System Element		The system element to which the reporting data relates Example 1: Plenum of RCS1 Example 2: Flight dynamics system	System Element Reference
Name		The relative name of the reporting data in the context of the system element Example 1: Pressure Example 2a: Attitude manoeuvre data Example 2b: Slew axis of attitude manoeuvre data	Name
Description		The description of the purpose of the reporting data	Character String
Type		The type of the reporting data. The set of values is {"**parameter**", "**compound parameter**"}. Example 1: Pressure is of type Parameter Example 2a: Attitude manoeuvre data is of type Compound Parameter Example 2b: Slew axis of attitude manoeuvre data is of type Parameter	Enumerated
List of	Domain Applicability	Where the reporting data depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated

Table 80   Reporting data (cont.)

Name			Definition	Data Type
List of Domain Specific Validity Conditions	List of	Domain Applicability	Where the validity condition depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		Validity Condition	The expression whose result determines whether interpretation of the reporting data is meaningful in the given domain	EXPL (yielding a Boolean result)
List of References	Name of Product		The name of a sub-product that has been integrated in the current product (see subclause 6.3.2)	Product Reference
	Name of System Element		The name of the system element within the sub-product to which the reporting data relates	System Element Reference
	Name of Reporting Data		The name of the reporting data within the sub-product	Reporting Data Reference
List of	Redundant Reporting Data		A reporting data that conveys the same information as (i.e. is redundant with) the reporting data. Example: Boom release sensor2 which provides the same information on the deployment status of the boom as Boom release sensor1	Reporting Data Reference

6.6.3   Parameters

6.6.3.1

For reporting data of type "**parameter**", the additional data specified in Table 81 shall be provided.

Table 81   Parameter data

Name	Definition	Data Type
Data Type	The data type of the engineering value of the parameter	Simple Data Type

6.6.3.2

For parameters whose references are transported within packets, the additional data specified in Table 82 shall be provided.

Table 82   Packet parameter data

Name	Definition	Data Type
Parameter Number	The reference of the parameter i.e. the "Parameter#" as defined in ECSS-E-70-41A. NOTE: The value "0" is not used since it is assigned a special meaning in ECSS-E-70-41A. Parameter numbers are assigned on a system-wide basis (i.e. at the level of system element of type system).	PTC 2

6.6.3.3

6.6.3.3.1

Within a telemetry packet, the value of a parameter is transported using its raw representation.

When the transported value can be directly taken as the engineering value, the additional data specified in Table 83 shall be provided.

Table 83   Encoding format data

Name	Definition	Data Type
PFC of Raw Value	The encoding format of the raw value within the telemetry	PFC **of** Data Type **of current parameter**

6.6.3.3.2

a.   When an interpretation function is used to translate the raw value into an engineering value, the additional data specified in Table 84 shall be provided.

Table 84   Interpretation data

Name			Definition	Data Type
PTC of Raw Value			The parameter type code of the parameter raw value within service reports	PTC
PFC of Raw Value			The parameter format code of the parameter raw value within service reports	PFC **of** PTC **of** Raw Value
List of Domain Specific Interpretation Functions	List of	Domain Applicability	Where the interpretation function depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Interpretation Functions	Selection Condition	An expression whose result determines whether the corresponding interpretation function is applied. Different interpretation functions can be applied (e.g. depending on the configuration of the associated unit). In the case that more than one selection condition is "TRUE", the first one in the list is applied.	EXPL (yielding a Boolean result)

Table 84   Interpretation data (cont.)

Name			Definition	Data Type
		Type	The type of the interpretation function. The set of values is {"**linear interpolation**", "**IFL**"}. For a linear interpolation, the engineering value is calculated by linear interpolation between calibration points encompassing the raw value of the parameter. For an IFL script, the engineering value is calculated using an expression compliant with the Interpretation Function Language defined within this Standard.	Enumerated

b.   For each linear interpolation function, the data specified in Table 85 shall be provided.

Table 85   Linear interpolation data

Name		Definition	Data Type
List of Calibration Points	Raw Value	The raw value of the calibration point	**same as** Raw Value **of** Interpretation data **of current parameter**
	Engineering Value	The engineering value of the calibration point	**same as** Data Type **of current parameter**
Extrapolation		The definition of whether a value lying outside of the calibration range is extrapolated from the last 2 (or first 2) calibration points of the curve or is declared invalid. The set of values is {"**extrapolate**", "**invalid**"}.	Enumerated

c.   For interpretation using IFL, the data specified in Table 86 shall be provided.

Table 86   IFL interpretation function data

Name	Definition	Data Type
Script	The expression used to generate the engineering value of the reporting data	IFL

d.   For all interpretation functions, there shall be a unique engineering value for a given raw value.

6.6.4 Compound parameters

6.6.4.1

For reporting data of type "**compound parameter**", the additional data specified in Table 87 shall be provided.

Table 87   Compound parameter data

Name	Definition	Data Type
Type	The type of compound parameter. The set of values is {"**record**", "**array**", "**deduced structure**"}.	Enumerated

6.6.4.2

For compound parameters of type "**record**", the additional data specified in Table 88 shall be provided.

Table 88   Record data

Name			Definition	Data Type
Ordered list of Components	Reporting Data		The reporting data that comprises the component	Reporting Data Reference
	To be provided if the compound parameter is contained within a telemetry packet			
		Time Offset	The time offset from the sampling time of the parent compound parameter at which the component is sampled on-board.	Relative Time

6.6.4.3

For compound parameters of type "**array**", the additional data specified in Table 89 shall be provided.

Table 89   Array data

Name		Definition	Data Type
Type		The type of array. The set of values is {"**fixed**", "**variable**"}.	Enumerated
Minimum Number of Repetitions		The minimum number of repetition of the array component	Unsigned Integer
Maximum Number of Repetitions		The maximum number of repetition of the array component	Unsigned Integer
Ordered list of	Reporting Data	The reporting data that comprises the component	Reporting Data Reference
	To be provided if the compound parameter is contained within a telemetry packet		
	Time Offset	The time offset from the sampling time of the parent compound parameter at which the first element of the array is sampled on-board	Relative Time
	Delta Time	The time interval between the on-board sampling time of successive elements of the array	Relative Time
	PFC of Repetition Number	In the case of a variable array, the encoding format code of the variable array repetition number (which appears at the front of a variable array and defines the number of repetitions within the array)	PFC **of** PTC 3

6.6.4.4

For compound parameters of type "**deduced structure**" (see ECSS-E-70-41A), the additional data specified in Table 90 shall be provided.

Table 90   Deduced structure data

Name				Definition	Data Type
List of Conditional Structures	Determining Condition			An expression whose result determines the presence of the corresponding list of reporting data. In case more than one condition is true, more than one deduced structure is considered to exist.	EXPL (yielding a Boolean result)
	Ordered list of Components	Reporting Data		The reporting data that comprises the component	Reporting Data Reference
		To be provided if the compound parameter is contained within a telemetry packet			
		Time Offset		The time offset from the sampling time of the parent compound parameter at which the component of the deduced structure is sampled on-board	Relative Time

NOTE   For each distinct possible structure that the deduced structure can assume, this table defines the condition which must be true (i.e. the expression whose Boolean result must be true) together with the corresponding reporting data definition.

6.6.5   Synthetic reporting data

For reporting data that is synthesized within the EMCS, the additional data specified in Table 91 shall be provided.

Table 91   Synthetic reporting data

Name	Definition	Data Type
Script	The script used to generate the engineering value of the reporting data. When the reporting data is a compound parameter, the script can assign a value to one or more of its components.	SPEL

6.6.6   Checking data

6.6.6.1

For reporting data that is limit-checked, the additional data specified in Table 92 shall be provided.

Table 92   Limit check data

Name			Definition	Data Type
List of Domain Specific Limit Sets	List of	Domain Applicability	Where the limit set depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Limit Checks	Validity Condition	An expression whose result determines the applicability of the corresponding limit set. Different limit sets can be applied depending on the prevailing conditions, such as the mission phase or the status (operational or standby) of the associated unit. In the case that more than one validity condition is "TRUE", the first one in the list is applied.	EXPL (yielding a Boolean result)
		Upper Danger Limit	The engineering value corresponding to the upper danger limit	**same as** Data Type **of current parameter**
		UDL Activity	The corrective action to be taken if the reporting data exceeds the upper danger limit. This corrective action does not depend on the previous checking state e.g. whether the parameter was "within limits" or outside "upper warning limit" on its previous check.	Activity Call
		Lower Danger Limit	The engineering value corresponding to the lower danger limit	**same as** Data Type **of current parameter**
		LDL Activity	The corrective action to be taken if the reporting data exceeds the lower danger limit	Activity Call
		Upper Warning Limit	The engineering value corresponding to the upper warning limit	**same as** Data Type **of current parameter**
		UWL Activity	The corrective action to be taken if the reporting data exceeds the upper warning limit	Activity Call
		Lower	The engineering value corresponding to the	**same as** Data

Table 92   Limit check data (cont.)

Name			Definition	Data Type
		Warning Limit	lower warning limit	Type **of current parameter**
		LWL Activity	The corrective action to be taken if the reporting data exceeds the lower warning limit	Activity Call

6.6.6.2

For reporting data that is delta-checked, the additional data specified in Table 93 shall be provided.

Table 93   Delta check data

Name			Definition	Data Type
List of Domain Specific Maximum Delta Checks	List of	Domain Applicability	Where the maximum delta check depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Maximum Delta Checks	Validity Condition	An expression whose result determines the applicability of the corresponding maximum delta check. In the case that more than one validity condition is "TRUE", the first one in the list is applied.	EXPL (yielding a Boolean result)
		Threshold	The differential between successive values of a reporting data which results in a check failure if exceeded. Different delta thresholds can be applied depending on the prevailing conditions.	**same as** Data Type **of current parameter**
		Activity	The corrective action to be taken if the reporting data exceeds its delta threshold	Activity Call
List of Domain Specific Minimum Delta Checks	List of	Domain Applicability	Where the minimum delta check depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Minimum Delta Checks	Validity Condition	An expression whose result determines the applicability of the corresponding minimum delta check. In the case that more than one validity condition is "TRUE", the first one in the list is applied.	EXPL (yielding a Boolean result)
		Threshold	The differential between successive values of a reporting data, which results in a check failure if not exceeded. Different delta thresholds can be applied depending on the prevailing conditions.	**same as** Data Type **of current parameter**
		Activity	The corrective action to be taken if the reporting data does not exceeds its delta threshold	Activity Call

6.6.6.3

For reporting data that is expected state checked, the additional data specified in Table 94 shall be provided.

Table 94   Expected state check data

Name				Definition	Data Type
List of Domain Specific Expected State Checks	List of	Domain Applicability		Where the expected state check depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Expected State Checks	Validity Condition		An expression whose result determines the applicability of the corresponding expected state check. In the case that more than one validity condition is "TRUE", the first one in the list is applied.	EXPL (yielding a Boolean result)
		List of	Value	An expected value of the reporting data. Different (lists of) expected values can exist depending on the prevailing conditions	**same as** Data Type **of current parameter**
		Activity		The corrective action to be taken if the reporting data violates its expected state check	Activity Call

6.6.6.4

For reporting data that is status consistency checked, the data specified in Table 95 shall be provided.

Table 95   Status consistency checking data

Name				Definition	Data Type
List of Domain Specific Status Consistency Checks	List of	Domain Applicability		Where the status consistency check depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Either	List of Values	Activity	An activity of type telecommand which conditions the status consistency check.	Activity Reference
			Argument	The activity argument against whose last uplinked value the reporting data value is checked to be equal. An alarm is raised if the values are not equal. The check is suspended during the execution window of the corresponding command. Example 1: Activity: Set Filter Wheel Position Argument: Position = UV Example 2: Activity: Switch LCL1 ON Reporting Data: LCL1 Status	Argument Reference **of current Activity**
	Exclusive OR	Expression		The expression that returns the value against which the reporting data value is checked to be equal. This value can be determined as the result of an autonomous on-board action (which is reported in the telemetry) or some other mission event. Example 1: Filter Wheel Position commanded autonomously on-board Example 2: Entry into eclipse	EXPL
	Activity			The corrective action to be taken if the reporting data violates its status consistency check	Activity Call

6.7 Activities

6.7.1 General

6.7.1.1

Activities are associated with system elements.

Activities can have arguments which can either be simple or compound in nature e.g. a commanded filter wheel position of type enumerated is a simple argument, a command to power up an instrument can comprise an array of CPDU command arguments, each argument comprising the output line number and the pulse duration.

6.7.1.2

For each activity, the data specified in Table 96 shall be provided.

Table 96 Activity definition data

Name		Definition	Data Type
Name of System Element		The system element to which the activity relates. Example: Housekeeping Application Process of AOCS	System Element Reference
Name		The relative name of the activity in the context of the system element. Example: Define New Housekeeping Parameter Report	Name
Description		The description that unambiguously describes the function of the activity	Character String
Type		The definition of the type of the activity. The set of values includes {"**ground procedure**", "**onboard procedure**", "**telecommand**", "**operating system command**"}	Enumerated
List of	Domain Applicability	Where the activity depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
List of References	Name of Product	The name of a sub-product that has been integrated in the current product (see subclause 6.3.2)	Product Reference
	Name of System Element	The name of the system element within the sub-product to which the reporting data relates	System Element Reference
	Name of Activity	The name of the activity within the sub-product	Activity Reference
List of	Redundant Activity	An activity that has the same effect as the activity	Activity Reference
List of	Reverse Activity	An activity that has the reverse effect of the activity	Activity Reference
Criticality		The criticality level of the activity (in accordance with ECSS-E-70-11). The set of values is {"**non critical**", "**locally critical**", "**mission critical**"}.	Enumerated

Table 96 Activity definition data (cont.)

Name		Definition	Data Type
Ordered List of Arguments[a]	Name	The relative name of an argument used in the context of the activity. Examples: 1. Structure ID (simple value). 2. Collection Interval (simple value). 3. Simply commutated Parameter Number (array). 4. Supercommutation instruction (array). 5. Repetition number of supercommutation instruction (simple value).	Name
	Description	The description that unambiguously describes the component	Character String
	Type	The type of the argument. The set of values is {any Simple Data Type, "**record**", "**activity call**"}.	Enumerated
	Arity	The arity of the argument. The set of values is {"**array**","**single value**"}.	Enumerated
	Default Value	The default value of the argument	VAL
	Fixed Value	The fixed value of the argument	VAL
[a]This is a flat list of arguments e.g. elements of a record are defined together with their parent.			

6.7.1.3

For each argument component of type "**activity call**", value type data type or value type set, the additional data specified in Table 97 shall be provided.

Table 97 Activity call and property component data

Name		Definition	Data Type
List of	Name of System Element	A system element to which the activity call relates or whose property can be used	System Element Reference

6.7.1.4

For each argument component of arity "**array**", the additional data specified in Table 98 shall be provided.

Table 98 Array component data

Name	Definition	Data Type
Name	The name of the array	Name
Minimum Number of Repetitions	The minimum number of repetitions of component in the array	Unsigned Integer
Maximum Number of Repetitions	The maximum number of repetitions of component in the array	Unsigned Integer

6.7.2 Activity argument value set

For each activity, the additional data specified in Table 99 shall be provided.

Table 99 Argument value set data

Name		Definition	Data Type
List of Argument Value Sets	Name	The unique name of a predefined set of argument values for the activity	Name
	Description	The description of the purpose and use of the argument set	Character String
	Value Set	The set of argument values	VAL

6.7.3 Activity execution data

6.7.3.1

The different execution states through which an activity can pass and the events that correspond to transitions between states (and sub-states) are shown in Table 100, together with the applicability to the different types of activity (✓ = applicable, n/a = not applicable).

Table 100 Activity execution states and associated events

State	Events	Procedure	Telecommand	
1. Not initiated	n/a	✓	✓	
2. Preconditions	Activity initiated	✓	✓	
	Preconditions evaluated	✓	✓ Pre-Transmission Validation (PTV)[a]	
3. Routing		n/a	Space segment	Ground segment
	Release from EGSE or MCS		✓	✓
	Reception by the ground station (or TC front-end)[b]		✓	n/a
	Start of uplink from the ground station[b]		✓	✓
	Reception on-board		✓[c] TC sent in AD mode	n/a
	Acceptance by the destination application process		✓ PUS Service 1 subtypes 1 and 2	✓ PUS Service 1 subtypes 1 and 2
4. Executing	Start	✓ Start Watchdog Body Start Main Body	✓ PUS Service 1 subtypes 3 and 4	
	See Table 103 for execution states and associated events for steps within an activity			
	Terminate	✓	n/a	

Table 100 Activity execution states and associated events

State	Events	Procedure	Telecommand
5. Confirmation	Confirmation completed	✓ Confirmation Body	✓ PUS Service 1 subtypes 7 and 8
	End-to-end verification in the telemetry	n/a	✓ Command Execution Verification (CEV)
6. Completed	n/a	✓	✓
a	The PTV applies only to the telecommand itself and not to any commands that it "contains" e.g. in the case of a schedule load command it applies to the load command and not to the commands that are being loaded.		
b	Whether or not these events can be reported depends on the configuration and capabilities of the ground system deployed. If the capability exists, reporting is done globally for all activities i.e. it is not activity-dependent.		
c	The capability for reporting this event is dependent on the on-board design (e.g. the CDMU).		

6.7.3.2

For each activity, the additional data specified in Table 101 shall be provided.

Table 101 Activity execution profile data

Name		Definition	Data Type
Expected Duration		The nominal duration for the execution of the activity	Relative Time
Minimum Duration		The minimum duration for the execution of the activity	Relative Time
Maximum Duration		The maximum duration for the execution of the activity	Relative Time
Earliest Start Time		The earliest time after initiation than the activity can start execution	Relative Time
Latest Start Time		The latest time after initiation than the activity can start execution	Relative Time
List of Resources	Name	A resource utilised during the execution of the activity. Resources are mission-specific in nature.	Name
	Quantity	The quantity of the resource used	Simple Data Type

6.7.3.3

An activity can be comprised of steps and each step can itself be further decomposed into lower-level steps.

For each step, the data specified in Table 102 shall be provided.

Table 102 Step definition data

Name	Definition	Data Type
Name	The name of the step that is unique within the current activity (or step of an activity)	Name
Description	The description of the step	Character String

6.7.3.4

The different execution states through which a step can pass and the events that correspond to transitions between states (and sub-states) are shown in Table 103, together with the applicability to the different types of activity.

Table 103 Step execution states and associated events

State	Events	Step within a procedure	Step within a telecommand
1. Not initiated	n/a	✓	n/a
2. Preconditions	Step initiated	✓	n/a
	Preconditions evaluated	✓	n/a
3. Executing	Start	✓ Start Watchdog Body Start Main Body	n/a
	Iterate for execution states and associated events for Steps within Steps		n/a
	Terminate	✓	n/a
4. Confirmation	Confirmation completed	✓ Confirmation Body	✓ PUS Service 1 subtypes 5 and 6
5. Completed	n/a	✓	✓

6.7.3.5

For each step, the additional data specified in Table 104 shall be provided.

Table 104 Step execution profile data

Name		Definition	Data Type
Minimum Duration		The minimum duration for the execution of the step	Relative Time
Maximum Duration		The maximum duration for the execution of the step	Relative Time
Earliest Start Time		The earliest time after initiation than the given step can start execution	Relative Time
Latest Start Time		The latest time after initiation than the given step can start execution	Relative Time
List of Resources	Name	A resource utilised during the execution of the step. Resources are mission-specific in nature.	Name
	Quantity	The quantity of the resource used	Simple Data Type

6.7.3.6

For each activity, the additional data specified in Table 105 shall be provided.

Table 105 Activity execution completion failure data

Name			Definition	Data Type
List of Domain Specific Failure Activities	List of	Domain Applicability	Where the failure activity depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		Failure Activity	The activity to be initiated if completion of execution of the activity is unsuccessful	Activity Call

6.7.4 Telecommands

6.7.4.1

For each activity of type "**telecommand**", the additional data specified in Table 106 shall be provided.

Table 106 Telecommand data

Name		Definition	Data Type
Service Type		The type of the PUS service to which the telecommand relates	Service Type
Service Subtype		The subtype of the PUS service to which the telecommand relates	Service Subtype
Default Application Process		The default application process via which the telecommand is sent	System Element Reference **of** Type "**application process**"
Priority		The definition of whether the telecommand can be sent as a high priority command on-board (for example a CPDU command can be sent as a high priority command). If it is to be sent as high priority, then the MAP (Multiplexed Access Point) ID for uplinking the command is forced to the value specified below.	Boolean
To be provided if Priority = TRUE			
	MAP	The MAP to be used for uplinking the telecommand as a high priority command	System Element Reference **of** Type "**MAP**"

6.7.4.2

For telecommand arguments of arity "**array**" (refer to Table 96), the additional data specified in Table 107 shall be provided:

Table 107 Telecommand array argument data

Name	Definition	Data Type
PFC of Repetition Number	The encoded format of the repetition number of the related array	PFC **of** PTC 3

6.7.4.3

For telecommand arguments that do not use an encoding function, the additional data specified in Table 108 shall be provided.

Table 108 Telecommand non interpreted argument data

Name	Definition	Data Type
PFC of Encoded Format	The encoded format of the argument within the command	PFC **of** Type **of current argument**

6.7.4.4

For telecommand arguments of type integer, unsigned integer or real that are encoded using a de-interpretation function, the additional data specified in Table 109 shall be provided.

Table 109 Telecommand interpreted argument data

Name			Definition	Data Type
PTC of Encoded Format			The parameter type code of the argument within the telecommand	PTC
PFC of Encoded Format			The parameter format code of the argument within the telecommand	PFC **of** PTC **of** Encoded Format
List of Domain Specific Deinterpretation Functions	List of	Domain Applicability	Where the de-interpretation function depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
	Ordered list of Deinterpretation Functions	Selection Condition	An expression whose result determines whether the corresponding de-interpretation function is applied	EXPL (yielding a Boolean result)
		Type	The type of the de-interpretation function. The set of values is {"**linear interpolation**", "**IFL**"}. For a linear interpolation, the raw (uplink) value is calculated by linear interpolation between the two calibration points encompassing the engineering value of the command parameter. If the engineering value of the command parameter lies outside the range of engineering values specified, it is declared invalid. For an IFL script, the raw value is calculated using an expression compliant with the Interpretation Function Language defined within this Standard.	Enumerated

6.7.4.5

For telecommand arguments of type system element property or reporting data property, the additional data specified in Table 110 shall be provided.

Table 110 Telecommand property argument data

Name	Definition	Data Type
PFC of Encoded Format	The encoded format of the argument within the command	PFC of Type **of current argument**

Example   APID is a system element property (ID of System Element of Type Application Process).

6.7.4.6

For each linear interpolation de-interpretation function, the data specified in Table 111 shall be provided.

Table 111 Linear interpolation deinterpretation function data

Name		Definition	Data Type
List of Calibration Points	Engineering Value	The engineering value of the calibration point	**same as** Type **of current argument** (see Table 96)
	Raw Value	The raw value of the calibration point	**same as** Encoded Format **of current argument**

6.7.4.7

For each IFL expression de-interpretation function, the data specified in Table 112 shall be provided.

Table 112 IFL deinterpretation function data

Name	Definition	Data Type
Script	The expression that returns the uplink value of the argument	IFL

6.7.4.8

For all de-interpretation functions, there shall be a unique raw value for a given engineering value.

6.7.4.9

For each activity of type "**telecommand**" (see subclause 6.5.5.2 for the related PUS telecommand verification service), the additional data specified in Table 113 shall be provided.

Table 113 Telecommand execution check data

Name			Definition	Data Type
List of Domain Specific PTV Conditions	List of	Domain Applicability	Where the PTV condition depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		PTV Condition	The expression whose result determines whether the initiation of the telecommand is allowed	EXPL (yielding a Boolean result)
Start Verification Capability			The definition of whether the start of execution of the telecommand can be verified using PUS service 1 (see subclause 6.5.5.2).	Boolean
Start Verification Condition[a]			The expression whose result determines whether the start of execution of the telecommand is confirmed	EXPL (yielding a Boolean result)
List of Domain Specific Start Failure Activities	List of	Domain Applicability	Where the start failure activity depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		Start Failure Activity	The activity to be initiated if start of execution of the telecommand is unsuccessful	Activity Call
Progress Verification Capability			The definition of whether the progress of execution of the telecommand can be verified using PUS service 1	Boolean
Completion Verification Capability			The definition of whether the completion of execution of the telecommand can be verified using PUS service 1	Boolean
List of Domain Specific CEV Conditions	List of	Domain Applicability	Where the CEV condition depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		CEV Condition[b]	The expression whose result determines whether the execution of the telecommand is completed	EXPL (yielding a Boolean result)

Table 113 Telecommand execution check data (cont.)

Name			Definition	Data Type
List of Command Failures	Name		The name of a specific command verification failure	Name
	Code		The corresponding failure code value. NOTE: Values reserved by ECSS-E-70-41A or specified at overall service level (see subclause 6.5.5.2.3) cannot be used.	PTC 2
	Description		The description of the command failure	Character String
	Ordered list of	Component	A component of the parameters field associated with the code value	Reporting Data Reference
[a]	This expresses the condition for verifying this stage on the ground using low-level telemetry (where possible), even if PUS service 1 can be used to verify this stage.			
[b]	The CEV for a telecommand can range from checking the value of a single measurement parameter to checking the value of each transmitted telecommand parameter against the value of a corresponding measurement parameter (otherwise called "echo" parameters) to checking a memory dump image against a load image.			

6.7.4.10

For each step of each activity of type "**telecommand**", the additional data specified in Table 114 shall be provided.

Table 114 Telecommand step execution check data

Name				Definition	Data Type
List of Steps	Number			The step number for each distinct step within the telecommand execution	PTC 2
	Verification Condition[a]			The expression whose result determines whether the step is confirmed	EXPL (yielding a Boolean result)
	List of Domain Specific Step Failure Activity	List of	Domain Applicability	Where the step failure activity depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
		Step Failure Activity		The activity to be initiated if execution of the step is unsuccessful	Activity Call
[a]	This expresses the condition for verifying this step on the ground using low-level telemetry (where possible), even if PUS service 1 can be used to verify this step.				

6.7.5 Procedures

6.7.5.1

For activities of type procedure, the additional data specified in Table 115 shall be provided.

Table 115 Procedure data

Name	Definition	Data Type
Initiation Mode	The definition of whether the procedure is explicitly initiated or whether it runs permanently in the background. The set of values is {"**background**", "**foreground**"}.	Enumerated
Earliest Validity Date	The earliest date from which the procedure can be executed	Absolute Time
Latest Validity Date	The latest date on which the procedure can be executed	Absolute Time

6.7.5.2

For activities of type "**ground procedure**", the additional data specified in Table 116 shall be provided.

Table 116 Ground procedure data

Name	Definition	Data Type
Script	The textual representation of the procedure written according to ECSS-E-70-32A	PLUTO
Execution Mode	The default execution mode of the procedure. The set of values is {"**automatic**", "**manual**"}.	Enumerated

6.7.5.3

For activities of type "**onboard procedure**", the additional data specified in Table 117 shall be provided.

Table 117 Onboard procedure data

Name	Definition	Data Type
Script	The textual representation of the procedure written according to ECSS-E-70-01	ECSS-E-70-01 compliant
Preloaded Onboard	The definition of whether the procedure is preloaded onboard	Boolean
Priority	The priority of the procedure (used by the onboard procedure execution system in the event of scheduling conflicts). The set of values is {"**high**", "**medium**", "**low**"}.	Enumerated

6.8   Events

For each event, the data specified in Table 118 shall be provided.

Table 118 Event data

Name			Definition	Data Type
Name of System Element			The system element to which the event relates	System Element Reference
Name			The relative name of the event in the context of the system element	Name
Description			The description that unambiguously describes the nature of the event	Character String
Type			The type of the event. Possible types include {"**anomaly report**", "**progress report**", "**information**", "**software error**", "**scheduling event**"}.	Enumerated
List of	Domain Applicability		Where the event depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", "**Software**"}.	Enumerated
List of References	Name of Product		The name of a sub-product that has been integrated in the current product (see subclause 6.3.2)	Product Reference
	Name of System Element		The name of the system element within the sub-product to which the event relates	System Element Reference
	Name of Event		The name of the event within the sub-product	Event Reference
Severity			The severity of the event. Possible types include {"**normal**", "**low**", "**medium**", "**high**"}. See also ECSS-E-70-41A, clause 10: Event reporting service.	Enumerated
Ordered list of Reporting Data Components	Reporting Data		A reporting data accompanying this event	Reporting Data Reference
	Time Offset		The time offset of the sampling time of the reporting data from the event time (e.g. the event report packet time)	Relative Time
List of Domain Specific Activities	List of	Domain Applicability	Where the activity depends on the configuration, a flag indicating the domain in which it may be used. The set of values includes {"**AIV**", "**Operations**", ."**Software**"}	Enumerated
	Activity		The action to be taken when the event occurs	Activity Call

Annex A (informative)

PUS service tailoring

A.1   Introduction

For a given mission, each on-board application process (see subclause 6.5.3.2) can host a subset of the standard services defined in ECSS-E-70-41A (PUS). Furthermore, different application processes can implement these PUS services at different levels of complexity. The process of selecting services and their implementation levels for each application process is part of the tailoring process defined in ECSS-M-00-03 and this is done to reflect the responsibilities assigned to a given application process and the specific needs of an individual mission.

The choices for the implementation level for each standard service are identified within ECSS-E-70-41A itself. These choices are organized such that a coherent sub-set of the full service capabilities (as defined in the PUS "service model") is provided. In addition to the standard PUS services, each mission can implement its own mission-specific extensions to a standard service, or indeed can implement complete mission-specific services. The "rules" for how this can be done are also covered by ECSS-E-70-41A.

This Annex contains the following tailoring information for each of the PUS standard services:

- A brief summary is provided of the PUS service model. This summary is not intended to be formal or complete (for this purpose, the reader is referred to the PUS itself), but rather to recall the main purpose of each service and to highlight the relevant data items that are the subject of standardization in the present document.

- The tailoring choices for the service are presented in the form of a flowchart. Each consecutive tailoring choice is represented as a question to which the answer is a simple "Yes" or "No". For each such question, there is a corresponding tailoring variable (Boolean) that is identified in the flowchart in a rectangular box following the "Yes" path. Note that the value "FALSE" for the variable is not shown in the flowchart, however it is implicit if the "No" path is taken. This simplification is taken to minimize cluttering of the flowcharts, which can become quite complex for some services. The tailoring variables are also summarised in subclause 6.5.5.

- The service-specific telemetry and telecommand packet structures are shown (see also Figure 4). Where relevant, the semantics of the contained

parameters are shown in the top row of the diagram. The next row identifies the packet data fields preserving the naming convention used in the PUS. The next row shows the data type for each field (these are also summarised in subclause 6.5.3.2). The data type may be shared by several packet fields and can even be standardized for several services or across the complete mission. Such standardization choices are made on a mission-specific basis. The bottom row identifies the condition that determines the presence of the corresponding packet field where this is dependent on a tailoring choice (in which case the value of the corresponding tailoring variable is shown) or where the field is identified in the PUS as optional for some other reason.
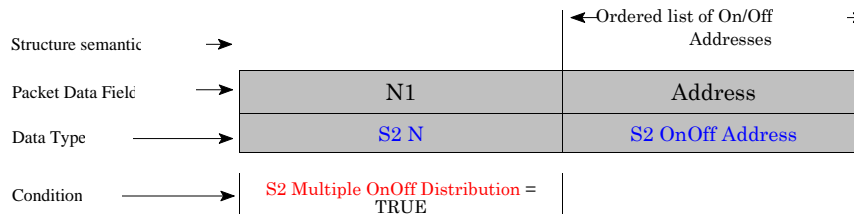

Figure 4 Diagram convention for PUS packet structures

NOTE Where the existence of a given packet is dependent on a tailoring choice, the associated tailoring condition is shown in the title of the corresponding subclause

A.2   Telecommand verification service

A.2.1   The PUS service model

This service provides the capability to perform explicit verification of telecommands at the following stages of execution on-board:

- acceptance of the telecommand by the destination application process;

- start of execution;

- progress of execution (at each progress step defined for the telecommand);

- completion of execution.

If verification at the corresponding stage is supported, then the service can generate a success or failure report (this is determined on a command-specific basis), the latter containing additional information enabling the ground to fully analyse the nature and cause of the failure.

The generic activity execution check data is defined in subclause 6.7.3. With reference to Table 100, whether telecommand verification is actually performed at stages 4 to 6 depends on:

- whether the corresponding verification capability is implemented for this application process (see Annex A.2.2), and

- whether the corresponding verification capability is implemented for the given command (this is specified on a per command basis, see subclause 6.7.4.1), and

- whether the corresponding verification stage has been requested for the given command, by setting the appropriate bits of the "Ack" field in the telecommand packet header (see ECSS-E-70-41A subclause 6.4.2).

The service reports of telecommand verification failure contain a failure code and (optionally) an associated parameter field that provides supplementary information pertaining to the given failure. Failure code values can be defined:

- on a service-wide basis i.e. for all commands and all verification stages (see subclause 6.5.5.2.3), or

- on a service-wide basis i.e. for all commands, but per verification stage (see subclause 6.5.5.2.3), or

- on a per command basis (in which case the code is specified in subclause 6.7.4.9).

A.2.2 Service tailoring data

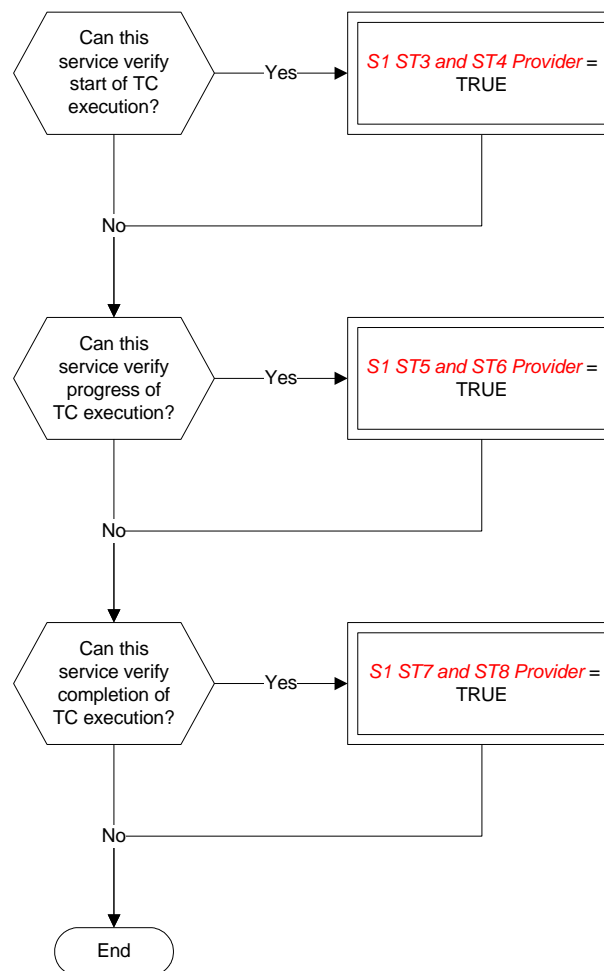The tailoring choices for the telecommand verification service are shown in Figure 5.

Figure 5 Tailoring choices for the telecommand verification service

A.2.3   Service requests and reports

A.2.3.1   Telecommand acceptance

The report of telecommand acceptance success (Type = 1, Subtype = 1) is:

Telecommand Packet ID	Packet Sequence Control
2 octets	2 octets

The report of telecommand acceptance failure (Type = 1, Subtype = 2) is:

			← Record of parameters (code-specific) →
Telecommand Packet ID	Packet Sequence Control	Code	Parameters
2 octets	2 octets	S1 Code	Any
			← Optional (presence or not is code-dependent) →

A.2.3.2   Telecommand execution started (S1 ST3 and ST4 Provider = TRUE)

The report of telecommand execution started success (Type = 1, Subtype = 3) is the same as for Subtype 1.

The report of telecommand execution started failure (Type = 1, Subtype = 4) is:

			← Record of parameters (code-specific) →
Telecommand Packet ID	Packet Sequence Control	Code	Parameters
2 octets	2 octets	S1 Code	Any
			← Optional (presence or not is APID or command-dependent) →

A.2.3.3   Telecommand execution progress (S1 ST5 and ST6 Provider = TRUE)

The report of telecommand execution progress success (Type = 1, Subtype = 5) is:

Telecommand Packet ID	Packet Sequence Control	Step Number
2 octets	2 octets	S1 Step Number

The report of telecommand execution progress failure (Type = 1, Subtype = 6) is:

				← Record of parameters (code-specific) →
Telecommand Packet ID	Packet Sequence Control	Step Number	Code	Parameters
2 octets	2 octets	S1 Step Number	S1 Code	Any
				← Optional (presence or not is APID or command-dependent) →

A.2.3.4 Telecommand execution complete (S1 ST7 and ST8 Provider = TRUE)

The report of telecommand execution complete success (Type = 1, Subtype = 7) is the same as for Subtype-1.

The report of telecommand execution complete failure (Type = 1, Subtype = 8) is:

Telecommand Packet ID	Packet Sequence Control	Code	Parameters
2 octets	2 octets	S1 Code	Any

Record of parameters (code-specific)

Optional (presence or not is APID or command-dependent)

A.3 Device command distribution service

A.3.1 The PUS service model

This service provides for the distribution of commands from ground to on-board devices. There are two types of device command distribution:

- the distribution of vital spacecraft commands using a command pulse distribution unit (CPDU);

- the distribution of On/Off and register load commands by an application process.

A CPDU is a command distribution unit within the decoder that is used to issue high priority commands directly to vital relays i.e. using a point-to-point connection with the minimum of on-board software intervention. Each CPDU can have up to 256 such output lines and is accessed via a dedicated application process. Most spacecraft include one or more CPDUs. A CPDU telecommand packet has a Packet Error Control field and is transported inside a single telecommand segment. The CPDU command specifies the output line and the duration of the pulse to be issued in units of <CPDU_DURATION_UNIT>. For a given implementation, there is a limit on the number of CPDU commands that can be conveyed in a single telecommand packet (at least 12 and at most 120), identified by the mission constant <CPDU_MAX_INSTR>.

An On/Off command consists of the on-board address of the corresponding On/Off device.

A Register Load command consists of the on-board address of the corresponding register plus the data to be loaded in the register.

Device commands can be grouped or sequenced in such a way that they constitute a higher-level command function. In order to ensure that either the complete function is executed, or nothing at all, the capability can be provided to uplink a number of device commands of the same type within a single telecommand packet. In this case, the commands are distributed in the same sequence in which the ground places them in the packet.

A.3.2   Service tailoring data

The tailoring choices for the device command distribution service are shown in Figure 6.

Does this service distribute CPDU commands? — Yes → S2 ST3 Provider = TRUE → End

No ↓

Does this service distribute On/Off commands? — Yes → S2 ST1 Provider = TRUE

Can this service distribute multiple On/Off commands? — Yes → S2 Multiple OnOff Distribution = TRUE

No →

Does this service distribute Register Load commands? — Yes → S2 ST2 Provider = TRUE

No →

Can this service distribute multiple Register Load commands? — Yes → S2 Multiple Register Load Distribution = TRUE
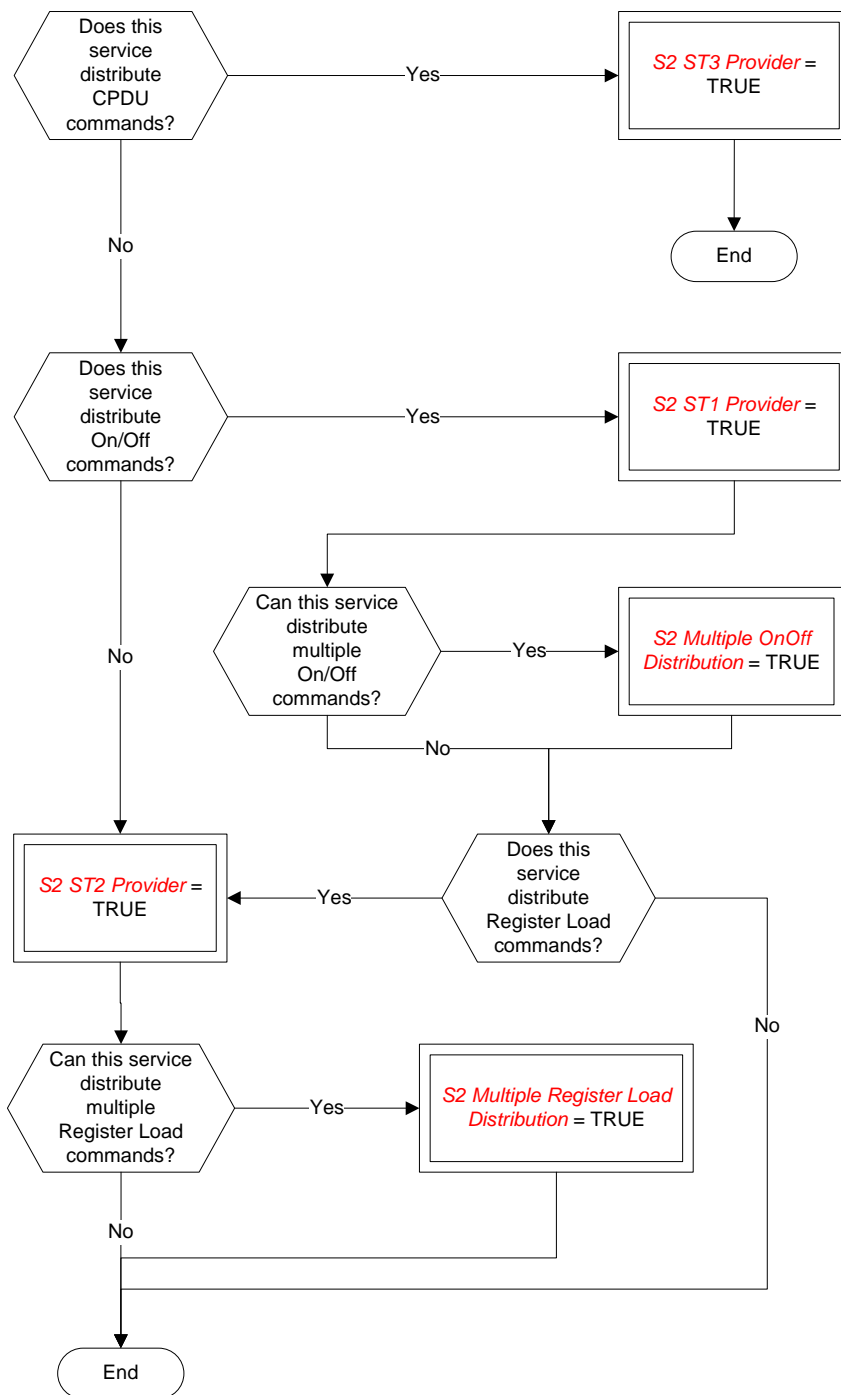
No → End

Figure 6   Tailoring choices for the device command distribution service

A.3.3   Service requests and reports

A.3.3.1   Distributing On/Off commands (S2 ST1 Provider = TRUE)

The telecommand for distribution of On/Off commands (Type = 2, Subtype = 1) is:

	Ordered list of On/Off Addresses
N	Address
S2 N	S2 OnOff Address

S2 Multiple OnOff Distribution = TRUE

A.3.3.2   Distributing register load commands (S2 ST2 Provider = TRUE)

The telecommand for distribution of register load commands (Type = 2, Subtype = 2) is:

	Ordered list of Register Load Instructions	
	Register Load Instruction	
N	Register Address	Register Data
S2 N	S2 Register Load Address	Record

S2 Multiple Register Load Distribution = TRUE

A.3.3.3   Distributing CPDU commands (S2 ST3 Provider = TRUE)

The telecommand for distribution of CPDU commands (Type = 2, Subtype = 3) is:

Ordered list of CPDU Command Instructions (Note: the number of instructions is derived from the overall TC packet length)	
Output Line ID	Duration
PTC 2 PFC 8	PTC 3 PFC 4

A.4   Housekeeping and diagnostic data reporting service

A.4.1   The PUS service model

This service provides for the reporting of low-level engineering data to the ground for the purposes of health monitoring, end-to-end telecommand verification and troubleshooting of on-board anomalies. To this end, two independent but functionally identical sub-services are provided, namely:

- housekeeping data reporting;

- diagnostic data reporting i.e. the reporting of engineering data for anomaly investigation purposes.

These are implemented as different sub-services in the sense that different subtypes are used for telemetry and telecommand packets, to facilitate differential routing and processing on the ground.

The service revolves around the concept of a Reporting Definition, which is a definition of a set of parameter samples that constitute a parameter report i.e. a housekeeping or diagnostic data packet. For housekeeping packets, there is a pre-defined set of reporting definitions stored on-board the satellite. These are designed by the satellite manufacturer according to the perceived requirements for the housekeeping monitoring of the mission. A service option exists for

modifying these definitions dynamically during the course of the mission, including modifying parameter sampling rates, the addition of completely new definitions and the deletion of obsolete ones. This capability accommodates the experience with past missions that the optimum housekeeping sampling patterns evolves with time reflecting the degradation of in-orbit equipment performance and the onset of anomalies. However, these capabilities for modifying reporting definitions are fundamental to the concept of the diagnostic data reporting sub-service, since the nature of anomalies is by definition not known in advance. Diagnostic packets are expected to be used predominantly to sample small sets of parameters at high rates in order to gain a better understanding of on-board anomalies from a higher resolution of associated information. In order to be able to achieve this high-rate sampling in diagnostic mode, the on-board design permits the sampling of successive instances of a given parameter at a specified minimum sampling interval given by the mission constant `<DIAG_MIN_INTERV>`. This sampling interval constitutes a time unit for the specification of several other time parameters in the PUS e.g. the collection interval for a housekeeping or diagnostic report.

In order to relieve the loading of the telemetry bandwidth with engineering data that has not changed in value, a service option is provided to report data only when something within a packet has changed value significantly. This concept is known as filtering and the ground can specify which parameters in the packet are to be checked on-board for a change of value and can also specify a threshold for the change of value (thus eliminating "noisy" values or changes that are considered operationally insignificant). When a packet has been set to filtered mode, a timeout comes into effect, whereby a one-shot packet is generated after a specified time interval if no change in parameter value has occurred in the meantime. This measure ensures that extensive periods of time do not elapse without the occurrence of a parameter report. Another important concept for this service is that of parameter sampling time on-board. With conventional time-division multiplexed (TDM) telemetry, the on-board sampling time of a parameter was derived directly from its location in the telemetry frame or format. This timing information is of paramount importance for correlating engineering measurements with external events or for investigating in detail the nature of anomalous behaviour. With the use of packet telemetry, the operational requirements still remain for knowing the absolute and relative sampling times of telemetry parameters, either from an intrinsic knowledge of the on-board sampling sequences or by directly measuring the on-board sampling times which are then reported in the telemetry. The accuracy with which the absolute and relative on-board sampling of parameters is known is given by the mission constants `<PARAM_ABS_SAMPL_TIME>` and `<PARAM_REL_SAMPL_TIME>`, respectively.

The PUS draws a clear distinction between the functions of packet generation and packet forwarding. Packet generation is a function that is managed at service level, whilst the control of packet forwarding to the ground is handled by a dedicated service at application process level (see Annex A.13). The diagnostic sub-service implements the ability to control packet generation, since diagnostic packets are foreseen to be "switched on and off" according to need. With the housekeeping sub-service, the capability goes hand-in-hand with the capability to modify or create housekeeping reporting definitions in-orbit.

A structure identifier (SID) is associated with each distinct reporting definition and the corresponding telemetry packet. The SID is used on the ground, together with the APID and the knowledge of the nature of the packet (i.e. whether it is a housekeeping or a diagnostic packet), to identify the telemetry packet and to interpret its content. The SID is unique for the service and

packet nature (i.e. housekeeping or diagnostic), however different application processes can use the same values of SID.

A.4.2   Service tailoring data

The tailoring choices for the housekeeping and diagnostic reporting service are shown in Figure 7 (Views 1 to 5).
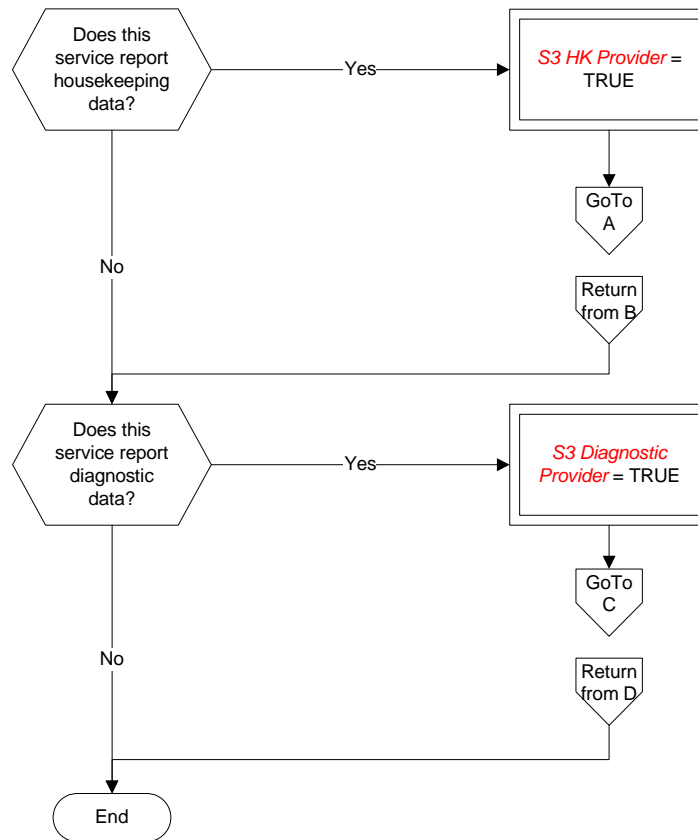
Figure 7   Tailoring choices for the housekeeping and diagnostic data reporting service (View 1)

A

Is control of
HK report
definitions
provided? —Yes→ *S3 ST1 ST3 ST5 and ST6 Provider* = TRUE

No

Is an implicit
packet
collection
interval used? —Yes→ *S3 HK Implicit Collection Interval* = TRUE

No

Can multiple
reporting
definitions be
cleared? —Yes→ *S3 HK Multiple Clear SID* = TRUE

No

Can multiple
reporting
definitions be
controlled? —Yes→ *S3 HK Multiple Control SID* = TRUE

No

Can this
service report
housekeeping
parameter
definitions? —Yes→ *S3 ST9 and ST10 Provider* = TRUE

No

Can this service
report multiple
housekeeping
parameter
definitions? —Yes→ *S3 HK Multiple Report SID* = TRUE

No

Can this
service report
HK parameter
sampling-time
offsets? —Yes→ *S3 ST13 and ST15 Provider* = TRUE
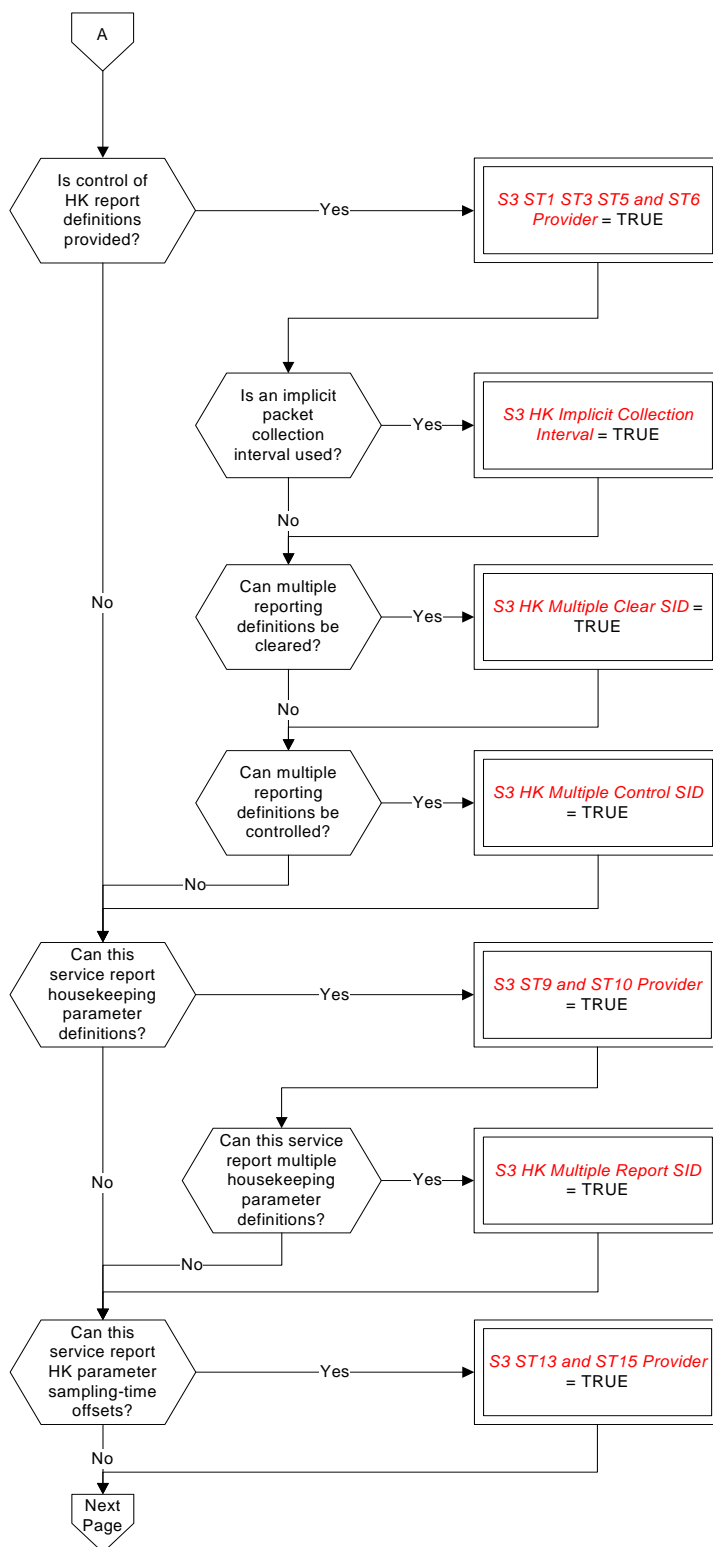
No

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Figure 7 Tailoring choices for the housekeeping and diagnostic data reporting service (View 2)

Figure 7 Tailoring choices for the housekeeping and diagnostic data reporting service (View 3)

C

Is an implicit packet collection interval used? —Yes→ *S3 Diagnostic Implicit Collection Interval* = TRUE

No

Can multiple reporting definitions be cleared? —Yes→ *S3 Diagnostic Multiple Clear SID* = TRUE

No

Can multiple reporting definitions be controlled? —Yes→ *S3 Diagnostic Multiple Control SID* = TRUE

No

Can this service report diagnostic parameter definitions? —Yes→ *S3 ST11 and ST12 Provider* = TRUE

No

Can this service report multiple diagnostic parameter definitions? —Yes→ *S3 Diagnostic Multiple Report SID* = TRUE

No

Can this service report diagnostic parameter sampling-time offsets? —Yes→ *S3 ST14 and ST16 Provider* = TRUE
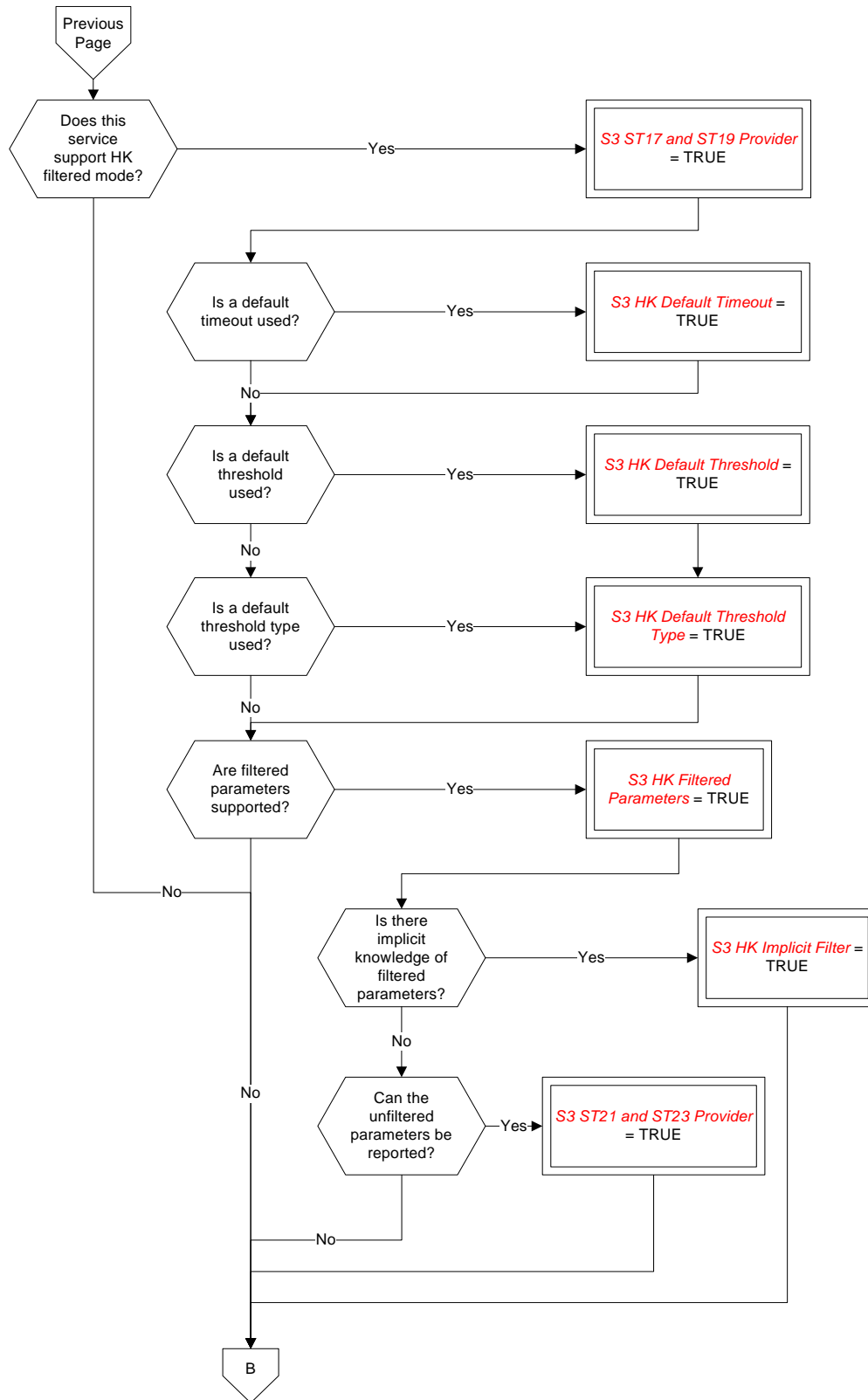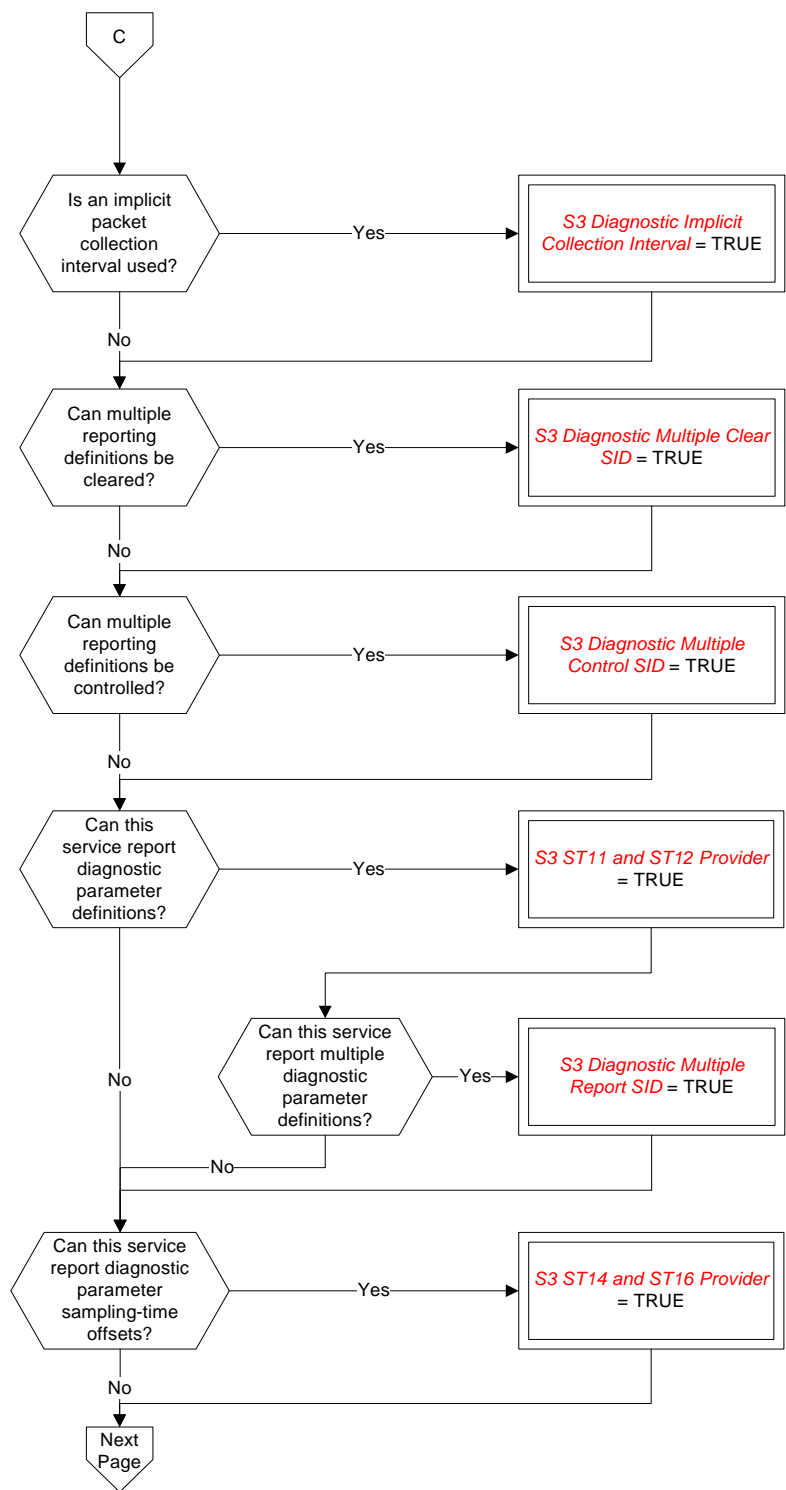
No

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Figure 7 Tailoring choices for the housekeeping and diagnostic data reporting service (View 4)
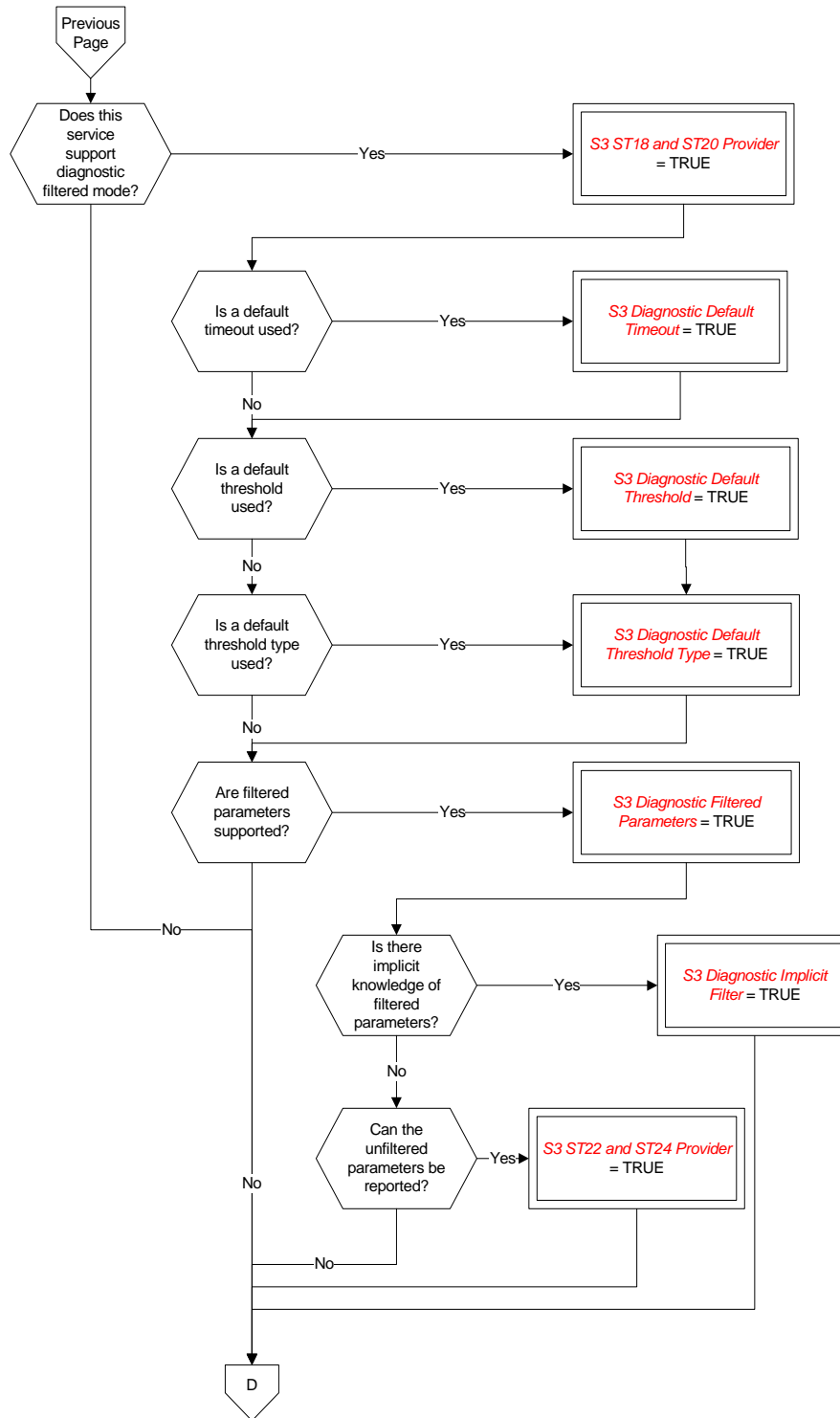
Figure 7 Tailoring choices for the housekeeping and diagnostic data reporting service (View 5)

A.4.3   Service requests and reports

The requests and reports relating to the housekeeping data reporting sub-service are presented first, followed by those for the diagnostic data reporting sub-service.

A.4.3.1   Defining new housekeeping parameter report (S3 ST1 ST3 ST5 and ST6 Provider = TRUE)

The telecommand for the definition of a new housekeeping parameter report (Type = 3, Subtype = 1) is:

			Ordered list of parameters			Ordered list of supercommutated parameter set definitions	Ordered list of parameters
SID	Collection Interval	NPAR1	Parameter#	NFA	NREP	NPAR2	Parameter#
S3 SID	S3 Collection Interval	S3 NPAR1	S3 Parameter Number	S3 NFA	S3 NREP	S3 NPAR2	S3 Parameter Number

S3 HK Implicit Collection Interval = FALSE

A.4.3.2   Clearing housekeeping parameter report definitions (S3 ST1 ST3 ST5 and ST6 Provider = TRUE)

The telecommand to clear one or more housekeeping parameter report definitions (Type = 3, Subtype = 3) is:

	List of housekeeping report identifier
NSID	SID
S3 NSID	S3 SID

S3 HK Multiple Clear SID = TRUE

A.4.3.3   Controlling the generation of housekeeping parameter reports (S3 ST1 ST3 ST5 and ST6 Provider = TRUE)

The telecommand to enable (Type = 3, Subtype = 5) or disable (Type = 3, Subtype = 6) the generation of one or more housekeeping parameters report definitions is:

	List of housekeeping report identifier
NSID	SID
S3 NSID	S3 SID

S3 HK Multiple Control SID = TRUE

A.4.3.4   Reporting housekeeping parameter report definitions (S3 ST9 and ST10 Provider = TRUE)

The telecommand to request a report of one or more housekeeping parameter report definitions (Type = 3, Subtype = 9) is:

	List of housekeeping report identifier
NSID	SID
S3 NSID	S3 SID

S3 HK Multiple Report SID = TRUE

The corresponding report containing the requested housekeeping parameter report definitions (Type = 3, Subtype = 10) is:

				List of housekeeping report identifiers and corresponding parameter report definitions		Ordered list of supercommutated parameter set definitions			
						Ordered list of parameters			Ordered list of parameters
NSID	SID	Collection Interval	NPAR1	Parameter#	NFA	NREP	NPAR2	Parameter#
S3 NSID	S3 SID	S3 Collection Interval	S3 NPAR1	S3 Parameter Number	S3 NFA	S3 NREP	S3 NPAR2	S3 Parameter Number
S3 HK Multiple Report SID = TRUE		S3 HK Implicit Collection Interval = FALSE						

A.4.3.5 Reporting housekeeping parameter sampling-time offsets (S3 ST13 and ST15 Provider = TRUE)

The telecommand to request a report of housekeeping parameter sampling-time offsets (Type = 3, Subtype = 13) is:

SID
S3 SID

The corresponding sampling-time report (Type = 3, Subtype = 15) is:

	Ordered list of parameter time offsets		
SID	Time Offset 1st Parameter	…	Time Offset Last Parameter
S3 SID	S3 Time Offset	…	S3 Time Offset

A.4.3.6 Selecting housekeeping parameter report generation mode (S3 ST17 and ST19 Provider = TRUE)

The telecommand to select the Periodic Generation Mode for a given housekeeping reporting definition (Type = 3, Subtype = 17) is:

SID
S3 SID

The telecommand to select the Filtered Generation Mode for a given housekeeping reporting definition (Type = 3, Subtype = 19) is:

			List of parameter threshold definitions		
SID	Timeout	N	Parameter#	Threshold Type	Threshold
S3 SID	S3 Timeout	S3 N	S3 Parameter Number	S3 Threshold Type	S3 Threshold
	S3 HK Default Timeout = FALSE	S3 HK Filtered Parameters = TRUE AND S3 HK Implicit Filter = FALSE		S3 HK Default Threshold = FALSE AND S3 HK Default Threshold Type = FALSE	S3 HK Default Threshold = FALSE

A.4.3.7 Reporting unfiltered housekeeping parameters (S3 ST21 and ST23 Provider = TRUE)

The telecommand to request a report of the parameters that are unfiltered for a given housekeeping reporting definition (Type = 3, Subtype = 21) is:

SID
S3 SID

The corresponding report (Type = 3, Subtype = 23) is:

		List of parameter threshold definition		
SID	N	Parameter#	Threshold Type	Threshold
S3 SID	S3 N	S3 Parameter Number	S3 Threshold Type	S3 Threshold
			S3 HK Default Threshold = FALSE AND S3 HK Default Threshold Type = FALSE	S3 HK Default Threshold = FALSE

A.4.3.8 Reporting housekeeping data (S3 HK Provider = TRUE)

The reports of the values of a set of housekeeping parameters (Type = 3, Subtype = 25) is:

		Sequence of simply commutated parameter values followed by a sequence of fixed arrays of supercommutated parameter values
SID	Mode	Parameters
S3 SID	S3 Mode	Any
	S3 ST17 and ST19 Provider = TRUE	

A.4.3.9 Defining new diagnostic parameter report (S3 Diagnostic Provider = TRUE)

The telecommand for the definition of a new diagnostic parameter report (Type = 3, Subtype = 2) is:

			Ordered list of parameters	Ordered list of supercommutated parameter set definitions			Ordered list of parameters
SID	Collection Interval	NPAR1	Parameter#	NFA	NREP	NPAR2	Parameter#
S3 SID	S3 Collection Interval	S3 NPAR1	S3 Parameter Number	S3 NFA	S3 NREP	S3 NPAR2	S3 Parameter Number
	S3 Diagnostic Implicit Collection Interval = FALSE						

A.4.3.10 Clearing diagnostic parameter report definitions (S3 Diagnostic Provider = TRUE)

The telecommand to clear one or more diagnostic parameter report definitions (Type = 3, Subtype = 4) is:

	List of diagnostic report identifiers →
NSID	SID
S3 NSID	S3 SID

S3 Diagnostic Multiple Clear SID = TRUE

A.4.3.11 Controlling the generation of diagnostic parameter reports (S3 Diagnostic Provider = TRUE)

The telecommand to enable (Type = 3, Subtype = 7) or disable (Type = 3, Subtype = 8) the generation of one or more diagnostic parameters report definitions is:

	List of diagnostic report identifiers →
NSID	SID
S3 NSID	S3 SID

S3 Diagnostic Multiple Control SID = TRUE

A.4.3.12 Reporting diagnostic parameter report definitions (S3 ST11 and ST12 Provider = TRUE)

The telecommand to request a report of one or more diagnostic parameter report definitions (Type = 3, Subtype = 11) is:

	List of diagnostic report identifiers →
NSID	SID
S3 NSID	S3 SID

S3 Diagnostic Multiple Report SID = TRUE

The corresponding report containing the requested diagnostic parameter report definitions (Type = 3, Subtype = 12) is:

				Ordered list of parameters				Ordered list of parameters
NSID	SID	Collection Interval	NPAR1	Parameter#	NFA	NREP	NPAR2	Parameter#
S3 NSID	S3 SID	S3 Collection Interval	S3 NPAR1	S3 Parameter Number	S3 NFA	S3 NREP	S3 NPAR2	S3 Parameter Number
S3 Diagnostic Multiple Report SID = TRUE		S3 Diagnostic Implicit Collection Interval = FALSE						

List of diagnostic report identifiers and corresponding parameter report definitions

Ordered list of supercommutated parameter set definitions

A.4.3.13 Reporting diagnostic parameter sampling-time offsets (S3 ST14 and ST16 Provider = TRUE)

The telecommand to request a report of diagnostic parameter sampling-time offsets (Type = 3, Subtype = 14) is:

SID
S3 SID

The corresponding sampling-time report (Type = 3, Subtype = 16) is:

	Ordered list of parameter time offsets		
SID	Time Offset 1st Parameter	…	Time Offset Last Parameter
S3 SID	S3 Time Offset	…	S3 Time Offset

A.4.3.14 Selecting diagnostic parameter report generation mode (S3 ST18 and ST20 Provider = TRUE)

The telecommand to select the Periodic Generation Mode for a given diagnostic reporting definition (Type = 3, Subtype = 18) is:

SID
S3 SID

The telecommand to select the Filtered Generation Mode for a given diagnostic reporting definition (Type = 3, Subtype = 20) is:

			List of parameter threshold definitions		
SID	Timeout	N	Parameter#	Threshold Type	Threshold
S3 SID	S3 Timeout	S3 N	S3 Parameter Number	S3 Threshold Type	S3 Threshold
	S3 Diagnostic Default Timeout = FALSE	S3 Diagnostic Filtered Parameters = TRUE AND S3 Diagnostic Implicit Filter = FALSE		S3 Diagnostic Default Threshold = FALSE AND S3 Diagnostic Default Threshold Type = FALSE	S3 Diagnostic Default Threshold = FALSE

A.4.3.15 Reporting unfiltered diagnostic parameters (S3 ST22 and ST24 Provider = TRUE)

The telecommand to request a report of the parameters that are unfiltered for a given diagnostic reporting definition (Type = 3, Subtype = 22) is:

SID
S3 SID

The corresponding report (Type = 3, Subtype = 24) is:

		List of parameter threshold definitions		
SID	N	Parameter#	Threshold Type	Threshold
S3 SID	S3 N	S3 Parameter Number	S3 Threshold Type	S3 Threshold
			S3 Diagnostic Default Threshold = FALSE AND S3 Diagnostic Default Threshold Type = FALSE	S3 Diagnostic Default Threshold = FALSE

A.4.3.16   Reporting diagnostic data (S3 Diagnostic Provider = TRUE)

The report of the values of a set of diagnostic parameters (Type = 3, Subtype = 26) is:

		Sequence of simply commutated parameter values followed by a sequence of fixed arrays of supercommutated parameter values
SID	Mode	Parameters
S3 SID	S3 Mode	Any
	S3 ST18 and ST20 Provider = TRUE	

A.5   Parameter statistics reporting service

A.5.1   The PUS service model

This service provides the capability for evaluating a standard set of statistics (maximum, minimum, mean and standard deviation) for a specified list of parameters and reporting the results to the ground. The ground can (optionally) modify the on-board list of parameters to be evaluated and the on-board interval for sampling these parameters.

Different options exist for reporting the results; this can be done either periodically or on request from the ground. In either case, a further option exists to reset the results whenever they are reported or to continue accumulating the results until the process is explicitly reset by ground command.

A.5.2   Service tailoring data

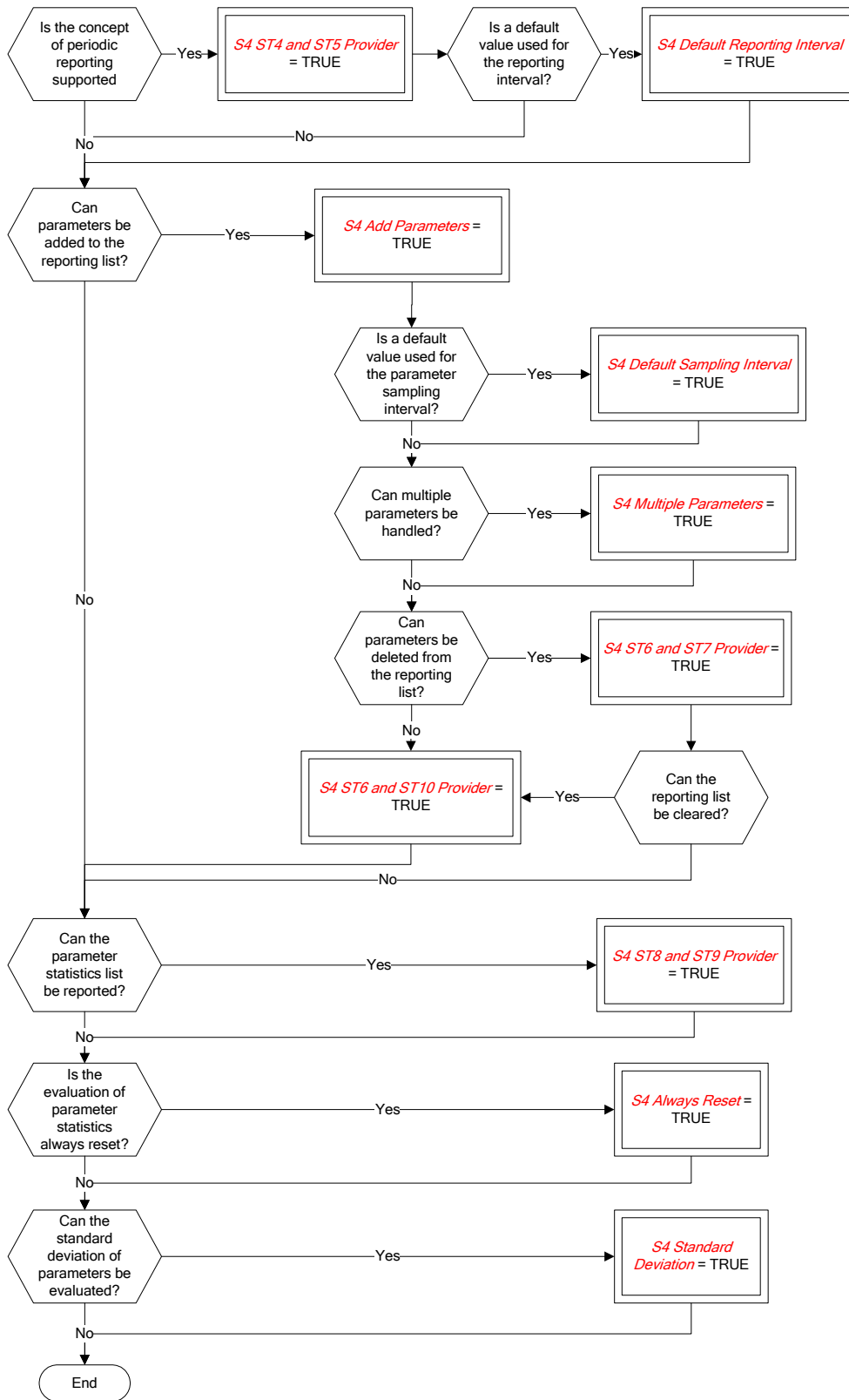The tailoring choices for the parameter statistics reporting service are shown in Figure 8.

Figure 8   Tailoring choices for the parameter statistics reporting service

A.5.3   Service requests and reports

A.5.3.1   Reporting the parameter statistics results

The telecommand to request a report of the parameter statistics results (Type = 4, Subtype = 1) is:

Reset Flag
S4 Reset Flag

S4 Always Reset = FALSE

The corresponding telemetry report (Type = 4, Subtype = 2) is:

List of parameters and their standard statistics result

t_{start}	NPAR	Parameter#	Maxval	t_{max}	Minval	t_{min}	Meanval	Stddevval
S4 Time	S4 NPAR	S4 Parameter Number	Deduced	S4 Time	Deduced	S4 Time	Deduced	Deduced
								S4 Standard Deviation = TRUE

A.5.3.2   Resetting the parameter statistics reporting

The telecommand to request a reset of the parameter statistics reporting (Type = 4, Subtype = 3) has no application data.

A.5.3.3   Selecting the parameter statistics reporting mode (S4 ST4 and ST5 Provider = TRUE)

The telecommand to request enabling of the periodic reporting of the parameter statistics (Type = 4, Subtype = 4) is:

Reporting Interval
S4 Relative Time

S4 Default Reporting Interval = FALSE

The telecommand to request disabling of the periodic reporting of the parameter statistics (Type = 4, Subtype = 5) has no application data.

A.5.3.4   Adding parameters to the parameter statistics list

The telecommand to add parameters to the parameter statistics list (Type = 4, Subtype = 6) is:

List of parameters and their corresponding sampling interval

NPAR	Parameter#	Sampling Interval
S4 NPAR	S4 Parameter Number	S4 Relative Time
S4 Multiple Parameters = TRUE		S4 Default Sampling Interval = FALSE

A.5.3.5 Deleting parameters from the parameter statistics list (S4 ST6 and ST7 Provider = TRUE)

The telecommand to request deletion of parameters from the parameter statistics list (Type = 4, Subtype = 7) is:

| | List of parameters | |
NPAR	Parameter#
S4 NPAR	S4 Parameter Number
S4 Multiple Parameters = TRUE	

A.5.3.6 Reporting the parameter statistics list (S4 ST8 and ST9 Provider = TRUE)

The telecommand to request reporting of the parameter statistics list (Type = 4, Subtype = 8) has no application data.

The corresponding report (Type = 4, Subtype = 9) is:

| | | List of parameters and their sampling interval | |
Reporting Interval	NPAR	Parameter#	Sampling Interval
S4 Relative Time	S4 NPAR	S4 Parameter Number	S4 Relative Time
S4 Default Reporting Interval = FALSE			S4 Default Sampling Interval = FALSE

A.5.3.7 Clearing the parameter statistics list (S4 ST6 and ST10 Provider = TRUE)

The telecommand to request clearing of the parameter statistics list (Type = 4, Subtype = 10) has no application data.

A.6 Event reporting service

A.6.1 The PUS service model

This service provides the capability for reporting to the ground the occurrence of on-board events of any nature. It is expected that this service is used to report:

- failures and anomalous behaviour;

- other detected events that are of operational significance whilst not anomalous in nature e.g. payload external events detected by an experiment;

- actions taken autonomously on-board (and possibly their outcome).

The event reports contain all necessary ancillary information used by the ground to understand the nature and circumstances of the reported event.

An option exists to disable the generation of specified event reports (and also to enable them) in order to reduce the on-board processing load.

A.6.2   Service tailoring data

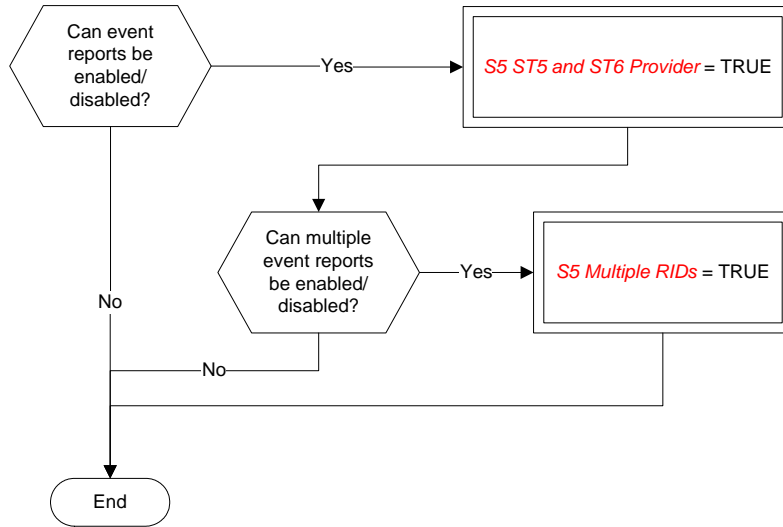The tailoring choices for the event reporting service are shown in Figure 9.

Figure 9   Tailoring choices for the event reporting service

A.6.3   Service requests and reports

A.6.3.1   Reporting events

All event reports have the same structure. The reports are:

Normal/Progress Report (Type = 5, Subtype = 1);

Error/Anomaly Report - Low Severity (Type = 5, Subtype = 2);

Error/Anomaly Report - Medium Severity (Type = 5, Subtype = 3);

Error/Anomaly Report - High Severity (Type = 5, Subtype = 4).

	Record of parameters (RID-specific
RID	Parameters
S5 RID	Any

A.6.3.2   Controlling the generation of event reports

The telecommand to enable (Type = 5, Subtype = 5) or disable (Type = 5, Subtype = 6) the generation of event reports is:

	List of event report identifiers
NRID	RID
S5 NRID	S5 RID

S5 Multiple RIDs = TRUE

A.7 Memory management service

A.7.1 The PUS service model

This service provides the capabilities for loading and dumping on-board memories and also for requesting the application process to check a memory area and report the result. A given application process can have access to none, one or several on-board memories and each on-board memory can use one of the following addressing techniques:

- base reference plus offset;
- absolute addressing.

The first of these techniques (base reference plus offset) can be used to supply a symbolic name, in the form of a character string, that corresponds to a well-defined address within the memory block.

A.7.2   Service tailoring data

The tailoring choices for the memory management service are shown in Figure 10 (Views 1 and 2).
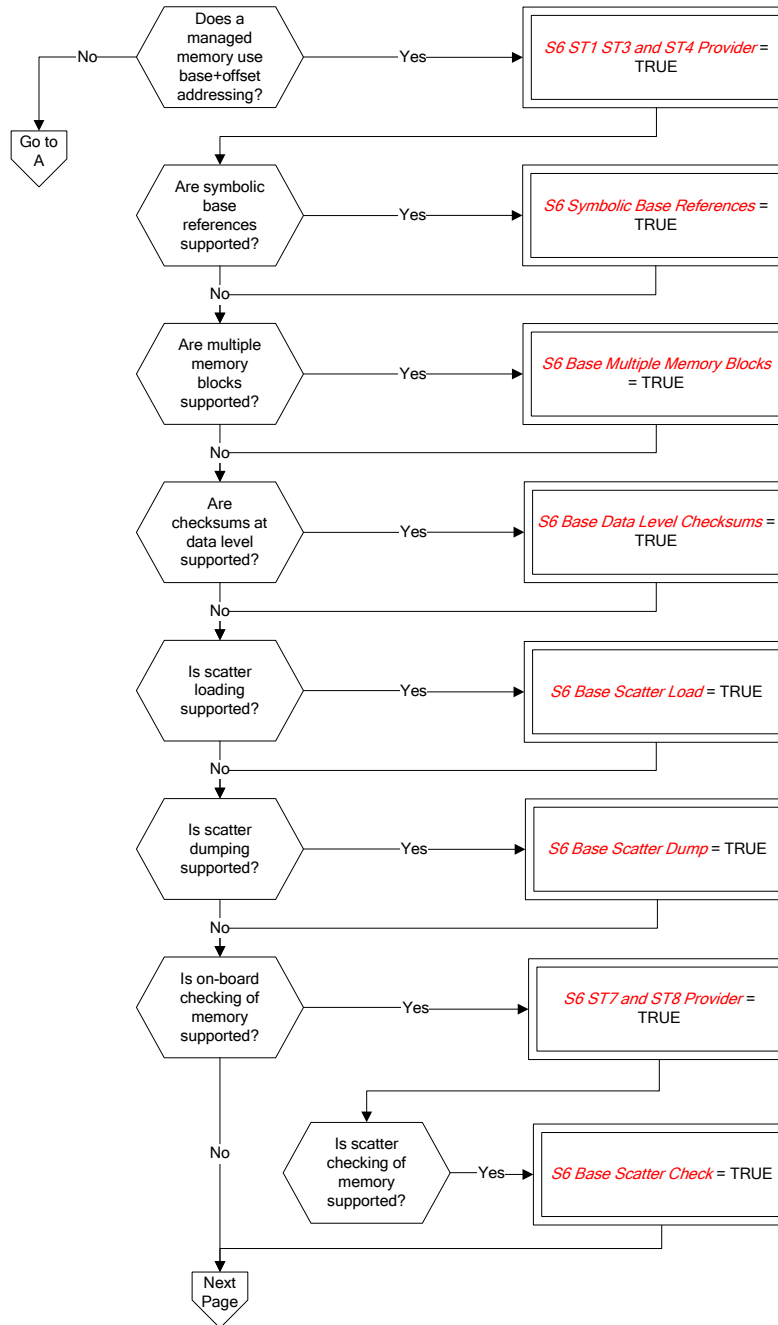
Figure 10 Tailoring choices for the memory management service (View 1)
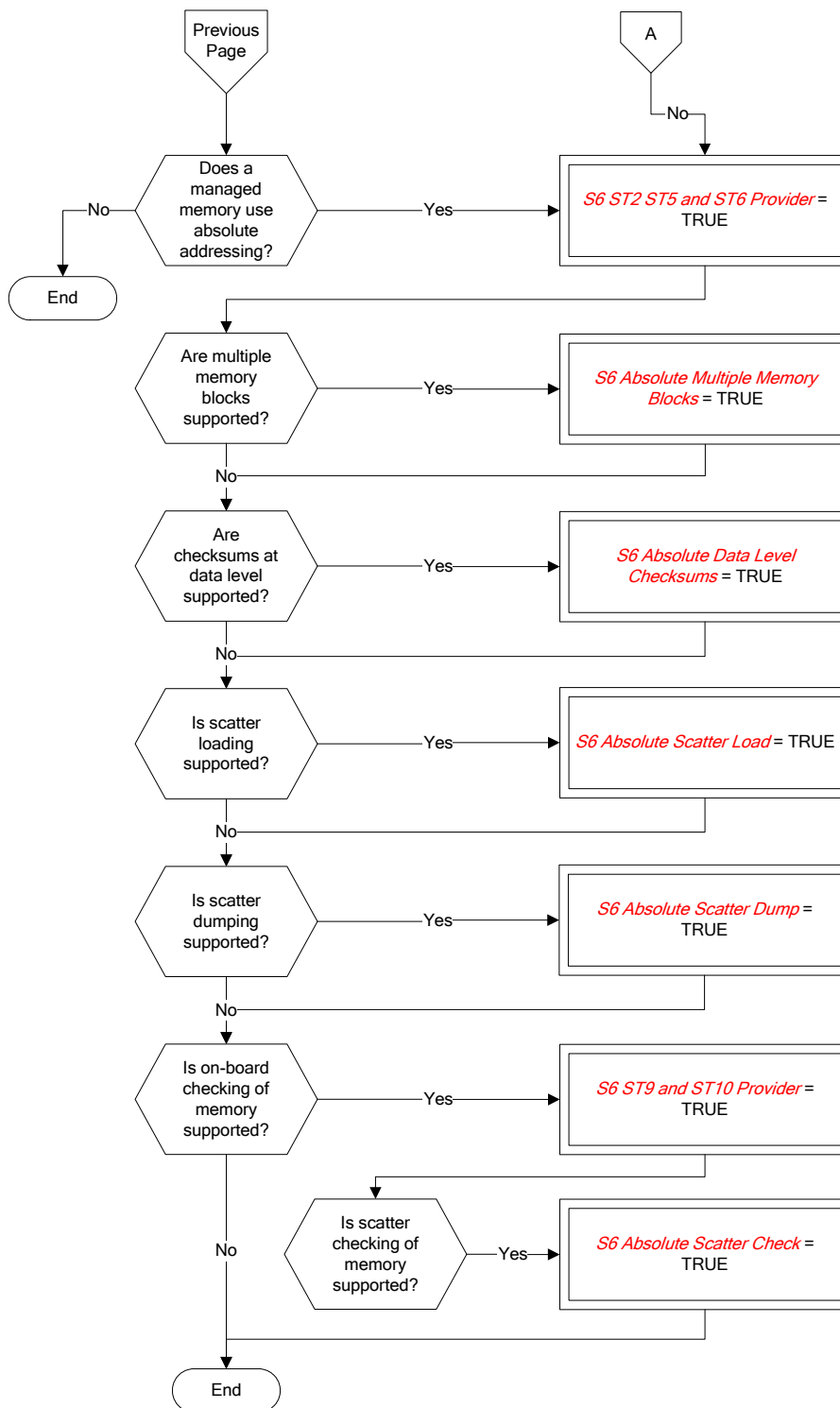
Figure 10   Tailoring choices for the memory management service (View 2)

A.7.3   Service requests and reports

A.7.3.1   Loading data in memory using base plus offsets (S6 ST1 ST3 and ST4 Provider = TRUE)

The telecommand to load data into one or more areas of a memory block defined using a base reference plus offsets (Type = 6, Subtype = 1) is:

			← List of data block definitions →			
Memory ID	Base	N	Offset	Length	Data	Checksum
S6 Memory ID	S6 Base	S6 N	S6 Offset	Variable Octet String		PTC 6 PFC 16
S6 Base Multiple Memory Blocks = TRUE		S6 Base Scatter Load = TRUE				S6 Base Data Level Checksums = TRUE

A.7.3.2   Loading data in memory using absolute addresses (S6 ST2 ST5 and ST6 Provider = TRUE)

The telecommand to load data to one or more areas of a memory block defined using absolute addresses (Type = 6, Subtype = 2) is:

		← List of data block definitions →			
Memory ID	N	Start Address	Length	Data	Checksum
S6 Memory ID	S6 N	S6 Start Address	Variable Octet String		PTC 6 PFC 16
S6 Absolute Multiple Memory Blocks = TRUE	S6 Absolute Scatter Load = TRUE				S6 Absolute Data Level Checksums = TRUE

A.7.3.3   Dumping memory using base plus offsets (S6 ST1 ST3 and ST4 Provider = TRUE)

The telecommand to dump the contents of one or more areas of a memory block defined using a base reference plus offsets (Type = 6, Subtype = 3) is:

			← List of data block definitions →	
Memory ID	Base	N	Offset	Length
S6 Memory ID	S6 Base	S6 N	S6 Offset	S6 Length
S6 Base Multiple Memory Blocks = TRUE		S6 Base Scatter Dump = TRUE		

The corresponding memory dump report (Type = 6, Subtype = 4) is:

			← List of dumped data blocks →			
Memory ID	Base	N	Offset	Length	Data	Checksum
S6 Memory ID	S6 Base	S6 N	S6 Offset	Variable Octet String		PTC 6 PFC 16
S6 Base Multiple Memory Blocks = TRUE		S6 Base Scatter Dump = TRUE				S6 Base Data Level Checksums = TRUE

A.7.3.4 Dumping memory using absolute addresses (S6 ST2 ST5 and ST6 Provider = TRUE)

The telecommand to dump the contents of one or more areas of a memory block defined using absolute addresses (Type = 6, Subtype = 5) is:

		List of data block definitions	
Memory ID	N	Start Address	Length
S6 Memory ID	S6 N	S6 Start Address	S6 Length
S6 Absolute Multiple Memory Blocks = TRUE	S6 Absolute Scatter Dump = TRUE		

The corresponding memory dump report (Type = 6, Subtype = 6) is:

			List of dumped data blocks		
Memory ID	N	Start Address	Length	Data	Checksum
S6 Memory ID	S6 N	S6 Start Address	Variable Octet String		PTC 6 PFC 16
S6 Absolute Multiple Memory Blocks = TRUE	S6 Absolute Scatter Dump = TRUE				S6 Absolute Data Level Checksums = TRUE

A.7.3.5 Checking memory using base plus offsets (S6 ST7 and ST8 Provider = TRUE)

The telecommand to check the contents of one or more areas of a memory block defined using a base reference plus offsets (Type = 6, Subtype = 7) is:

			List of dumped data blocks	
Memory ID	Base	N	Offset	Length
S6 Memory ID	S6 Base	S6 N	S6 Offset	S6 Length
S6 Base Multiple Memory Blocks = TRUE		S6 Base Scatter Check = TRUE		

The corresponding memory check report (Type = 6, Subtype = 8) is:

				List of data blocks and their checksum	
Memory ID	Base	N	Offset	Length	Checksum
S6 Memory ID	S6 Base	S6 N	S6 Offset	S6 Length	PTC 6 PFC 16
S6 Base Multiple Memory Blocks = TRUE		S6 Base Scatter Check = TRUE			

A.7.3.6 Checking memory using absolute addresses (S6 ST9 and ST10 Provider = TRUE)

The telecommand to check the contents of one or more areas of a memory block defined using absolute addresses (Type = 6, Subtype = 9) is:

		List of data block definitions	
Memory ID	N	Start Address	Length
S6 Memory ID	S6 N	S6 Start Address	S6 Length
S6 Absolute Multiple Memory Blocks = TRUE	S6 Absolute Scatter Check = TRUE		

The corresponding memory check report (Type = 6, Subtype = 10) is:

<div align="right">← List of data blocks and their checksum →</div>

Memory ID	N	Start Address	Length	Checksum
S6 Memory ID	S6 N	S6 Start Address	S6 Length	PTC 6 PFC 16
S6 Absolute Multiple Memory Blocks = TRUE	S6 Absolute Scatter Check = TRUE			

A.8 Function management service

A.8.1 The PUS service model

This service provides the capabilities for controlling those software functions of an application process that are not implemented as standard or as mission-specific services. The specialized role of a given application process is reflected in the internal functions that it supports. For example:

- attitude or orbit manoeuvres for an application process hosted within an AOCS processor;

- payload control for an application process hosted within an experiment processor.

A Function ID is defined at the level of each individual control for the corresponding function and run-time parameters can also be loaded from ground.

A.8.2 Service tailoring data

The tailoring choices for the function management service are shown in Figure 11.
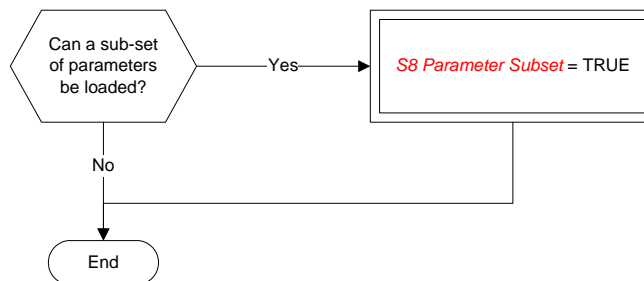
Figure 11 Tailoring choices for the function management service

A.8.3   Service requests and reports

A.8.3.1   Perform function (S8 Provider = TRUE)

There are two possibilities for the telecommand to perform a function (Type = 8, Subtype = 1). Where the full set of parameters is always provided (or where the function has no parameters), the telecommand is:

Function ID	Parameters
S8 Function ID	Any

List of parameters

Optional (function-specific)

Where a sub-set of parameters can be supplied (**S8 Parameter Subset** = TRUE), the telecommand is:

List of parameters and their value

Function ID	N	Parameter#	Value
S8 Function ID	S8 N	S8 Parameter Number	Deduced

A.9   Time management service

A.9.1   The PUS service model

This service provides the generation of the standard time report (for application process = 0) and the optional capability to control the frequency of generation of this report. Note that the latter capability may be provided by a different application process from that which generates the time report itself.

Unless a very basic time reporting capability is provided, the status of the time reporting service is included in the time report itself.

The standard time report is the means that the ground uses to perform correlation between on-board time (OBT) and ground time, which is Universal Time Coordinated (UTC). The procedures used on the ground for this correlation are fully defined in ECSS-E-70-41A. This time correlation is used by many ground functions, for example:

- by the commanding system to ensure that any OBT time fields contained in uplinked commands destined to the on-board operations scheduling service use the latest available time correlation;

- by any ground function that uses the absolute time of on-board sampling of a given telemetry parameter (this is deduced from the packet time and the sampling time offset which is known for each parameter in the packet).

A.9.2   Service tailoring data

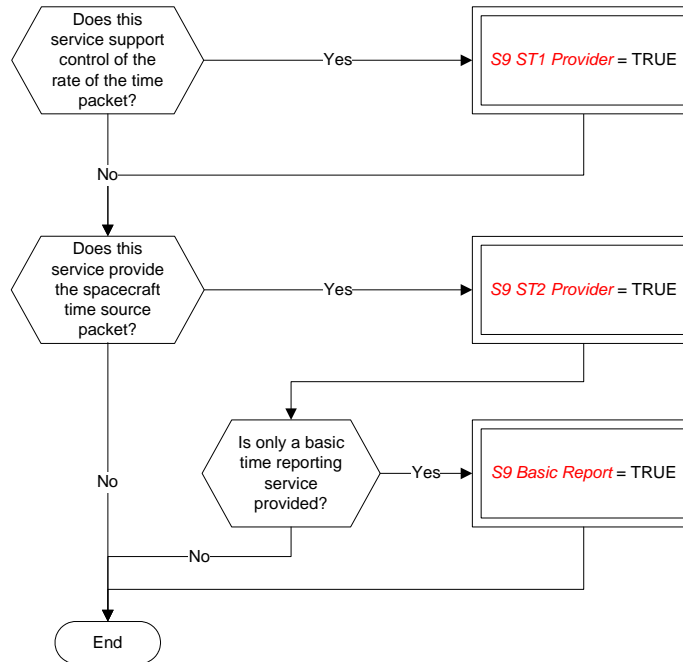The tailoring choices for the time management service are shown in Figure 12.

Figure 12 Tailoring choices for the time management service

Only one application process is an S9 ST1 Provider.

A.9.3   Service requests and reports

A.9.3.1   Controlling the time report generation rate (S9 ST1 Provider = TRUE)

The telecommand to change the rate of generation of the time report (Type = 9, Subtype = 1) is:

Rate
Unsigned Integer (1 octet)

A.9.3.2   Time reporting (S9 ST2 Provider = TRUE)

The Spacecraft Time Source Packet (Type = 9, Subtype = 2) is:

Rate	Satellite Time	Status
Unsigned Integer (1 octet)	S9 Satellite Time	S9 Status
S9 ST1 Provider = TRUE		S9 Basic Report = FALSE

A.10   On-board operations scheduling service

A.10.1 The PUS service model

This service provides the capability to schedule telecommands for distribution on-board when their release times become due. The basic functionalities of the service include the capability to add and delete commands from the on-board schedule and to enable and disable the on-board schedule. A number of more advanced (and optional) capabilities are also provided within the framework of this service, including:

- the capability to report the current contents of the on-board schedule to the ground;

- the capability to load telecommands into different on-board sub-schedules. A sub-schedule is a group of commands that can be independently controlled (as an entity) from the ground;

- the capability to define interlocks between telecommands within the same sub-schedule. An interlock allows the release of a telecommand to be dependent upon the successful (or alternatively, unsuccessful) execution of a previous telecommand released from the on-board schedule;

- the capability to time-shift a group of telecommands i.e. to change their release times by the same relative time, without the need to delete and re-load them from ground. This is effectively a "re-scheduling" capability;

- the capability to define the release time relative to an on-board event. A number of standard events are defined, however this list can be added to on a mission-specific basis.

A.10.2 Service tailoring data

The tailoring choices for the on-board operations scheduling service are shown in Figure 13 (Views 1 to 3).
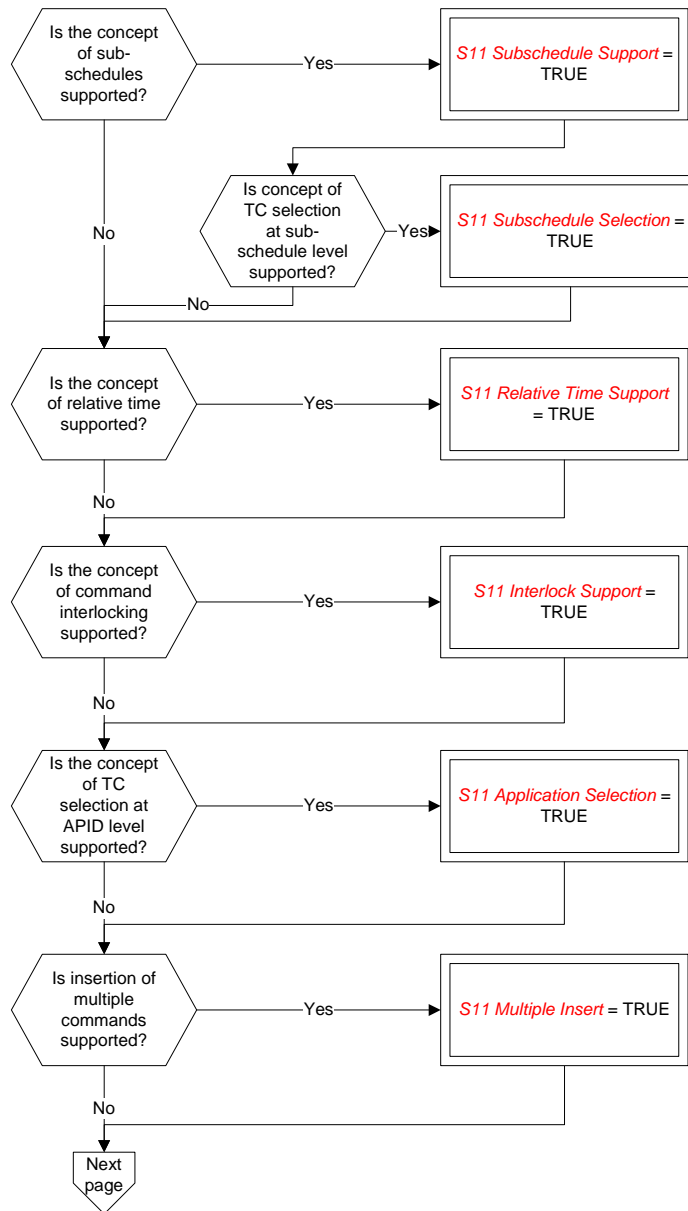
Figure 13 Tailoring choices for the on-board operations scheduling service
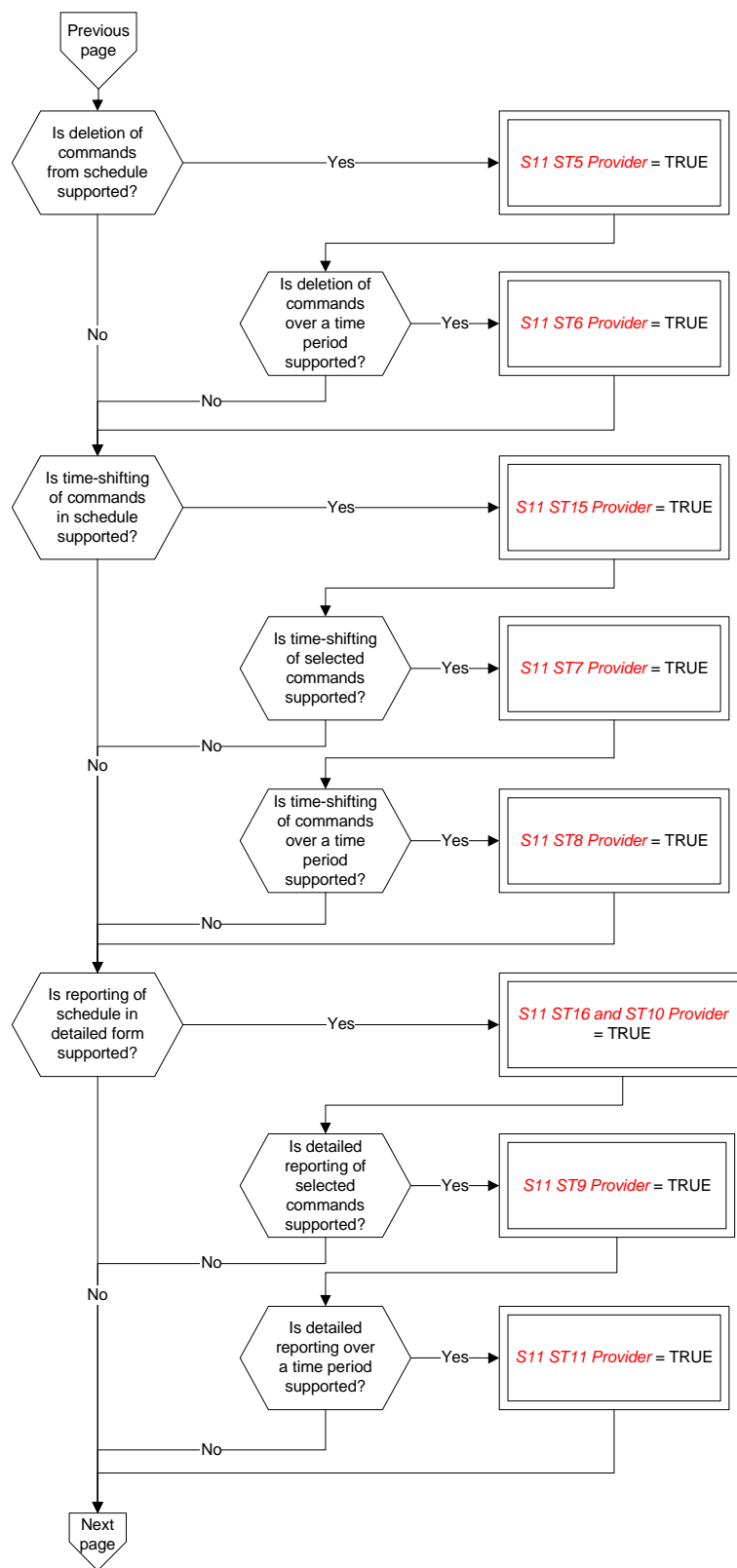(View 1)

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Is deletion of
commands
from schedule
supported?   ——Yes——▶   *S11 ST5 Provider* = TRUE

No   Is deletion of
                                commands
                                over a time   ——Yes——▶   *S11 ST6 Provider* = TRUE
                                period
                                supported?

                                     ——No——

Is time-shifting
of commands
in schedule   ——Yes——▶   *S11 ST15 Provider* = TRUE
supported?

                                Is time-shifting
                                of selected
                                commands   ——Yes——▶   *S11 ST7 Provider* = TRUE
                                supported?

No   ——No——

                                Is time-shifting
                                of commands
                                over a time   ——Yes——▶   *S11 ST8 Provider* = TRUE
                                period
                                supported?

                                     ——No——

Is reporting of
schedule in
detailed form   ——Yes——▶   *S11 ST16 and ST10 Provider*
supported?   = TRUE

                                Is detailed
                                reporting of
                                selected   ——Yes——▶   *S11 ST9 Provider* = TRUE
                                commands
                                supported?

No   ——No——

                                Is detailed
                                reporting over
                                a time period   ——Yes——▶   *S11 ST11 Provider* = TRUE
                                supported?

                                     ——No——

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**Figure 13   Tailoring choices for the on-board operations
scheduling service** (View 2)

Figure 13 Tailoring choices for the on-board operations scheduling service (View 3)

NOTE S11 Scattering Support = TRUE implies that either S11 ST5 Provider = TRUE OR S11 ST15 Provider = TRUE OR S11 ST16 and ST10 Provider = TRUE.

A.10.3 Service requests and reports

A.10.3.1 Controlling the release of telecommands

The telecommands to enable (Type = 11, Subtype = 1) and to disable (Type = 11, Subtype = 2) the release of selected telecommands are:

N1	Sub-schedule ID	N2	Application Process ID
S11 N1	S11 Subschedule ID	S11 N2	S11 APID

A.10.3.2 Resetting the command schedule

The telecommand to reset the command schedule (Type = 11, Subtype = 3) has no application data.

A.10.3.3 Inserting telecommands in the command schedule

The telecommand to insert telecommands in the command schedule (Type =11, Subtype = 4) is:

Sub-schedule ID	N
S11 Subschedule ID	S11 N
S11 Subschedule Support = TRUE	S11 Multiple Insert = TRUE

List of telecommands and their scheduling attributess

Interlock Set ID	Interlock Assessed ID	Assessment Type	Scheduling Event	Abs/Rel Time Tag	Execution Timeout	Telecommand Packet
S11 Interlock ID	S11 Interlock ID	S11 Assessment Type	S11Scheduling Event	S11 Absolute CUC Time or S11 Relative CUC Time	S11 Relative CUC Time	Any TC
		Optional (TC is interlock dependent)	S11 Relative Time Support = TRUE		Optional (TC sets an interlock)	

S11 Interlock Support = TRUE

A.10.3.4 Deleting telecommands from the command schedule

A.10.3.4.1 Deleting telecommands (S11 ST5 Provider = TRUE)

The request to delete sets of telecommands from the command schedule (Type = 11, Subtype = 5) is:

List of command sets to be deleted

N	Application Process ID	Sequence Count	No. of Telecommands
S11 N	S11 APID	S11 Sequence Count	S11 Number of TCs
S11 Scattering Support = TRUE			

A.10.3.4.2 Deleting telecommands over a time period (S11 ST6 Provider = TRUE)

The telecommand to delete commands from the command schedule over a time period (Type = 11, Subtype = 6) is:

List of command sets to be deleted

List of APIDs

Range	Time Tag 1	Time Tag 2	N1	Sub-schedule ID	N2	Application Process ID
S11 Range	S11 Absolute CUC Time	S11 Absolute CUC Time	S11 N1	S11 Subschedule ID	S11 N2	S11 APID
	Optional (depends on value of "Range")		S11 Subschedule Selection = TRUE		S11 Application Selection = TRUE	

A.10.3.5 Time-shifting of telecommands in the command schedule

A.10.3.5.1 Time-shifting all telecommands (S11 ST15 Provider = TRUE)

The telecommand to time-shift all telecommands (Type = 11, Subtype = 15) is:

Time Offset
S11 Relative CUC Time

A.10.3.5.2 Time-shifting selected telecommands (S11 ST15 Provider = TRUE and S11 ST7 Provider = TRUE)

The telecommand to time-shift selected telecommands (Type = 11, Subtype = 7) is:

		List of command sets to be time-shifted		
Time Offset	N	Application Process ID	Sequence Count	No. of Telecommands
S11 Relative CUC Time	S11 N	S11 APID	S11 Sequence Count	S11 Number of TCs
	S11 Scattering Support = TRUE			

A.10.3.5.3 Time-shifting selected telecommands over a time period (S11 ST15 Provider = TRUE and S11 ST7 Provider = TRUE and S11 ST8 Provider = TRUE)

The telecommand to time-shift selected telecommands over a time period (Type = 11, Subtype = 8) is:

Range	Time Tag 1	Time Tag 2	Time Offset	
S11 Range	S11 Absolute CUC Time	S11 Absolute CUC Time	S11 Relative CUC Time	

Optional (depends on value of "Range")

	List of command sets to be time-shifted		List of APIDs
N1	Sub-schedule ID	N2	Application Process ID
S11 N1	S11 Subschedule ID	S11 N2	S11 APID

S11 Subschedule Selection = TRUE · S11 Application Selection = TRUE

A.10.3.6 Reporting of the command schedule contents

A.10.3.6.1 Detailed reporting of the command schedule (S11 ST16 and ST10 Provider = TRUE)

The telecommand to obtain a detailed report of all telecommands in the command schedule (Type = 11, Subtype = 16) has no application data.

The corresponding detailed report of the command schedule (Type = 11, Subtype = 10) is:

N	Sub-schedule ID	Interlock Set ID	Interlock Assessed ID	Assessment Type
S11 N	S11 Subschedule ID	S11 Interlock ID	S11 Interlock ID	S11 Assessment Type

List of commands and their scheduling attribute

S11 Subschedule Support = TRUE

S11 Interlock Support = TRUE

Optional (TC is interlock dependent)

Scheduling Event	Abs/Rel Time Tag	Execution Timeout	Telecommand Packet
S11 Scheduling Event	S11 Absolute CUC Time or S11 Relative CUC Time	S11 Relative CUC Time	Any TC

List of commands and their scheduling attributes (contd.)

S11 Relative Time Support = TRUE

Optional (TC sets an interlock)

A.10.3.6.2 Detailed reporting of a subset of the command schedule (S11 ST16 and ST10 Provider = TRUE and S11 ST9 Provider = TRUE)

The telecommand to obtain a detailed report of a selected subset of telecommands in the command schedule (Type = 11, Subtype = 9) is:

N	Application Process ID	Sequence Count	No. of Telecommands
S11 N	S11 APID	S11 Sequence Count	S11 Number of TCs

List of command sets to be reported

S11 Scattering Support = TRUE

A.10.3.6.3 Summary reporting of the command schedule (S11 ST17 and ST13 Provider = TRUE)

The telecommand to obtain a summary report of all telecommands in the command schedule (Type = 11, Subtype = 17) has no application data.

The corresponding summary report of the command schedule (Type = 11, Subtype = 13) is:

N	Sub-schedule ID	Scheduling Event	Abs/Rel Time Tag	Application Process ID	Sequence Count
S11 N	S11 Subschedule ID	S11 Scheduling Event	S11 Absolute CUC Time or S11 Relative CUC Time	S11 APID	S11 Sequence Count

List of commands and their scheduling attribute

S11 Subschedule Support = TRUE

S11 Relative Time Support = TRUE

A.10.3.6.4 Summary reporting of a subset of the command schedule (S11 ST17 and ST13 Provider = TRUE and S11 ST12 Provider = TRUE)

The telecommand to obtain a summary report of a selected subset of telecommands in the command schedule (Type = 11, Subtype = 12) is the same as for (Type = 11, Subtype = 9).

A.10.3.6.5   Detailed reporting of the command schedule over a time period (S11 ST16 and ST10 Provider = TRUE and S11 ST9 Provider = TRUE and S11 ST11 Provider = TRUE)

The telecommand to obtain a detailed report of telecommands in the command schedule over a time period (Type = 11, Subtype = 11) is:

| | | | | | | List of command sets to be reported | |
| | | | | | | | List of APIDs |
Range	Time Tag 1	Time Tag 2	N1	Sub-schedule ID	N2	Application Process ID
S11 Range	S11 Absolute CUC Time	S11 Absolute CUC Time	S11 N1	S11 Subschedule ID	S11 N2	S11 APID
	Optional (depends on value of "Range")			S11 Subschedule Selection = TRUE	S11 Application Selection = TRUE	

A.10.3.6.6   Summary reporting of the command schedule over a time period (S11 ST17 and ST13 Provider = TRUE and S11 ST12 Provider = TRUE and S11 ST14 Provider = TRUE)

The telecommand to obtain a detailed report of telecommands in the command schedule over a time period (Type = 11, Subtype = 14) is the same as for (Type = 11, Subtype = 11).

A.10.3.7   Reporting of the status of the command schedule (S11 ST18 and ST19 Provider = TRUE)

The telecommand to obtain a status report of the command schedule (Type = 11, Subtype = 18) has no application data.

The corresponding status report (Type = 11, Subtype = 19) is:

| | | | List of Sub-schedule/APID combinations and their statuses | | |
| | | | | List of APIDs and their statuses | |
N1	Sub-schedule ID	Status	N2	Application Process ID	Status
S11 N1	S11 Subschedule ID	S11 Status	S11 N2	S11 APID	S11 Status
S11 Subschedule Support = TRUE					

A.11   On-board monitoring service

A.11.1 The PUS service model

This service provides an on-board capability for health checking of parameters which is functionally similar to the monitoring of telemetry parameters that is performed on the ground (see also subclause 6.6.3).

The service maintains a list of monitored parameters and their monitoring attributes and generates a report whenever a check transition is detected. Depending on the nature of the parameter being monitored, the check can be a limit set, a delta-check or an expected status check.

A number of more advanced (and optional) capabilities are also provided within the framework of this service, including:

- the capability for the ground to add and delete parameters from the on-board monitoring list, or to modify the monitoring attributes of a parameter in the list;

- the capability to define that a parameter is only checked if an associated "validity" parameter is TRUE;

- the capability to specify several checks per parameter, where each check has an associated selection parameter;

- the capability to generate event reports as the result of specified check transitions;

- the capability to report, on request from the ground, the current on-board monitoring list or the list of parameters currently out-of-limits.

A.11.2 Service tailoring data

The tailoring choices available for the on-board monitoring service are shown in Figure 14 (Views 1 to 3).
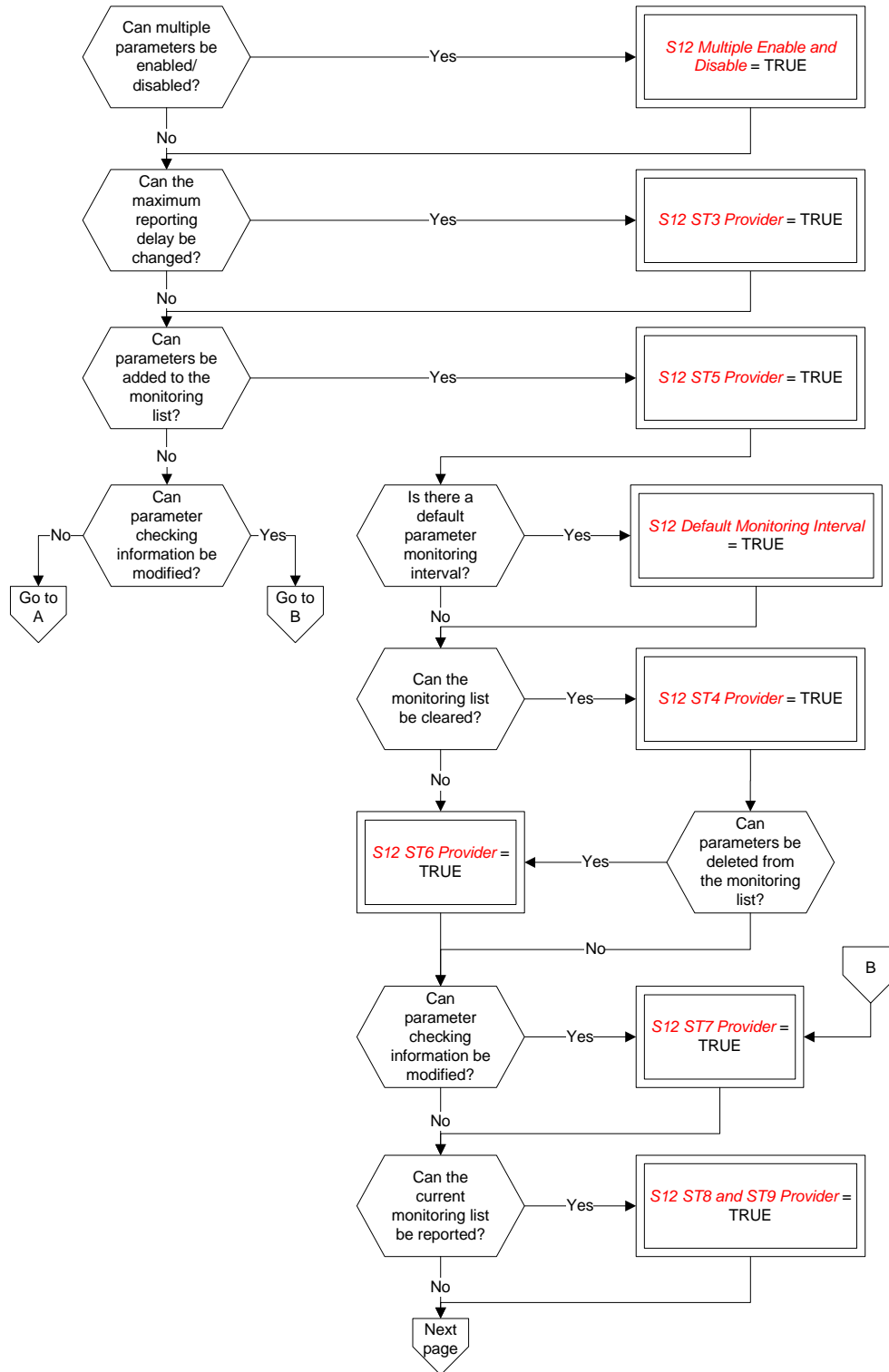
Figure 14 Tailoring choices for the on-board monitoring service (View 1)
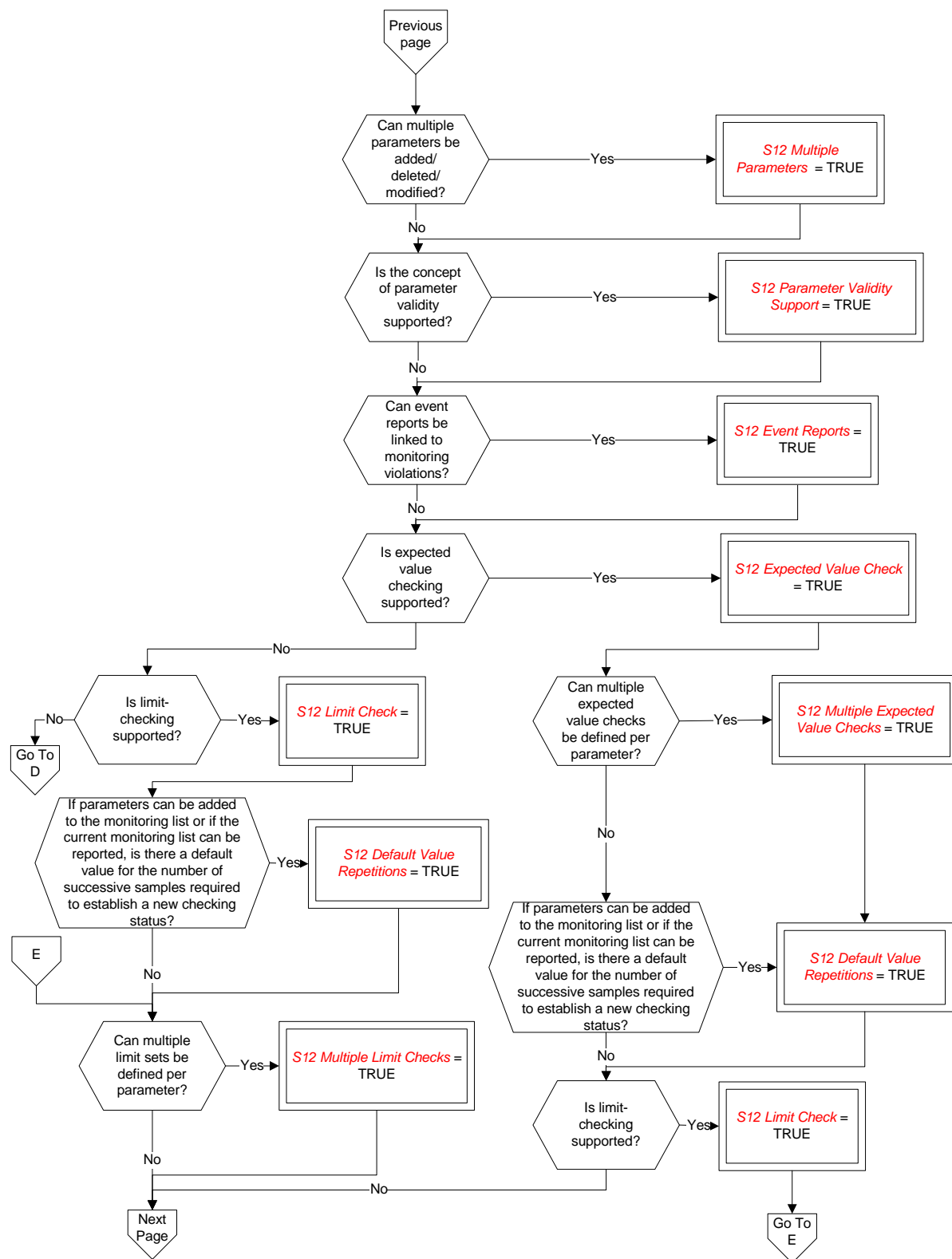
Figure 14 Tailoring choices for the on-board monitoring service
(View 2)
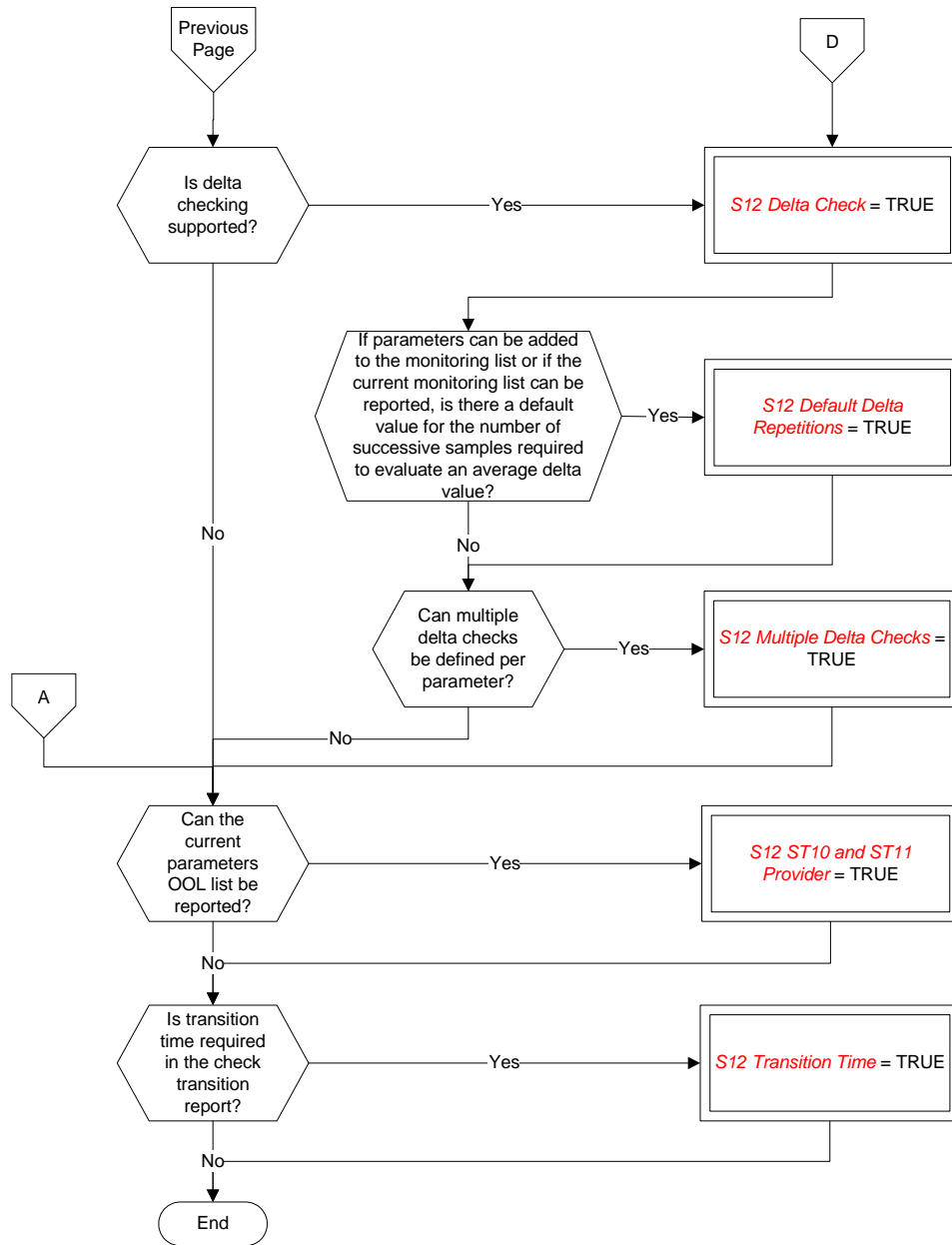
Figure 14 Tailoring choices for the on-board monitoring service
(View 3)

A.11.3 Service requests and reports

A.11.3.1 Controlling the on-board monitoring

The telecommands to enable (Type = 12, Subtype = 1) and disable (Type = 12, Subtype = 2) the on-board monitoring are:

N	Parameter#
S12 N	S12 Parameter Number
S12 Multiple Enable and Disable = TRUE	

A.11.3.2 Changing the maximum reporting delay (S12 ST3 Provider = TRUE)

The telecommand to change the maximum reporting delay (Type = 12, Subtype = 3) is:

Max Reporting Delay
S12 Maximum Reporting Delay

A.11.3.3 Clearing the monitoring list (S12 ST4 Provider = TRUE and S12 ST5 Provider = TRUE)

The telecommand to clear the monitoring list (Type = 12, Subtype = 4) has no application data.

A.11.3.4 Adding parameters to the monitoring list (S12 ST5 Provider = TRUE)

The telecommand to add parameters to the monitoring list (Type = 12, Subtype = 5) is:

◄ List of parameters and monitoring attribute ─

Parameter Monitoring Interval	Value #REP	Delta #REP	N	Parameter#	Validity Parameter#
S12 Parameter Monitoring Interval	S12 Repetitions	S12 Repetitions	S12 N	S12 Parameter Number	S12 Parameter Number
S12 Default Monitoring Interval = FALSE	S12 Default Value Repetitions = FALSE	S12 Default Delta Repetitions = FALSE	S12 Multiple Parameters = TRUE		S12 Parameter Validity Support = TRUE

List of parameters and monitoring attributes (contd.)
List of limit sets definitions and associated event repor

NOL	Check Selection Parameter#	Low Limit	RID	High Limit	RID
S12 NOL	S12 Parameter Number	Deduced	S12 RID	Deduced	S12 RID
S12 Multiple Limit Checks = TRUE			S12 Event Reports = TRUE		S12 Event Reports = TRUE

List of parameters and monitoring attributes (contd.
List of delta checks definitions and associated event report

NOD	Check Selection Parameter#	Low Delta Threshold	RID	High Delta Threshold	RID
S12 NOD	S12 Parameter Number	Deduced	S12 RID	Deduced	S12 RID
S12 Multiple Delta Checks = TRUE			S12 Event Reports = TRUE		S12 Event Reports = TRUE

List of parameters and monitoring attributes (contd.
List of expected value check definitions and associated event reports

NOE	Check Selection Parameter#	Expected Value	RID

S12 NOE	S12 Parameter Number	Deduced	S12 RID
	S12 Multiple Expected Value Checks = TRUE		S12 Event Reports = TRUE

A.11.3.5 Deleting parameters from the monitoring list (S12 ST5 Provider = TRUE and S12 ST6 Provider = TRUE)

The telecommand to delete specified parameters from the monitoring list (Type = 12, Subtype = 6) is:

◄──── List of parameters ────►

N	Parameter#
S12 N	S12 Parameter Number
S12 Multiple Parameters = TRUE	

A.11.3.6 Modifying the parameter checking information (S12 ST7 Provider = TRUE)

The telecommand to modify the checking information for specified parameters (Type = 12, Subtype = 7) is:

◄──── List of parameters and monitoring attributes ────

N	Parameter#	Validity Parameter#
S12 N	S12 Parameter Number	S12 Parameter Number
S12 Multiple Parameters = TRUE		S12 Parameter Validity Support = TRUE

List of parameters and monitoring attributes (contd
List of limit sets definitions and associated event repor

NOL	Check Position	Check Selection Parameter#	Low Limit	RID	High Limit	RID
S12 NOL	S12 Check Position	S12 Parameter Number	Deduced	S12 RID	Deduced	S12 RID
	S12 Multiple Limit Checks = TRUE			S12 Event Reports = TRUE		S12 Event Reports = TRUE

List of parameters and monitoring attributes (contd
List of delta checks definitions and associated event report

NOD	Check Position	Check Selection Parameter#	Low Delta Threshold	RID	High Delta Threshold	RID
S12 NOD	S12 Check Position	S12 Parameter Number	Deduced	S12 RID	Deduced	S12 RID
	S12 Multiple Delta Checks = TRUE			S12 Event Reports = TRUE		S12 Event Reports = TRUE

	List of parameters and monitoring attributes (contd.				
		List of expected value check definitions and associated event report			
NOE	Check Position	Check Selection Parameter#	Expected Value	RID
S12 NOE	S12 Check Position	S12 Parameter Number	Deduced	S12 RID
	S12 Multiple Expected Value Checks = TRUE			S12 Event Reports = TRUE

A.11.3.7 Reporting the current monitoring list contents (S12 ST8 and ST9 Provider = TRUE)

The telecommand to report the current monitoring list contents (Type = 12, Subtype = 8) has no application data.

The corresponding monitoring list contents report (Type = 12, Subtype = 9) is:

	List of parameters and monitoring attribute						
Monitoring Status	Maximum Reporting Delay	N	Parameter#	Validity Parameter#	Parameter Monitoring Interval	Parameter Monitoring Status	Value #REP
S12 Monitoring Status	S12 Maximum Reporting Delay	S12 N	S12 Parameter Number	S12 Parameter Number	S12 Parameter Monitoring Interval	S12 Monitoring Status	S12 Repetitions
				S12 Parameter Validity Support = TRUE			S12 Default Value Repetitions = FALSE

	List of parameters and monitoring attributes (contd							
		List of limit sets and associated event reports					List of expected value check definitions and associated event reports	
Delta #REP	NOL	Check Selection Parameter#	Low Limit	RID	High Limit	RID	NOD	Check Selection Parameter#
S12 Repetitions	S12 NOL	S12 Parameter Number	Deduced	S12 RID	Deduced	S12 RID	S12 NOD	S12 Parameter Number
S12 Default Delta Repetitions = FALSE	S12 Multiple Limit Checks = TRUE			S12 Event Reports = TRUE		S12 Event Reports = TRUE		S12 Multiple Delta Checks = TRUE

	List of parameters and monitoring attributes (contd						
	List of expected value check definitions and associated event reports (contd.)						
Low Delta Threshold	RID	High Delta Threshold	RID	NOE	Check Selection Parameter#	Expected Value	RID
Deduced	S12 RID	Deduced	S12 RID	S12 NOE	S12 Parameter Number	Deduced	S12 RID
	S12 Event Reports = TRUE		S12 Event Reports = TRUE	S12 Multiple Expected Value Checks = TRUE			S12 Event Reports = TRUE

A.11.3.8 Reporting the current parameters out-of-limit list (S12 ST10 and ST11 Provider = TRUE)

The telecommand to request a report of the current parameters out-of-limits list (Type = 12, Subtype = 10) has no application data.

The corresponding current parameters out-of-limits report (Type = 12, Subtype = 11) is:

				List of out-of-limits parameters and their out-of-limit detail		
N	Parameter#	Parameter Value	Limit Crossed	Previous Checking Status	Current Checking Status	Transition Time
S12 N	S12 Parameter Number	Deduced	Deduced	S12 Checking Status	S12 Checking Status	S12 Time

A.11.3.9 Reporting the check transitions

The Out-of-limit Report (Type = 12, Subtype = 12) is:

				List of out-of-limits parameters and their out-of-limit detail		
N	Parameter#	Parameter Value	Limit Crossed	Previous Checking Status	Current Checking Status	Transition Time
S12 N	S12 Parameter Number	Deduced	Deduced	S12 Checking Status	S12 Checking Status	S12 Time

S12 Transition Time = TRUE

A.12 Large data transfer service

A.12.1 The PUS service model

This is a supporting service that provides the capability of transferring (either on the uplink or on the downlink) a service data unit belonging to another on-board service that is too large to be transmitted in a normal service telecommand or telemetry packet. This service can be provided:

- where the service data unit is larger than the maximum allowed by CCSDS;

- where the service data unit is smaller than this CCSDS limit but where the mission has defined a smaller maximum packet size for operational reasons e.g. bandwidth limitations.

The original service data unit is split into parts at the sending end and each of these parts is then embedded in a packet whose size is equal to (smaller in the case of the last packet) the maximum allowable size for the mission. The packets are transmitted in sequence to the sending end where the original service data unit is reconstructed and routed to its destination (on-board or on the ground).

Optional extensions to the service are:

- the use of a sliding window, where the number of parts "in transmission" at any given time is limited. This means that the sending end waits for a confirmation of the successful reception of a specified part before transmitting the next part that it has available;

- the capability to selectively re-transmit lost or erroneous parts.

A.12.2 Service tailoring data

The tailoring choices available for the large data transfer service are shown in Figure 15 (Views 1 and 2).
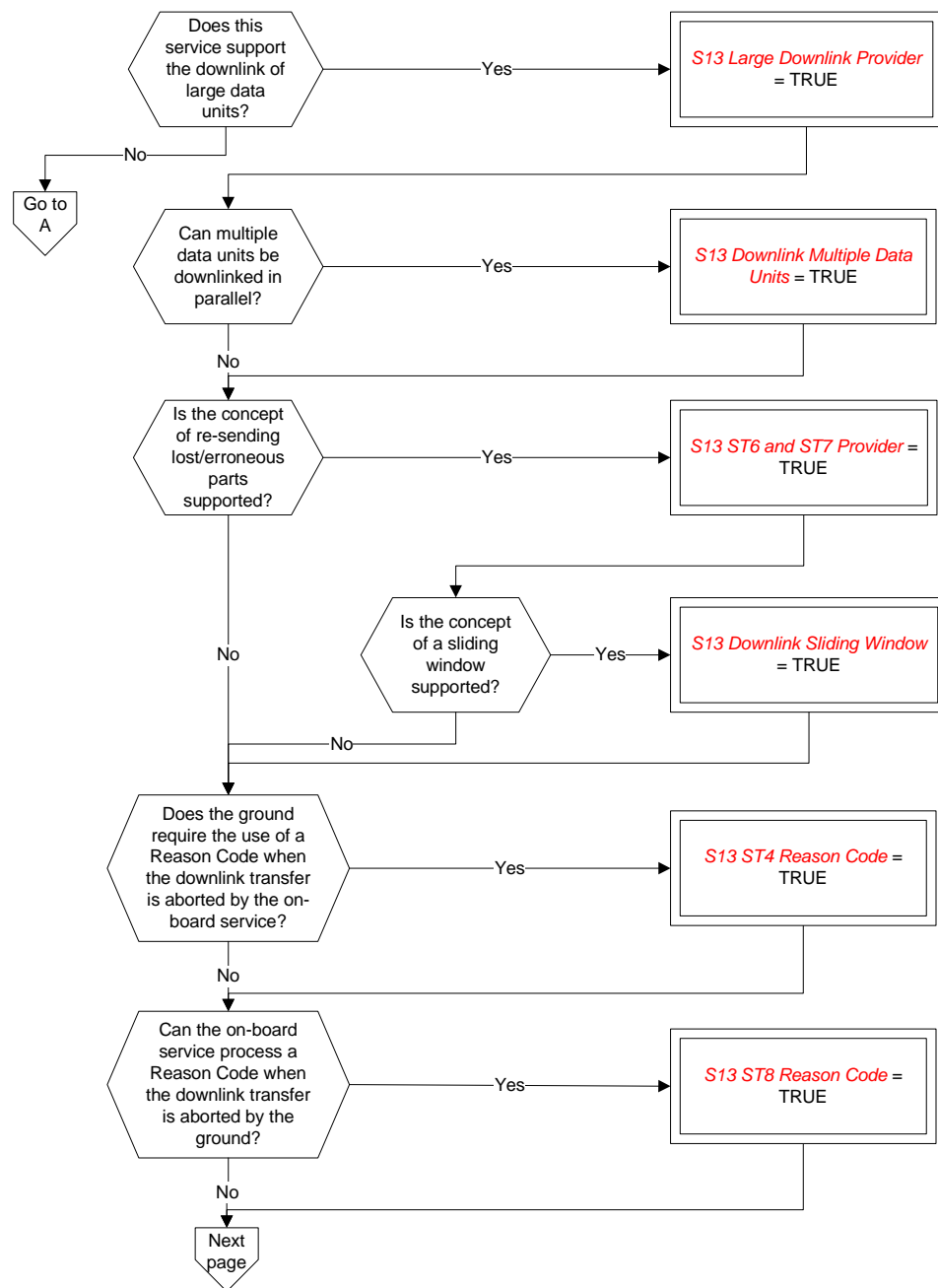
Figure 15 Tailoring choices for the large data transfer service (View 1)
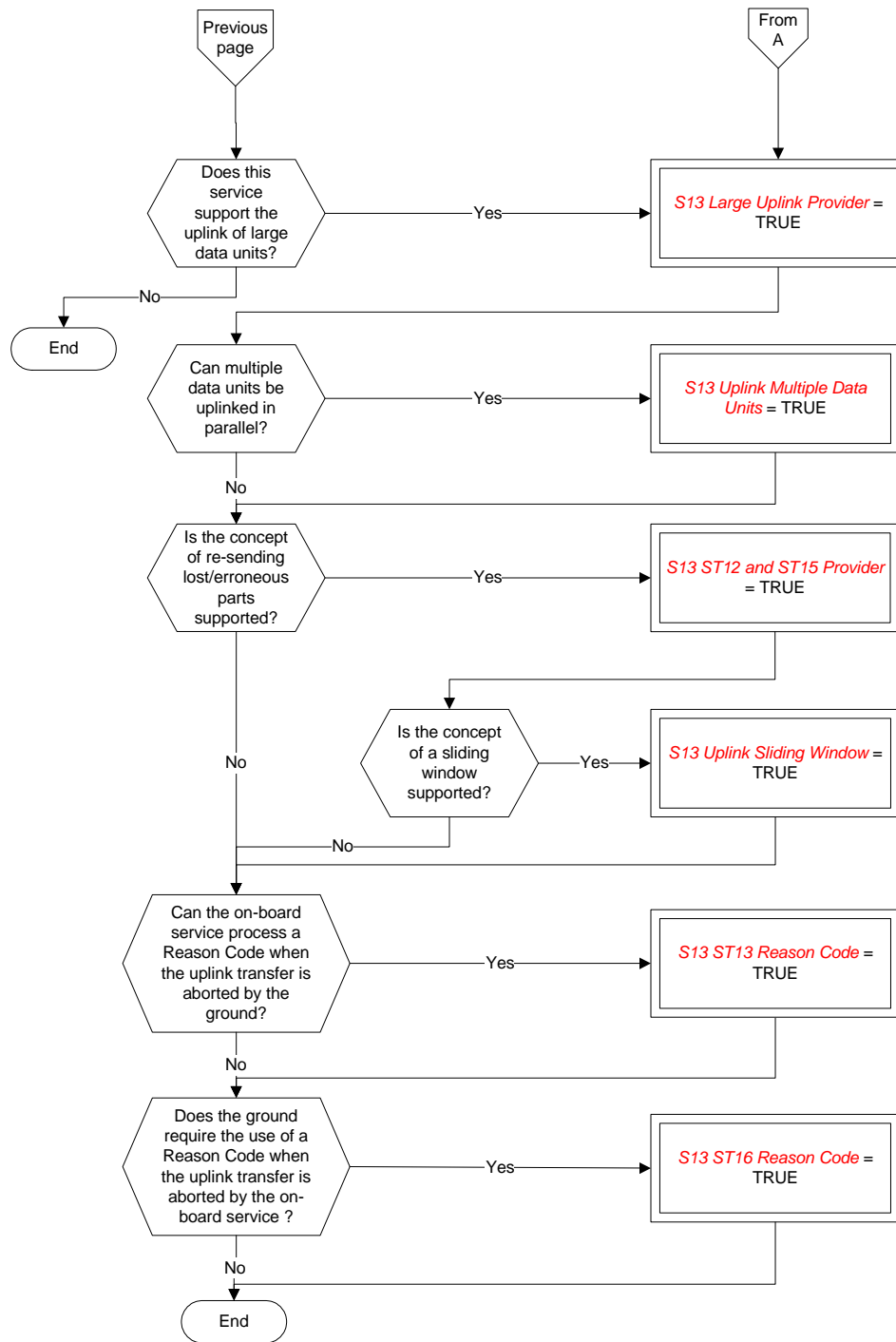
Figure 15   Tailoring choices for the large data transfer service
(View 2)

A.12.3 Service requests and reports

A.12.3.1   Transferring the first part of a service data unit

(S13 Large Downlink Provider = TRUE): The telemetry report to downlink (Type = 13, Subtype = 1) the first part of a large service data unit is:

Large Data Unit ID	Sequence Number	Service Data Unit Part
S13 Large Data Unit ID	S13 Sequence Number	Fixed Octet String
S13 Downlink Multiple Data Units = TRUE		

 (S13 Large Uplink Provider = TRUE): The telecommand to uplink (Type = 13, Subtype = 9) the first part of a large service data unit is:

Large Data Unit ID	Sequence Number	Service Data Unit Part
S13 Large Data Unit ID	S13 Sequence Number	Fixed Octet String
S13 Uplink Multiple Data Units = TRUE		

A.12.3.2   Transferring an intermediate part of a service data unit

(S13 Large Downlink Provider = TRUE): The telemetry report to downlink (Type = 13, Subtype = 3) an intermediate part of a large service data unit is the same as for (Type 13, Subtype 1).

(S13 Large Uplink Provider = TRUE): The telecommand to uplink (Type = 13, Subtype = 10) an intermediate part of a large service data unit is the same as for (Type 13, Subtype 9).

A.12.3.3   Transferring the last part of a service data unit

(S13 Large Downlink Provider = TRUE): The telemetry report to downlink (Type = 13, Subtype = 3) the last part of a large service data unit is the same as for (Type 13, Subtype 1) but with possibly fewer octets.

(S13 Large Uplink Provider = TRUE): The telecommand to uplink (Type = 13, Subtype = 10) the last part of a large service data unit is the same as for (Type 13, Subtype 9) but with possibly fewer octets.

A.12.3.4   Re-transferring a part of a service data unit

(S13 Large Downlink Provider = TRUE and S13 ST6 and ST7 Provider = TRUE): The telemetry report to re-downlink (Type = 13, Subtype = 7) a part of a large service data unit whose retransmission has been requested by the ground is the same as for (Type 13, Subtype 1) or (Type 13, Subtype 3).

(S13 Large Uplink Provider = TRUE and S13 ST12 and ST15 Provider = TRUE): The telecommand to re-uplink (Type = 13, Subtype = 12) a part of a large service data unit whose retransmission has been requested by the on-board service is the same as for (Type 13, Subtype 9) or (Type 13, Subtype 10).

A.12.3.5   Transfer abort initiated by the sending end

(S13 Large Downlink Provider = TRUE): The telemetry report (Type = 13, Subtype = 4) to notify a transfer abort initiated by the on-board service is:

Large Data Unit ID	Reason Code
S13 Large Data Unit ID	S13 Reason Code
S13 Downlink Multiple Data Units = TRUE	S13 ST4 Reason Code = TRUE

(S13 Large Uplink Provider = TRUE): The telecommand (Type = 13, Subtype = 13) to notify a transfer abort initiated by the ground is:

Large Data Unit ID	Reason Code
S13 Large Data Unit ID	S13 Reason Code
S13 Uplink Multiple Data Units = TRUE	S13 ST13 Reason Code = TRUE

A.12.3.6 Acknowledging the successful reception up to a part

(S13 Large Uplink Provider = TRUE): The telemetry report (Type = 13, Subtype = 14) to acknowledge the successful reception of the large service data unit up to a specified part is:

Large Data Unit ID	Sequence Number
S13 Large Data Unit ID	S13 Sequence Number
S13 Uplink Multiple Data Units = TRUE	

(S13 Large Downlink Provider = TRUE): The telecommand (Type = 13, Subtype = 5) to acknowledge the successful reception of the large service data unit up to a specified part is:

Large Data Unit ID	Sequence Number
S13 Large Data Unit ID	S13 Sequence Number
S13 Downlink Multiple Data Units = TRUE	

A.12.3.7 Notifying which parts have not been properly received

(S13 Large Uplink Provider = TRUE and S13 ST12 and ST15 Provider = TRUE): The telemetry report (Type = 13, Subtype = 15) to notify the ground that specified parts were not received or were erroneously received is:

Large Data Unit ID	N	Sequence Number
		List of sequence numbers
S13 Large Data Unit ID	S13 N	S13 Sequence Number
S13 Uplink Multiple Data Units = TRUE		

(S13 Large Downlink Provider = TRUE and S13 ST6 and ST7 Provider = TRUE): The telecommand (Type = 13, Subtype = 6) to notify the on-board sending sub-service that specified parts were not received or were erroneously received is:

Large Data Unit ID	N	Sequence Number
		List of sequence numbers
S13 Large Data Unit ID	S13 N	S13 Sequence Number
S13 Downlink Multiple Data Units = TRUE		

A.12.3.8   Transfer abort initiated by the receiving end

(S13 Large Uplink Provider = TRUE): The telemetry report (Type = 13, Subtype = 16) is:

Large Data Unit ID	Reason Code
S13 Large Data Unit ID	S13 Reason Code
S13 Uplink Multiple Data Units = TRUE	S13 ST16 Reason Code = TRUE

(S13 Large Downlink Provider = TRUE): The telecommand (Type = 13, Subtype = 8) is:

Large Data Unit ID	Reason Code
S13 Large Data Unit ID	S13 Reason Code
S13 Downlink Multiple Data Units = TRUE	S13 ST8 Reason Code = TRUE

A.13   Packet forwarding control service

A.13.1 The PUS service model

This service provides the means to control which packets are enabled for forwarding to ground at any given time. The minimum capability is for the ground to specify which packets are to be enabled (or disabled) by type and subtype. More complex service implementations enable:

- the ground to request specific housekeeping, diagnostic or event report packets to be enabled or disabled;

- the ground to request the service to report the list of currently enabled packets.

The service can either be provided by the application process that generates the packets concerned or by a centralised application process that is responsible for routing packets on the downlink.

A.13.2 Service tailoring data

The tailoring choices available for the packet forwarding control service are shown in Figure 16 (Views 1 and 2).
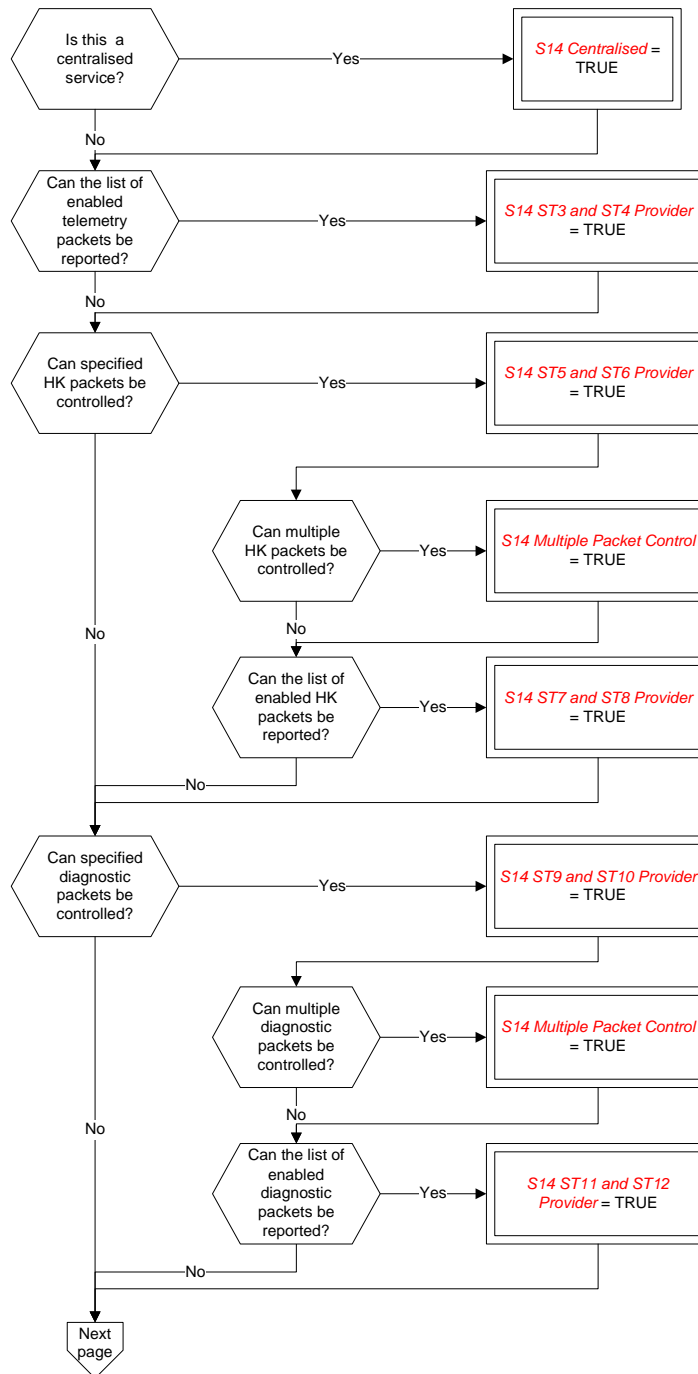
Figure 16 Tailoring choices for the packet forwarding control service (View 1)
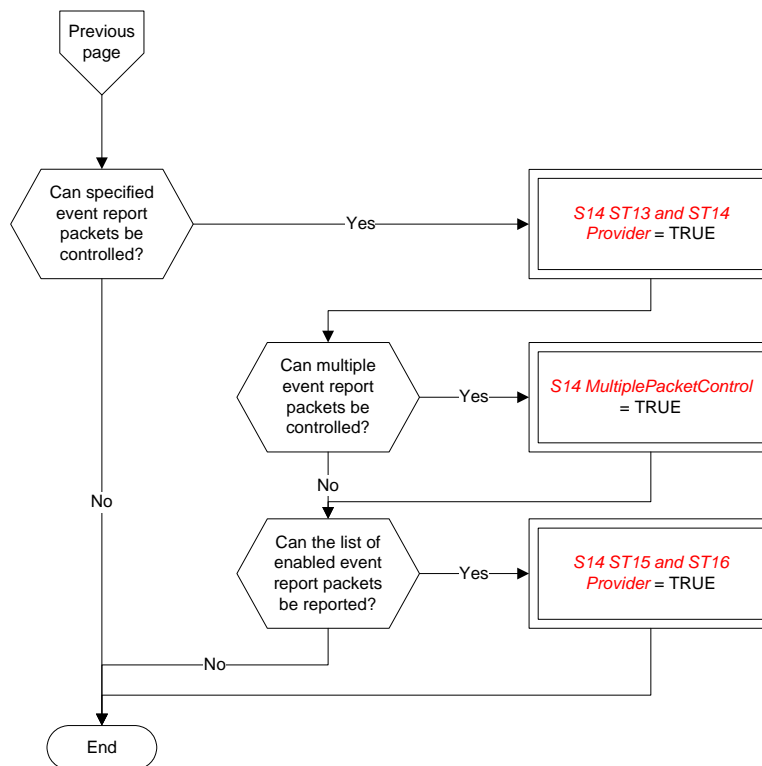
Figure 16 Tailoring choices for the packet forwarding control service (View 2)

A.13.3 Service requests and reports

A.13.3.1   Controlling the forwarding of specified telemetry source packets

The telecommands to enable (Type = 14, Subtype = 1) or disable (Type = 14, Subtype = 2) the forwarding of telemetry source packets of specified type and subtype are:

N1	Application Process ID	N2	Type	N3	Subtype
S14 N	S14 APID	S14 N	S14 Type	S14 N	S14 Type

S14 Centralised = TRUE

A.13.3.2   Reporting the list of enabled telemetry source packets (S14 ST3 and ST4 Provider = TRUE)

The telecommand to report the list of telemetry source packet types and subtypes from the application process with an "Enabled" forwarding status (Type = 14, Subtype = 3) has no application data.

The corresponding telemetry report (Type = 14, Subtype = 4) is:

	List of APID and packet selection			List of Type/Sub-types combinations	List of Sub-types	
N1	Application Process ID	N2	Type	N3	Subtype
S14 N	S14 APID	S14 N	S14 Type	S14 N	S14 Type

S14 Centralised = TRUE
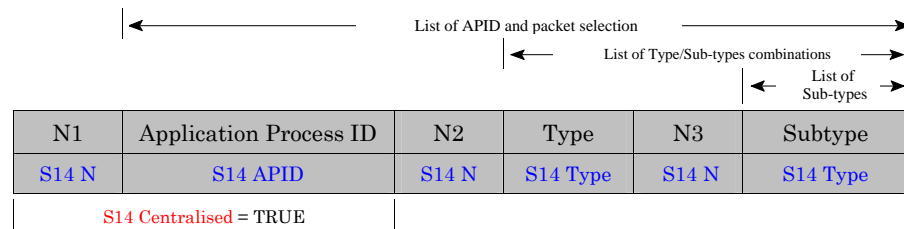
A.13.3.3 Controlling the forwarding of specified housekeeping packets (S14 ST5 and ST6 Provider = TRUE)

The telecommands to enable (Type = 14, Subtype = 5) and disable (Type = 14, Subtype = 6) forwarding of selected housekeeping packets are:

	List of APID/SID combinations		List of housekeeping report identifiers
N1	Application Process ID	N2	SID
S14 N	S14 APID	S14 N	S14 SID

S14 Centralised = TRUE and S14 Multiple Packet Control = TRUE | S14 Centralised = TRUE | S14 Multiple Packet Control = TRUE
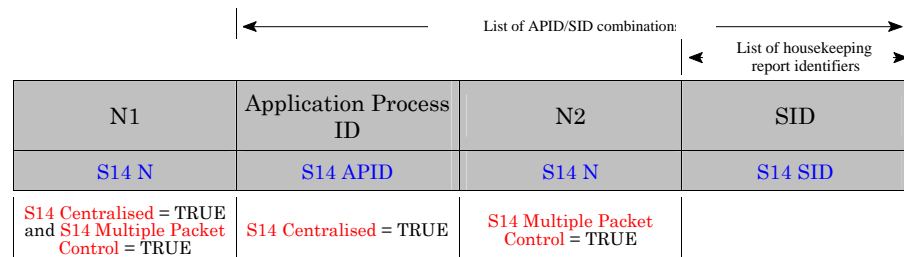
A.13.3.4 Reporting the list of enabled housekeeping packets (S14 ST7 and ST8 Provider = TRUE)

The telecommand to report the list of housekeeping report identifiers with an "Enabled" forwarding status (Type = 14, Subtype = 7) has no application data.

The corresponding telemetry report of enabled housekeeping report identifiers (Type = 14, Subtype = 8) is:

	List of APID/SID combination		List of housekeeping report identifiers
N1	Application Process ID	N2	SID
S14 N	S14 APID	S14 N	S14 SID

S14 Centralised = TRUE
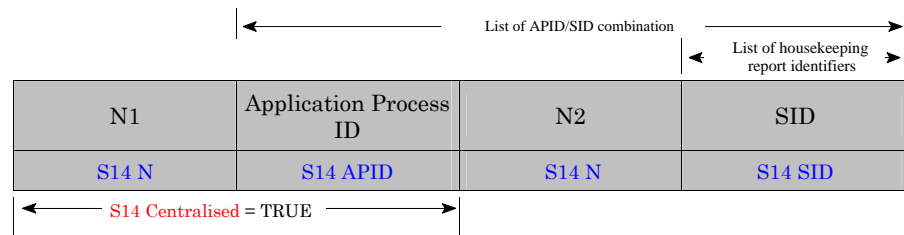
A.13.3.5 Controlling the forwarding of specified diagnostic packets (S14 ST9 and ST10 Provider = TRUE)

The telecommands to enable (Type = 14, Subtype = 9) and disable (Type = 14, Subtype = 10) forwarding of selected diagnostic packets are:

	List of APID/SID combination		List of diagnostic report identifiers
N1	Application Process ID	N2	SID
S14 N	S14 APID	S14 N	S14 SID

S14 Centralised = TRUE and S14 Multiple Packet Control = TRUE | S14 Centralised = TRUE | S14 Multiple Packet Control = TRUE
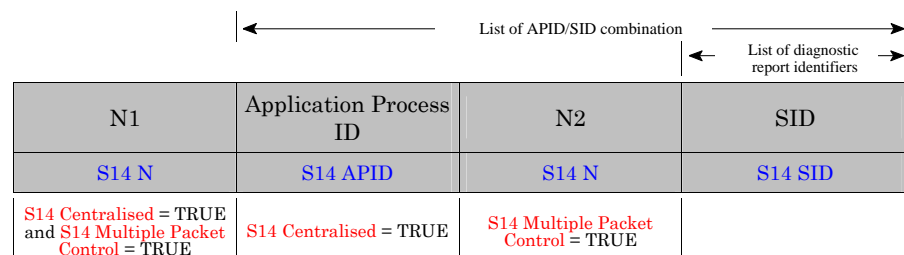
A.13.3.6 Reporting the list of enabled diagnostic packets (S14 ST11 and ST12 Provider = TRUE)

The telecommand to report the list of diagnostic report identifiers with an "Enabled" forwarding status (Type = 14, Subtype = 11) has no application data.

The corresponding telemetry report of enabled diagnostic report identifiers (Type = 14, Subtype = 12) is:
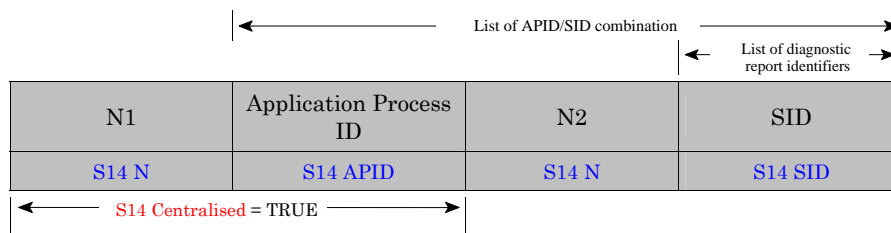
A.13.3.7 Controlling the forwarding of specified event report packets (S14 ST13 and ST14 Provider = TRUE)

The telecommands to enable (Type = 14, Subtype = 13) and disable (Type = 14, Subtype = 14) forwarding of selected event report packets are:
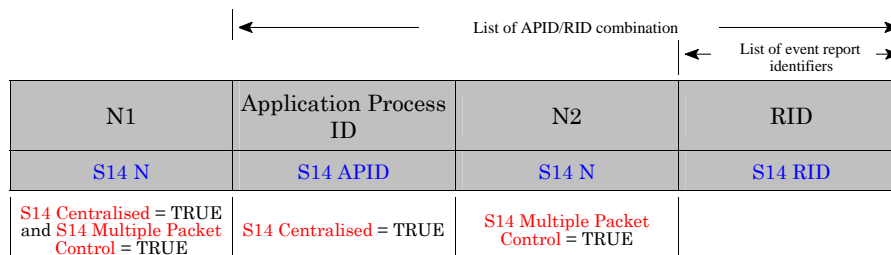
A.13.3.8 Reporting the list of enabled event report packets (S14 ST15 and ST16 Provider = TRUE)

The telecommand to report the list of event report identifiers with an "Enabled" forwarding status (Type = 14, Subtype = 15) has no application data.

The corresponding telemetry report of enabled event report identifiers (Type = 14, Subtype = 16) is:
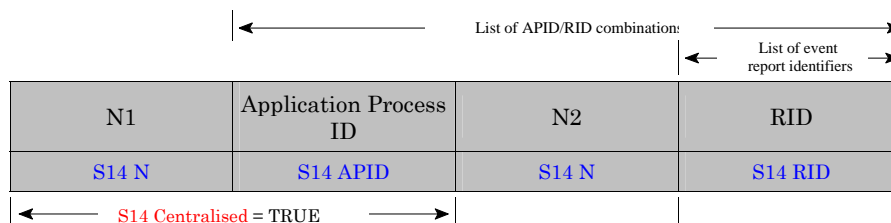
A.14   On-board storage and retrieval service

A.14.1 The PUS service model

This is a supporting service that provides the capability to selectively store telemetry packets on-board for subsequent retrieval and downlink on request from the ground. There are two sub-services defined, viz.:

- the packet selection sub-service which is responsible for selecting which packets shall be sent for on-board storage;

- the packet storage and retrieval sub-service which is responsible for managing the packet store(s) and the subsequent retrieval and downlink of packets requested from ground.

Two possible implementations are supported. In the centralised option, a single application process provides both of these sub-services. In the decentralised option, the sub-services are provided by different on-board application processes.

Two types of packet store are foreseen, circular and bounded. When a circular packet store is full, any subsequently received packet over-writes the oldest packet in the store. When a bounded packet store is full, any subsequently received packet is ignored. The contents of a bounded packet store are explicitly deleted by ground to free up storage space and enable the resumption of storage of newly arriving packets.

Retrieved packets can be downlinked:

- in the same VC as real-time packets, in which case they are wrapped in packet containers belonging to the on-board storage and retrieval service;

- in a VC dedicated for retrieval purposes, in which case the packets are downlinked exactly as they were originally received by the store.

Optional extensions to the service include:

- capabilities to modify the packet storage selection and to report the current selection to the ground on request;

- the capability to retrieve by specifying a time range or a packet range;

- the capability to maintain a catalogue of the contents of a store and to report the catalogue to the ground on request.

A.14.2 Service tailoring data

The tailoring choices available for the on-board storage and retrieval service are shown in Figure 17 (Views 1 to 3).
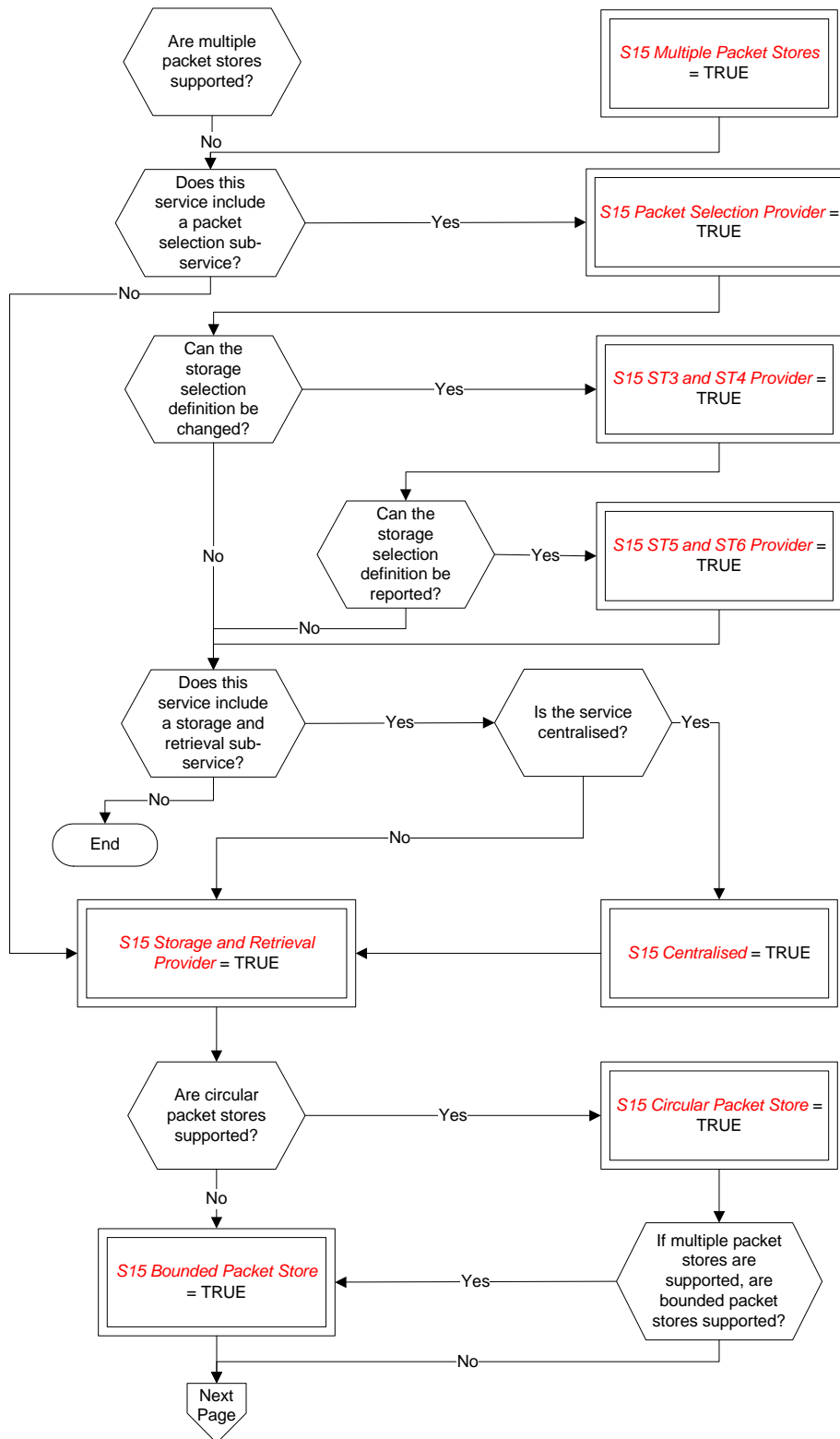
Figure 17   **Tailoring choices for the on-board storage and
retrieval service** (View 1)

Figure 17   Tailoring choices for the on-board storage and retrieval service (View 2)

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Are packets time-stamped at the time of storage?

Yes → S15 Time Stamping = TRUE

No → Go To H

Can packets be downlinked for a specified time period?

Yes → S15 ST9 Provider = TRUE

No → Go To I

Can "all" packet set criterion be used to request downlink of packet store?

Yes → S15 ST9 All Criterion = TRUE

No

J

Can "between" packet set criterion be used to request downlink of packet store?

Yes → Go To J

No

Can "between" packet set criterion be used to request downlink of packet store?

Yes → S15 ST9 Between Criterion = TRUE

No

K

Can "before" packet set criterion be used to request downlink of packet store?

No → Go To L

Yes → Go To K

Can "before" packet set criterion be used to request downlink of packet store?

Yes → S15 ST9 Before Criterion = TRUE

No

L

Can "after" packet set criterion be used to request downlink of packet store?

Yes → S15 ST9 After Criterion = TRUE

No

I

If bounded packet stores are supported, can packet store contents be deleted up to a specified time?

Yes → S15 ST11 Provider = TRUE

H

No

Is reporting of catalogues supported?

Yes → S15 ST12 and ST13 Provider = TRUE

No → End

Figure 17   Tailoring choices for the on-board storage and retrieval service (View 3)

A.14.3 Service requests and reports

A.14.3.1 Controlling the storage in specified packet stores (S15 Packet Selection Provider = TRUE)

The telecommands to enable (Type = 15, Subtype = 1) and disable (Type = 15, Subtype = 2) storage in specified packet stores are:

	List of store identifiers
N	Store ID
S15 N	S15 Store ID
S15 Multiple Packet Stores = TRUE	

A.14.3.2 Modifying the definition of a storage selection criteria (S15 Packet Selection Provider = TRUE and S15 ST3 and ST4 Provider = TRUE)

The telecommand to add (Type = 15, Subtype = 3) and remove (Type = 15, Subtype = 4) packet types and subtypes to/from the storage selection definition for a specified packet store are:

List of packet selection criteria							
				List of Type/Sub-types combination			
						List of Sub-types	
Store ID	N1	Application Process ID	N2	Type	N3	Subtype
S15 Store ID	S15 N	S15 N	S15 N	S15 Type	S15 N	S15 Type
S15 Multiple Packet Stores = TRUE	S15 Centralised = TRUE					

A.14.3.3 Reporting a storage selection definition (S15 Packet Selection Provider = TRUE and S15 ST3 and ST4 Provider = TRUE and S15 ST5 and ST6 Provider = TRUE)

The telecommand to report a storage selection definition (Type = 15, Subtype = 5) is:

Store ID
S15 Store ID
S15 Multiple Packet Stores = TRUE

The corresponding telemetry report (Type = 15, Subtype = 6) is

List of packet selection criteria							
				List of Type/Sub-types combination			
						List of Sub-types	
Store ID	N1	Application Process ID	N2	Type	N3	Subtype
S15 Store ID	S15 N	S15 APID	S15 N	S15 Type	S15 N	S15 Type
S15 Multiple Packet Stores = TRUE	S15 Centralised = TRUE					

A.14.3.4 Downlinking the contents of a packet store for a specified packet range (S15 Storage and Retrieval Provider = TRUE and S15 ST7 Provider = TRUE)

The telecommand to downlink the contents of a packet store for a specified packet range (Type = 15, Subtype = 7) is:

Store ID	Packet Set	Application Process ID 1	Source Sequence Count 1	Application Process ID 2	Source Sequence Count 2
S15 Store ID	S15 Packet Set	S15 APID	S15 Source Sequence Count	S15 APID	S15 Source Sequence Count
S15 Multiple Packet Stores = TRUE	Condition 1 (see below)	← Packet Set = Between, Before or After →		← Packet Set = Between →	

Condition 1 = If only one of the variables (S15 ST7 All Criterion, S15 ST7 Between Criterion, S15 ST7 Before Criterion, S15 ST7 After Criterion) has the value = TRUE

If packets are downlinked in the same Virtual Channel as real-time packets (S15 ST8 Provider = TRUE), the corresponding telemetry report of the packet store contents (Type = 15, Subtype = 8) is:

	← List of telemetry packets →
N	TLM Packet
S15 N	Any TM

A.14.3.5 Downlinking the contents of a packet store for a specified time period (S15 Storage and Retrieval Provider = TRUE and S15 Time Stamping = TRUE and S15 ST9 Provider = TRUE)

The telecommand to downlink the contents of a packet store for a specified time period (Type = 15, Subtype = 9) is:

Store ID	Time Span	Storage Time 1	Storage Time 2
S15 Store ID	S15 Time Span	S15 Time	S15 Time
S15 Multiple Packet Stores = TRUE	Condition 2 (see below)	Time Span = Between, Before or After	Time Span = Between

Condition 2 = If only one of the variables (S15 ST9 All Criterion, S15 ST9 Between Criterion, S15 ST9 Before Criterion, S15 ST9 After Criterion) has the value = TRUE

A.14.3.6 Deleting the contents of specified packet stores up to specified packets (S15 Storage and Retrieval Provider = TRUE and S15 ST10 Provider = TRUE)

The telecommand to delete the contents of specified packet stores up to specified packets (Type = 15, Subtype = 10) is:

		List of store/packet identifier combination		
Deletion Set	N	Store ID	Application Process ID	Source Sequence Count
S15 Packet Set	S15 N	S15 Store ID	S15 APID	S15 Source Sequence Count
Condition 3 (see below)	S15 Multiple Packet Store = TRUE		Deletion Set = Before	

Condition 3 = If only one of the variables (S15 ST10 All Criterion, S15 ST10 Before Criterion) has the value = TRUE

A.14.3.7 Deleting the contents of specified packet stores up to a specified storage time (S15 Storage and Retrieval Provider = TRUE and S15 ST11 Provider = TRUE)

The telecommand to delete the contents of specified packet stores up to a specified storage time (Type = 15, Subtype =11) is:

		List of store identifiers
End Time	N	Store ID
S15 Time	S15 N	S15 Store ID
	S15 Multiple Packet Stores = TRUE	

A.14.3.8 Reporting packet store catalogues (S15 Storage and Retrieval Provider = TRUE and S15 ST12 and ST13 Provider = TRUE)

The telecommand to report the catalogues of selected packet stores (Type = 15, Subtype = 12) is:

	List of store identifiers
N	Store ID
S15 N	S15 Store ID
S15 Multiple Packet Stores = TRUE	

The corresponding telemetry report of packet store catalogues (Type = 15, Subtype = 13) is:

	List of packet store catalogue				
N	Store ID	Application Process ID 1	Source Sequence Count 1	Service Type1	Service Subtype1
S15 N	S15 Store ID	S15 APID	S15 Source Sequence Count	S15 Type	S15 Type

S15 Multiple Packet Stores = TRUE

List of packet store catalogues (contd.

Packet Sub-counter1	Storage Time 1	Application Process ID 2	Source Sequence Count 2	Service Type2	Service Subtype2	
S15 Packet Subcounter	S15 Time	S15 APID	S15 Source Sequence Count	S15 Type	S15 Type	
Optional	S15 Time Stamping = TRUE					

List of packet store catalogues (contd.

Packet Sub-counter2	Storage Time 2	Percentage Filled	Percentage Downlinked	No. of Packets Stored	No. of Packets Downlinked
S15 Packet Subcounter	S15 Time	S15 Percent	S15 Percent	S15 No Of Packets	S15 No Of Packets
Optional	S15 Time Stamping = TRUE				

A.15 Test service

A.15.1 The PUS service model

The test service provides the capability to exercise in-built test functions and to report the results to the ground. It is envisaged that the majority of such test functions are mission-specific in nature. The only generic test identified in the PUS is an end-to-end connection test. This consists of a test request sent from the ground, as a result of which the on-board test service generates a standard test report. This serves to confirm that the uplink and downlink routes are operational and that the application process is alive and capable of performing basic functions including telecommand processing and telemetry packet generation.

A.15.2 Service tailoring data

There are no tailoring choices available for this service.

A.15.3 Service requests and reports

The telecommand to perform an end-to-end connection test (Type = 17, Subtype = 1) has no application data.

The corresponding connection test report (Type = 17, Subtype = 2) has no Source Data.

A.16 On-board operations procedure service

A.16.1 The PUS service model

This service provides the capability for the ground to load operational procedures on-board and to control their subsequent execution. The minimum implementation of the service enables the ground to load a procedure, delete a procedure, start, stop, suspend and resume a procedure.

A procedure can comprise a number of distinct self-contained steps and the suspend operation can specify a step number at which the procedure shall be "held"; similarly the resume operation can indicate the step from which the procedure execution shall be re-started.

Extensions to the service implementation enable:

- parameters to be supplied to the procedure whilst it is running;

- the reporting of the list of procedures loaded on-board and the list of currently active procedures;

A.16.2 Service tailoring data

The tailoring choices available for the on-board operations procedure service are shown in Figure 18.
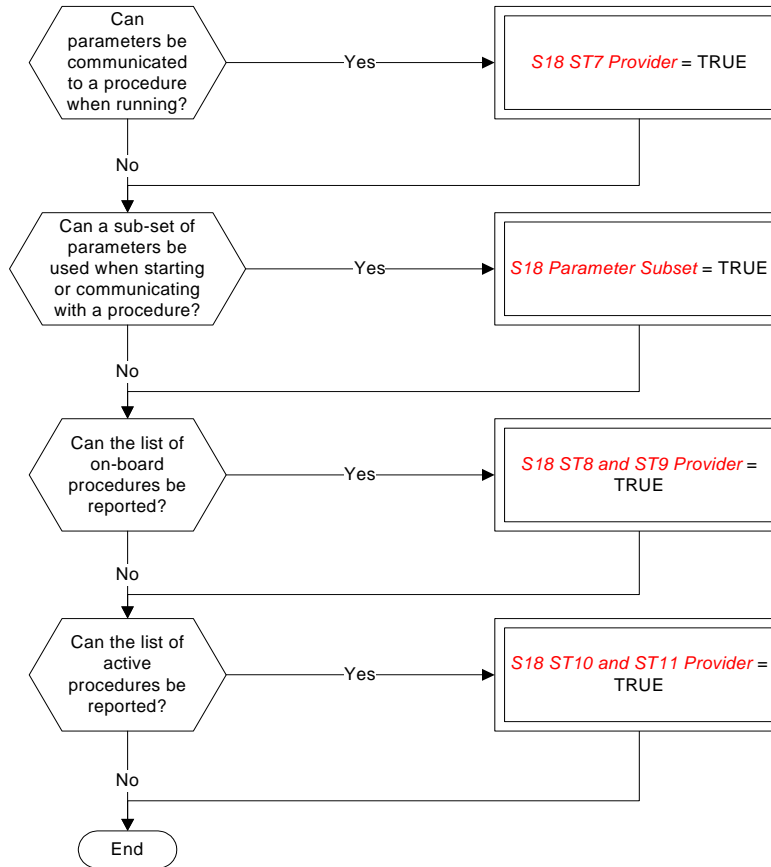
Figure 18 Tailoring choices for the on-board operations procedure service

A.16.3 Service requests and reports

A.16.3.1   Loading a procedure

The telecommand to load a procedure (Type = 18, Subtype = 1) is:

Procedure ID	Length	Procedure Code
S18 Procedure ID	Variable Octet String	

A.16.3.2   Deleting a procedure

The telecommand to delete a procedure (Type = 18, Subtype = 2) is:

Procedure ID
S18 Procedure ID

A.16.3.3   Starting a procedure

There are two possibilities for the telecommand to start a procedure (Type = 18, Subtype = 3). Where the full set of parameters is always provided (or where the procedure has no parameters), the telecommand is:

	← List of parameters →
Procedure ID	Parameters
S18 Procedure ID	Any
	← Optional (procedure-specific) →

Where a variable number of parameters can be supplied (S18 Parameter Subset = TRUE), the telecommand is:

		← List of parameters and their value →	
Procedure ID	N	Parameter#	Value
S18 Procedure ID	S18 N	S18 Parameter Number	Deduced
	← S18 Parameter Subset = TRUE →		

A.16.3.4   Stopping a procedure

The telecommand to stop a procedure (Type = 18, Subtype = 4) is:

Procedure ID	Step ID
S18 Procedure ID	S18 Step ID
	← Optional →

A.16.3.5   Suspend a procedure

The telecommand to suspend a procedure (Type = 18, Subtype = 5) is:

Procedure ID	Step ID
S18 Procedure ID	S18 Step ID
	← Optional →

A.16.3.6   Resume a procedure

The telecommand to resume a procedure (Type = 18, Subtype = 6) is:

Procedure ID	Step ID
S18 Procedure ID	S18 Step ID
	← Optional →

A.16.3.7   Abort a procedure

The telecommand to abort a procedure (Type = 18, Subtype = 12) is:

Procedure ID
S18 Procedure ID

A.16.3.8 Communicate parameters to a procedure (S18 ST7 Provider = TRUE)

There are two possibilities for the telecommand to communicate parameters to a procedure (Type = 18, Subtype =7). Where the full set of parameters is always provided (or where the procedure has no parameters), the telecommand is:

|← List of parameters →|

Procedure ID	Parameters
S18 Procedure ID	Any

|← Optional (procedure-specific) →|

Where a variable number of parameters can be supplied (S18 Parameter Subset = TRUE), the telecommand is:

|← List of parameters and their value →|

Procedure ID	N	Parameter#	Value
S18 Procedure ID	S18 N	S18 Parameter Number	Deduced

|← S18 Parameter Subset = TRUE →|

A.16.3.9 Reporting the list of on-board operations procedures (S18 ST8 and ST9 Provider = TRUE)

The telecommand to report the list of on-board operations procedures (Type = 18, Subtype = 8) has no application data.

The corresponding telemetry report (Type = 18, Subtype = 9) is:

|← List of procedures →|

NPROC	Procedure ID
S18 NProc	S18 Procedure ID

A.16.3.10 Reporting the list of active on-board operations procedures (S18 ST10 and ST11 Provider = TRUE)

The telecommand to report the list of active on-board operations procedures (Type = 18, Subtype = 10) has no application data.

The corresponding telemetry report (Type = 18, Subtype = 11) is:

|← List of procedures and their statuse →|

NPROC	Procedure ID	Status	Step ID
S18 NProc	S18 Procedure ID	S18 Status	S18 Step ID

A.17 Event/action service

A.17.1 The PUS service model

The event/action service enables the definition of an on-board **action** to be implemented when a specified on-board **event** is detected. In the PUS service model, the event is limited to the receipt of a given event report packet (see Annex A.6) and the associated action is limited to the issuing of a telecommand.

The ground can add event/action couplets to the on-board list and can also delete event/action couplets or clear the list altogether.

Optional extensions to the service enable:

- individual actions to be enabled or disabled (whilst the associated event remains nevertheless in the on-board list);

- reporting of the current content of the on-board list on ground request.

A.17.2 Service tailoring data

The tailoring choices available for the event/action service are shown in Figure 19.
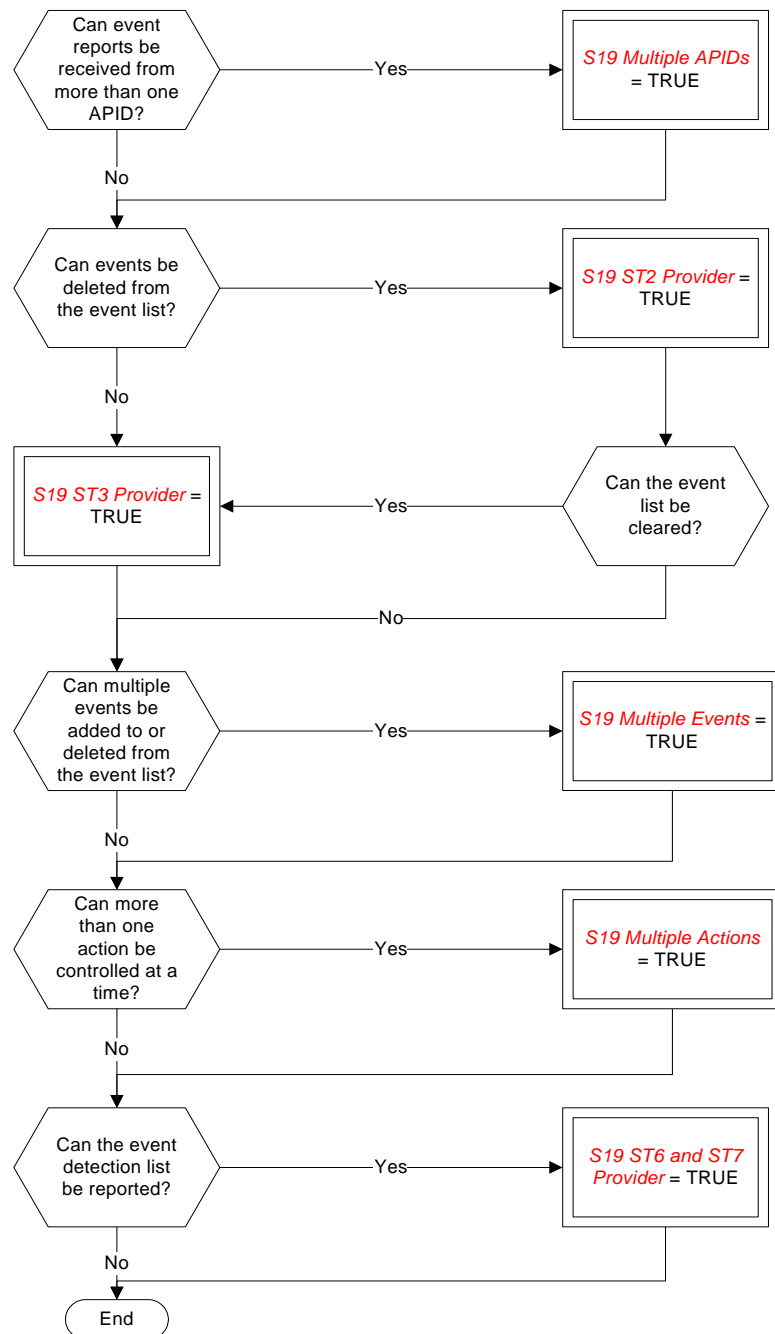
Figure 19 Tailoring choices for the event/action service

A.17.3 Service requests and reports

A.17.3.1 Adding events to the detection list

The telecommand to add events to the detection list (Type = 19, Subtype = 1) is:

N	Application Process ID	RID	Telecommand Packet
S19 N	S19 APID	S19 RID	Any TC

S19 Multiple Events = TRUE | S19 Multiple APIDs = TRUE

List of events report identifiers, their sources and associated actions

A.17.3.2 Deleting events from the detection list (S19 ST2 Provider = TRUE)

The telecommand to delete events from the detection list (Type = 19, Subtype = 2) is:

N	Application Process ID	RID
S19 N	S19 APID	S19 RID

S19 Multiple Events = TRUE | S19 Multiple APIDs = TRUE

List of event report identifiers and their sources

A.17.3.3 Clearing the event detection list (S19 ST3 Provider = TRUE)

The telecommand to clear the event detection list (Type = 19, Subtype = 3) has no application data.

A.17.3.4 Controlling the actions associated with events

The telecommands to enable actions (Type = 19, Subtype = 4) and to disable actions (Type = 19, Subtype = 5) are:

N	Application Process ID	RID
S19 N	S19 APID	S19 RID

S19 Multiple Actions = TRUE | S19 Multiple APIDs = TRUE

List of event report identifiers and their sources

A.17.3.5 Reporting the event detection list (S19 ST6 and ST7 Provider = TRUE)

The telecommand to report the event detection list (Type = 19, Subtype = 6) has no application data.

The corresponding telemetry report (Type = 19, Subtype = 7) is:

N	Application Process ID	RID	Action Status
S19 N	S19 APID	S19 RID	S19 Status

S19 Multiple APIDs = TRUE

List of events and the status of their associated actions

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Annex B (informative)

Data type definitions

B.1   Conventions

In this annex, the ISO extended Backus-Naur form (EBNF) is used as an alternative convention to specify the syntax of data types and language constructs. The complete specification of ISO EBNF is given in ISO/IEC 14977: 1996 (E), but the salient features of the convention are summarised below.

Each syntax rule consists of a non-terminal symbol and an EBNF expression separated by an equal sign (=) and terminated with a semicolon (;) e.g.:

Integer Constant = Sign, { Digit }- ;

The right-hand side of the rule is the definition of the non-terminal symbol on the left-hand side.

The EBNF expression consists of terminal symbols, non-terminal symbols and connective symbols as defined in Table B-1, separated by a ",".

A terminal symbol is a sequence of one or more characters forming an irreducible element. A terminal symbol may consist of one or more words separated by one or more separators. The space, tab and end-of-line characters are separators.

Non-printing characters such as space, tab and end-of-line have no formal effect on the syntax as long as they appear outside of a terminal symbol.

Table B-1 EBNF symbols and meanings

Symbol	Meaning
X | Y	One of X or Y (exclusive or)
[X]	Zero or one occurrence of X
{ X }	Zero or more occurrences of X
{ X }-	One or more occurrences of X
n * X	A repetition of X exactly n times
(X, Y)	Grouping construct

| "Text" | Terminal symbol (text between double quotes representing a keyword). If a double quote is used inside the text, the text is enclosed instead by single quotes. |

Example 1   If Statement = "**if**", Expression, "**then**", {Statement, "**;**"}-, ["**else**", {Statement, "**;**"}-], "**end if**";

means that a set of one or more statements, each followed by a "**;**" appears after the "**then**" part of the definition. The part of the definition within the square brackets (the "**else**" part) is optional, but if present occurs once only in the "if statement".

Example 2   Integer Constant = [Sign], { Digit }- , [? Engineering Units ?];

means that an integer constant is defined as an optional sign (a plus or a minus) followed by a sequence of one or more digits, followed by an optional engineering units.

B.2   Comments

Comments may be inserted anywhere within the script of a complex data type and have no effect on the execution of the script.

Comments begin and end with the character pair symbols "**/***" and "***/**" respectively.

B.3   Data types and data items

B.3.1   Definitions

Data types and data items are defined in clause 5.

B.3.2   EBNF Representation

Absolute Time =

"**absolute time**";

Absolute Time Constant =

(Year, "-", Month, "-", Day Of Month,

"**T**", Hour, "**:**", Minute, "**:**", Second ,

"**.**", Fraction Of Second, ["**Z**"])

| (Year, "-", Day,

"**T**", Hour, "**:**", Minute, "**:**", Second , "**.**",

Fraction Of Second, ["**Z**"]);

Activity Reference =

["**activity**"], Name;

Argument Reference =

["**argument**"], Name;

Binary Digit =

"**0**" | "**1**";

Binary Symbol =

"**0b**";

Bit String =

"**bit string**";

Bit String Constant =

Binary Symbol, {Binary Digit}-;

Boolean =

"**Boolean**";

Boolean Constant =

"**TRUE**" | "**FALSE**";

Character =

Digit | Letter | " " | "**!**" | "**\"**" | "**#**" | "**$**" | "**%**" | "**&**" | "**'**" | "**(**"

| "**)**" | "***** " | "**+**" | "**,**" | "**-**" | "**.**" | "**/**" | "**:**" | "**;**" | "**<**" | "**=**" | "**>**"

| "**?**" | "**@**" | "**[**" | "****" | "**]**" | "**^**" | "**_**" | "**`**" | "**{**" | "**|**" | "**}**" | "**~**";

Character String =

"**character string**";

Character String Constant =

"**"**", {Character}, "**"**";

Complex Data Type =

"**Activity Call**"

|"**EXPL**"

|"**IFL**"

|"**SPEL**"

|" **VAL**"

|"**PLUTO**";

Complex Data Type Constant =

Activity Call

|?Expression Language Expression Definition?

|?Interpretation Function Language Expression Definition?

|?Synthetic Parameter Expression Definition?

|?Value Set Definition?

|?Procedure Definition?

Data Type =

Simple Data Type

| Complex Data Type

Data Value =

Name

| Object Reference

| Boolean Constant

| Integer Constant

| Real Constant

| Character String Constant

| Absolute Time Constant

| Relative Time Constant

| PTC Constant

| PFC Constant

| Service Type Constant

| Service Subtype Constant

| Complex Data Type Constant

| Simple Data Type;

Day =

3 * Digit;

Day Of Month =

2 * Digit;

Days =

{Digit}-;

Digit =

"0" | "1" | "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9";

Entity Type =

      Identifier;

Entity Type Reference =

      Entity Type, "**reference**" ;

Enumerated Constant =

      "", {Character}-, **""**;

Event Reference =

      ["**event**"], Name;

Fraction Of Second =

      {Digit}-;

Hexadecimal Constant =

      Hexadecimal Symbol, {Hexadecimal Digit}-;

Hexadecimal Digit =

      Digit | "**A**" | "**B**" | "**C**" | "**D**" | "**E**" | "**F**";

Hexadecimal Symbol =

      "**0x**";

Hour =

      2 * Digit;

Hours =

      {Digit}-;

Identifier =

      Identifier First Word, {Identifier Subsequent Word };

Identifier First Word =

      Letter, {Letter | Digit };

Identifier Subsequent Word =

      Letter, {Letter | Digit };

Integer =

      ["**long**"], "**integer**", ["**with units**", ?Engineering Units?],

      ["**in the interval {**", Integer Constant, "**,**", Integer Constant, "**}**"];

Integer Constant =

    [Sign], {Digit}-, [?Engineering Units?];

Letter =

    "**a**" | "**b**" | "**c**" | "**d**" | "**e**" | "**f**" | "**g**" | "**h**" | "**i**" | "**j**"| "**k**" | "**l**" | "**m**" | "**n**"

    | "**o**" | "**p**" | "**q**" | "**r**" | "**s**"| "**t**" | "**u**" | "**v**" | "**w**" | "**x**" | "**y**" | "**z**" | "**A**"

    | "**B**"| "**C**" | "**D**" | "**E**" | "**F**" | "**G**" | "**H**" | "**I**" | "**J**" | "**K**"| "**L**" | "**M**"

    | "**N**" | "**O**" | "**P**" | "**Q**" | "**R**" | "**S**" | "**T**"| "**U**" | "**V**" | "**W**" | "**X**" | "**Y**"

    | "**Z**";

Minute =

    2 * Digit;

Minutes =

    {Digit}-;

Month =

    2 * Digit;

Name =

    Identifier {"**of**", Object Reference};

Object Reference =

    [Entity Type], Name;

Octet String =

    "**octet string**";

Octet String Constant =

    Hexadecimal Symbol, { 2 x Hexadecimal Digit}-;

PC =

    "**PTC**", {Digit}-, ["**PFC**", {Digit}-];

PFC =

    "**PFC**", "**of**", "**PTC**", {Digit}-;

PFC Constant =

    "**PFC**", {Digit}-;

Product Reference =

    ["**product**"], Name;

PTC =

    "**PTC**";

PTC Constant =

    "**PTC**, {Digit}-;

PUS Data Type =

     PC

    | PTC

    | PFC

    | Service Type

    | Service Subtype;

Real =

    ["**long**"], "**real**", ["**with units**", ?Engineering Units?]

    ["**in the interval {**", Real Constant, "**,**", Real Constant, "**}**"];

Real Constant =

    [Sign], {Digit}-, ["**.**", {Digit}-],

    [("**e**"|"**E**"), [Sign], {Digit}-],

    [?Engineering Units?];

Relative Time =

    "**relative time**";

Relative Time Constant =

    ([Sign], (Days, "**d**")

    | ([Days, "**d**"],

      ((Hours, "**h**")

      | ([Hours, "**h**"],

        ((Minutes, "**min**")

        | ([Minutes, "**min**"], Seconds,

         ["**.**", Fraction Of Second], "**s**"))))))

    | ([Sign], Days, "**:**", Hour, "**:**", Minute, "**:**", Second ,

    "**:**", Fraction Of Second);

Reporting Data Reference =

    ["**reporting data**" | "**parameter**"], Name;

Second =

      2 * Digit;

Seconds =

      {Digit}-;

Service Subtype =

      "**service subtype**", "**of**", Service Type, {Digit}-;

Service Subtype Constant =

      "**service subtype**", {Digit}-;

Service Type =

      "**service type**";

Service Type Constant =

      "**service type**", {Digit}-;

Sign =

      "**+**" | "**-**";

Simple Data Type =

      Boolean

      | Integer

      | Unsigned Integer

      | Real

      | Bit String

      | Octet String

      | Character String

      | Absolute Time

      | Relative Time

      | Value Type Set

      | Value Type Data Type

      | PUS Data Type

      | User Defined Enumerated Type;

System Element Reference =

      ["**system element**"], Name;

Unsigned Integer =

["**long**"], "**unsigned integer**", ["**with units**", ?Engineering Units?]

["**in the interval {**", Unsigned Integer Constant, "**,**",

Unsigned Integer Constant, "**}**"];

Unsigned Integer Constant =

({Digit}-, [?Engineering Units?])| Hexadecimal Constant;

User Defined Enumerated Type =

"**enumerated type**", User Defined Enumerated Type Reference;

User Defined Enumerated Type Reference =

Name;

Value Type =

Identifier;

Value Type Data Type =

"**same as**", Value Type, {"**of**", Entity Type},

"**of**",(Object Reference|("**current**", Entity Type));

Value Type Set =

(Value Type,

(({"**of**", ["**current**"], Entity Type}-,

[("**of**",((Object Reference)

|(Value Type, {"**of**", Entity Type}, Data Value)))])

| ("**of**",Object Reference)))

| (Entity Type Reference,

["**of**", Value Type, {"**of**", Entity Type}, Data Value]);

Year =

4 * Digit;

B.4   Activity Call

The use of Activity Call ensures conformance with the activity call requirements given in subclause 6.2.2.

The syntax for defining constants of type Activity Call is specified in Annex A.3.9.28 of ECSS-E-70-32A.

B.5 EXPL - Expression Language

B.5.1 Definitions

The use of EXPL ensures conformance with the expression requirements given in subclause 6.2.3.

The syntax for defining constants of type EXPL (i.e. Expression Language Expression Definition) is the following:

Expression Language Expression Definition =

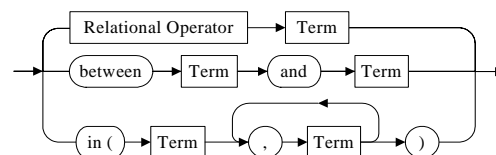Expression

Expression =

Relational Expression → Boolean Operator → Expression
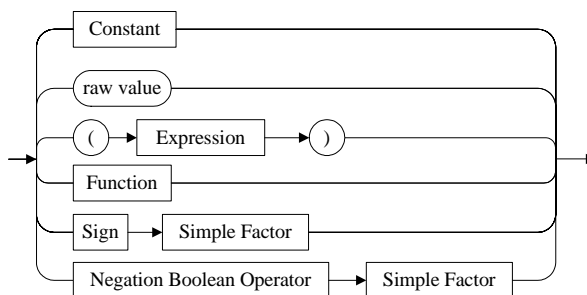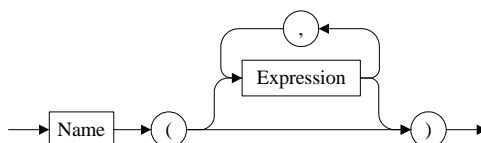
Relational Expression =

Term → Comparative Expression

Term =

Product → Addition Operator → Term

Comparative Expression =

Relational Operator → Term
between → Term → and → Term
in (→ Term → , → Term →)

Product =

Factor → Multiplication Operator → Product

Factor =

Simple Factor → ** → Factor

Simple Factor =

Function =

where:

- Table 6 of ECSS-E-70-32A defines, for each operator, the types that can be used for the operands.

- Boolean Operator is one of the symbols {"AND", "OR", "XOR"}.

- Addition Operator is one of the characters {"+", "-"}.

- Relational Operator is one of the symbols {"AND", "OR", "XOR"}.

- Multiplication Operator is one of the characters {"*", "/"}.

- Sign is one of the characters {"+", "-"}.

- Negation Boolean Operator is the symbol "NOT".

- Function is one of the functions defined in ECSS-E-70-32A Annex C.

- Object Reference, Boolean Constant, Integer Constant, Real Constant, Character String Constant, Absolute Time Constant, Relative Time Constant and Simple Data Type are as defined in subclauses 5.4 and 5.5.

B.5.2   EBNF Representation

Addition Operator =

"**+**" | "**-**";

Boolean Operator =

"**AND**" | "**OR**" | "**XOR**";

Comparative Expression =

(Relational Operator, Term)

| ("**between**", Term, "**and**", Term)
| ("**in (**", Term,{"**,**", Term}, "**)**");

Constant =

        Object Reference

        | Boolean Constant

        | Integer Constant

        | Real Constant

        | Character String Constant

        | Absolute Time Constant

        | Relative Time Constant

        | Simple Data Type;

Expression =
        Relational Expression, [Boolean Operator, Expression];

Expression Language Expression Definition =
        Expression;

Factor =
        Simple Factor, ["**", Factor];

Function =
        Name "(", [Expression, {",", Expression}], ")";

Multiplication Operator =
        "*" | "/";

Negation Boolean Operator =
        "NOT";

Product =
        Factor, [Multiplication Operator, Product];

Relational Expression =
        Term, [Comparative Expression];

Relational Operator =
        "=" | "!=" | "<" | ">" | "<=" | ">=";

Sign =
        "+" | "-";

Simple Factor =

 Constant

 | "**raw value**"

 | ("**(**",Expression, "**)**")

 | Function

 | (Sign, Simple Factor)

 | (Negation Boolean Operator, Simple Factor);


Term =

 Product, [Addition Operator, Term];

B.6 IFL - Interpretation Function Language

B.6.1 Definition

The use of IFL ensures conformance with the requirements given in subclause 6.2.4.

The syntax for defining constants of type IFL (i.e. Interpretation Function Language Expression Definition) is the following:

Interpretation Function Language Expression Definition =

Expression =

Relational Expression =

Term =

Comparative Expression =

Product =

Factor =

Simple Factor =

Function =

where:

- Table 6 of ECSS-E-70-32A defines, for each operator, the types that can be used for the operands.

- Boolean Operator is one of the symbols {"AND", "OR", "XOR"}.

- Addition Operator is one of the characters {"+", "-"}.

- Relational Operator is one of the symbols {"AND", "OR", "XOR"}.

- Multiplication Operator is one of the characters {"*", "/"}.

- Sign is one of the characters {"+", "-"}.

- Negation Boolean Operator is the symbol "NOT".

- Function is one of the functions defined in ECSS-E-70-32A Annex C.

- Object Reference, Boolean Constant, Integer Constant, Real Constant, Character String Constant, Absolute Time Constant, Relative Time Constant and Simple Data Type are as defined in subclauses 5.4 and 5.5.

B.6.2   EBNF Representation

Addition Operator =

        "+" | "-";

Boolean Operator =

    "**AND**" | "**OR**" | "**XOR**";

Comparative Expression =

    (Relational Operator, Term)

    | ("**between**", Term, "**and**", Term)
    | ("**in (**", Term,{"**,**", Term}, "**)**");

Constant =

    Object Reference

    | Boolean Constant

    | Integer Constant

    | Real Constant

    | Character String Constant

    | Absolute Time Constant

    | Relative Time Constant

    | Simple Data Type;

Expression =

    Relational Expression, [Boolean Operator, Expression];

Factor =

    Simple Factor, ["******", Factor];

Function =

    Name "**(**", [Expression, {"**,**", Expression}], "**)**";

Interpretation Function Language Expression Definition =
    Expression;

Multiplication Operator =

    "*****" | "**/**";

Negation Boolean Operator =

    "**NOT**";

Product =

    Factor, [Multiplication Operator, Product];

Relational Expression =

    Term, [Comparative Expression];

Relational Operator =

    "**=**" | "**!=**" | "**<**" | "**>**" | "**<=**" | "**>=**";

Sign =

   "**+**" | "**-**";

Simple Factor =

   Constant

   | "**raw value**"

   | ("**(**",Expression, "**)**")

   | Function

   | (Sign, Simple Factor)

   | (Negation Boolean Operator, Simple Factor);

 Term =

   Product, [Addition Operator, Term];

B.7   SPEL - Synthetic Parameter Expression Language

B.7.1   Definitions

The use of SPEL ensures conformance with the requirements given in subclause 6.2.6.

The syntax for defining constants of type SPEL (i.e. Synthetic Parameter Expression Definition) is the following:

Synthetic Parameter Expression Definition =
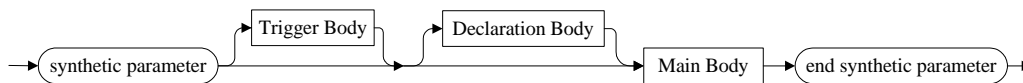
where:

- Trigger Body defines the conditions under which the calculation is executed.

- Declaration Body declares the local variables used for the calculation.

- Main Body contains the statements that perform the synthetic parameter calculation.

Trigger Body =
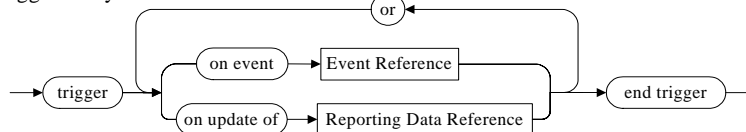
Declaration Body =
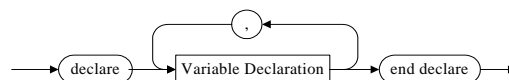
Variable Declaration =
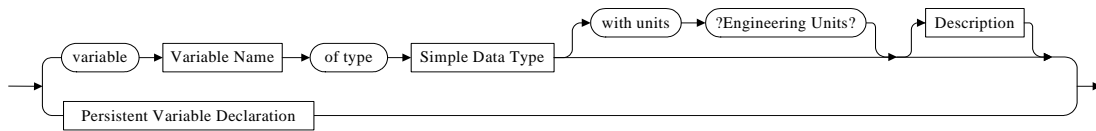
Persistent Variable Declaration =
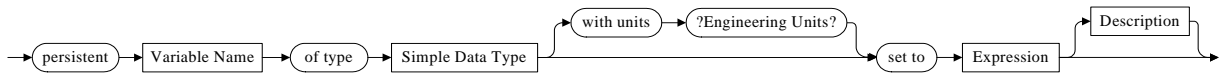
Description =

where:

- Variable Declaration declares the local variables used for the synthetic parameter calculation.

- Persistent Variable Declaration are those variables that maintain their values from one synthetic parameter calculation to the next (Example: A synthetic parameter that uses the delta between the current value and the previous value of a given parameter).

- Simple Data Type is one of the simple data types defined in subclause 5.5.2.

Main Body =
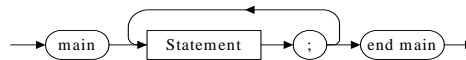
Statement =
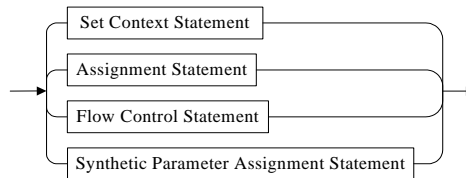
where:

- Set Context Statement defines the context in which the related set of statement executes.

- Assignment Statement assigns a value to a local variable.

- Flow Control Statement controls the execution flow through the main body.

- Synthetic Parameter Assignment Statement assigns the engineering value of the synthetic parameter or of one of its components.

Set Context Statement =
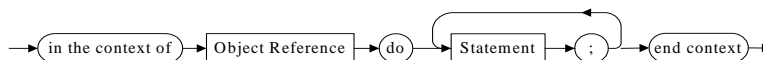
where Set Context Statement defines the context in which a set of statements executes, i.e. a system element or a reporting data context identified by the Object Reference.

Assignment Statement =

→ Variable Reference → := → Expression →
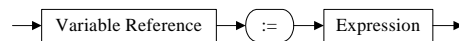
where Assignment Statement assigns the value of a local variable.

Flow Control Statement =

→ If Statement / Case Statement →

If Statement =

→ if → Expression → then → Statement → ; → else → Statement → ; → end if →

Case Statement =

→ in case → Expression → is → Case Tag → : → Statement → ; or is → otherwise → : → Statement → ; → end case →

Case Tag =

→ Comparative Expression → Boolean Operator → Comparative Expression →
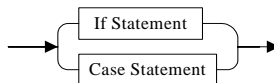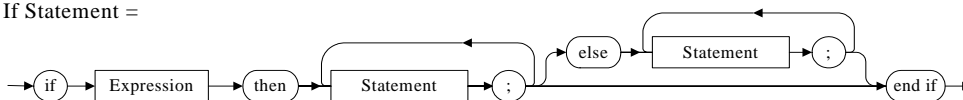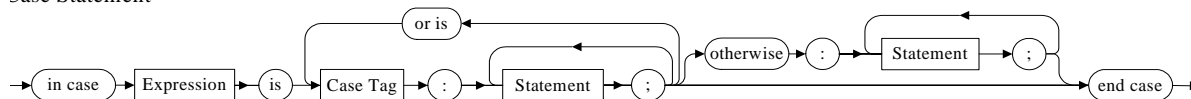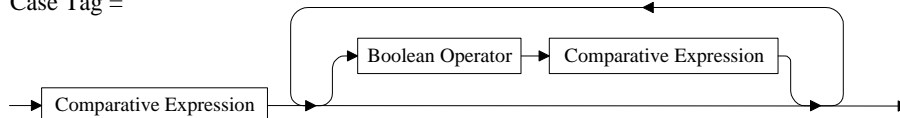
where:

The Case Statement works in the following way:

1. If the value of the "**in case**" expression corresponds to the value of one of the case tags then the corresponding statement (or set of statements) is executed.

2. If the value of the "**in case**" expression does not correspond to any of the values of the case tags, and if there is an "**otherwise**" case tag, then the corresponding statement (or set of statements), and only that one, is executed.

3. Otherwise, no statement (or set of statements) is executed.

If two or more case tags have the same value only the first one is processed.

If the "**in case**" expression corresponds to the value of two or more case tags, only the first one is processed.

Synthetic Parameter Assignment Statement =
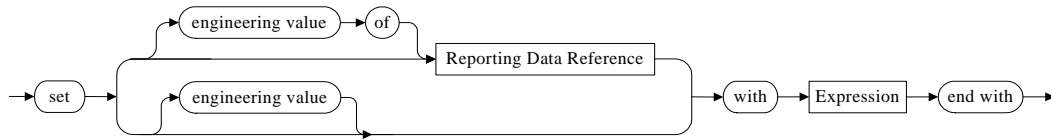
where Synthetic Parameter Assignment Statement assigns the engineering value of a synthetic parameter or the engineering value of one of the components of a compound synthetic parameter.

Object Property Request =
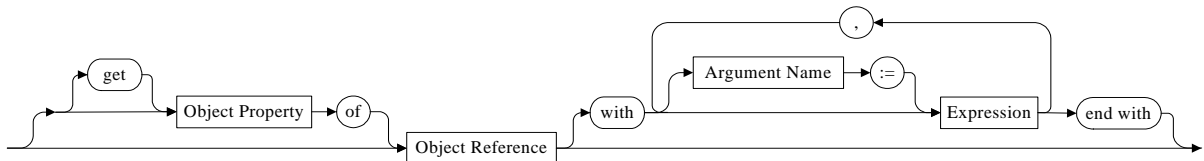
where Reporting Data Property Request obtains the requested property of the related reporting data. The standard properties that can be requested for a reporting data or a variable are defined in Table A-6 of ECSS-E-70-32A.

The following conventions apply:

- Reference to a property of a reporting data alone implies the "get" request (e.g. "If Raw Value **of** Battery1 Voltage > 127, then…." implies that the raw value of the parameter Battery1 Voltage is "got").

- Reference to a parameter alone (i.e. no request and no property) implies the "get" Engineering Value request (e.g. "Wait until Elevation **of** Redu Prime Antenna < 5 deg ….." implies that the engineering value of the parameter Elevation of Redu Prime Antenna is "got").
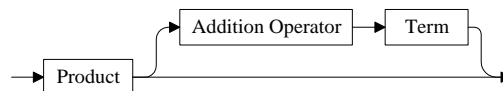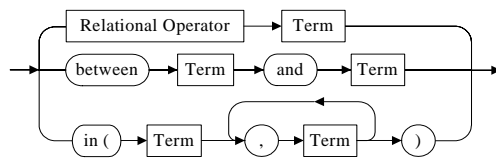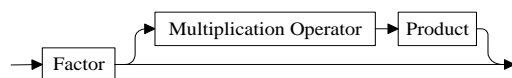
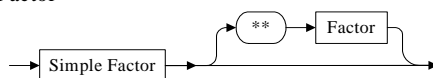Expression =
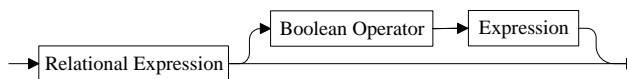
Relational Expression =
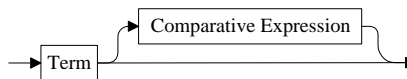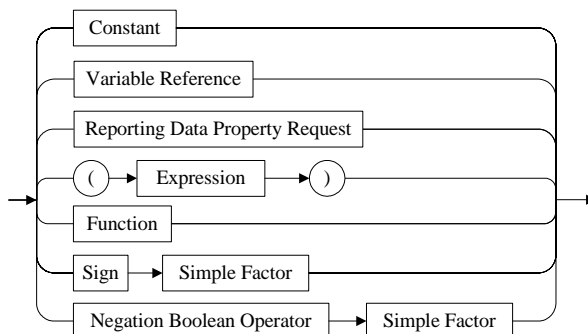

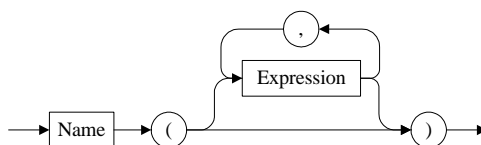
Term =

Comparative Expression =

Product =

Factor =

Simple Factor =

Function =

where:

- Table 6 of ECSS-E-70-32A defines, for each operator, the types that can be used for the operands.

- Boolean Operator is one of the symbols {"**AND**", "**OR**", "**XOR**"}.

- Addition Operator is one of the characters {"**+**", "**-**"}.

- Relational Operator is one of the symbols {"**AND**", "**OR**", "**XOR**"}.

- Multiplication Operator is one of the characters {"*****", "**/**"}.

- Sign is one of the characters {"**+**", "**-**"}.

- Negation Boolean Operator is the symbol "**NOT**".

- Function is one of the functions defined in ECSS-E-70-32A Annex C or one of the bit-manipulation functions defined in Annex B.7.2.

- Object Reference, Boolean Constant, Integer Constant, Real Constant, Character String Constant, Absolute Time Constant, Relative Time Constant and Simple Data Type are as defined in subclauses 5.4 and 5.5.

B.7.2   Bit-manipulation functions

Name	Arguments Type	Result Type	Description	Example
bitand	integer (list of 2 arguments)	integer	Returns the bit wise and of the arguments.	bitand(7, 5) = 5
bitnot	integer	integer	Returns the bit wise negative of the argument.	bitnot(x)+1 = -x
bitor	integer (list of 2 arguments)	integer	Returns the bit wise or of the arguments.	bitor(7, 5) = 7
bitxor	integer (list of 2 arguments)	integer	Returns the bit wise exclusive or of the arguments.	bitxor(7, 5) = 2
bitshl	integer (list of 2 arguments)	integer	Returns the value of the first argument, shifted to the left by the number of bits given in the second argument.	bitshl(7, 1) = 14
bitshr	integer (list of 2 arguments)	integer	Returns the value of the first argument, shifted to the right by the number of bits given in the second argument. NOTE: The sign bit is not copied. Right-shifting a negative number will yield a positive result.	bitshr(7, 1) = 3

B.7.3   EBNF Representation

Addition Operator =

"**+**" | "**-**";

Assignment Statement =

Variable Reference, "**:=**", Expression;

Boolean Operator =

"**AND**" | "**OR**" | "**XOR**";

Case Statement =

"**in case**", Expression, "**is**", Case Tag, "**:**", {Statement, "**;**"}-

{"**or is**", Case Tag, "**:**", {Statement, "**;**"}-},

["**otherwise**", "**:**", {Statement, "**;**"}-],

"**end case**";

Case Tag =

    Comparative Expression,

    {Boolean Operator, Comparative Expression};

Comparative Expression =

    (Relational Operator, Term)

    | ("**between**", Term, "**and**", Term)
    | ("**in (**", Term,{"**,**", Term}, "**)**");

Constant =

    Object Reference

    | Boolean Constant

    | Integer Constant

    | Real Constant

    | Character String Constant

    | Absolute Time Constant

    | Relative Time Constant

    | Simple Data Type;

Declaration Body =

    "**declare**",

    Variable Declaration,

    {"**,**", Variable Declaration},

    "**end declare**";

Description =

    "**described by**", Character String Constant;

Expression =

    Relational Expression, [Boolean Operator, Expression];

Factor =

    Simple Factor, ["******", Factor];

Flow Control Statement =

    If Statement

    | Case Statement;

Function =

    Name "**(**", [Expression, {"**,**", Expression}], "**)**";

If Statement =

"**if**", Expression,

"**then**", {Statement, "**;**"}-,

["**else**", {Statement, "**;**"}-],

"**end if**";

Main Body =

("**main**", {Statement, "**;**"}-, "**end main**")

| {Statement, "**;**"}-;

Multiplication Operator =

"*****" | "**/**";

Negation Boolean Operator =

"**NOT**";

Persistent Variable Declaration =

"**persistent**", Name, "**of type**", Simple Data Type,

["**with units**", ?Engineering Units?],

"**set to**", Expression,

[Description];

Product =

Factor, [Multiplication Operator, Product];

Relational Expression =

Term, [Comparative Expression];

Relational Operator =

"**=**" | "**!=**" | "**<**" | "**>**" | "**<=**" | "**>=**";

Reporting Data Property Name =

Name;

Reporting Data Property Request =

[["**get**"], Reporting Data Property Name, " **of** "],

Reporting Data Reference;

Set Context Statement =

    "**in the context of**", Object Reference, "**do**",

    {Statement, "**;**"}-,

    "**end context**";

Sign =

    "**+**" | "**-**";

Simple Data Type =

    Boolean

    | Integer

    | Unsigned Integer

    | Real

    | Character String

    | Absolute Time

    | Relative Time;

Simple Factor =

    Constant

    | Variable Reference

    | Reporting Data Property Request

    | ("**(**", Expression, "**)**")

    | Function

    | (Sign, Simple Factor)

    | (Negation Boolean Operator, Simple Factor);

Statement =

    Set Context Statement

    | Assignment Statement

    | Flow Control Statement

    | Synthetic Parameter Assignment Statement;

Synthetic Parameter Assignment Statement =

    "**set**", ((["**engineering value**", "**of**"], Reporting Data Reference)

    | ["**engineering value**"]), "**with**", Expression, "**end with**";

Synthetic Parameter Expression Definition =

"**synthetic parameter**",

[Trigger Body],

[Declaration Body],

Main Body,
"**end synthetic parameter**";

Term =

Product, [Addition Operator, Term];

Trigger Body =

"**trigger**",

("**on event**", Event Reference)

| ("**on update of**", Reporting Data Reference),

{"**or**", ("**on event**", Event Reference)

| ("**on update of**", Reporting Data Reference)},

"**end trigger**";

Variable Declaration =

"**variable**" (Name, "**of type**", Simple Data Type,

["**with units**", ?Engineering Units?],

 [Description])

| Persistent Variable Declaration;

Variable Reference =

["**variable**"], Name;

B.8   PLUTO – Procedure Language

The use of PLUTO ensures conformance with the requirements given in subclause 6.2.5.

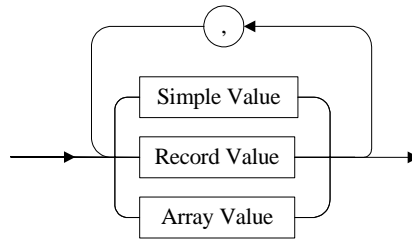The syntax for defining constants of type PLUTO (i.e. Procedure Definition is defined in Annex A of ECSS-E-70-32A.

B.9   VAL – Value Language
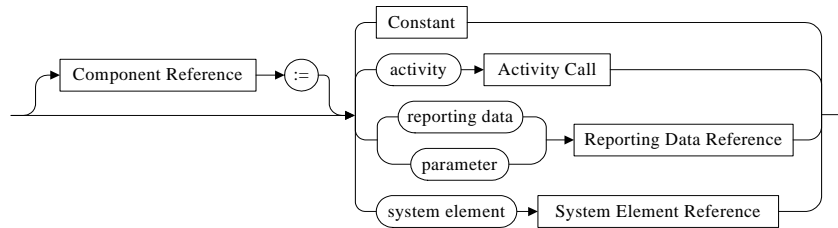
B.9.1   Definition

The use of VAL ensures conformance with the requirements given in subclause 6.2.7.

The syntax for defining constants of type VAL (i.e. Value Set Definition) is the following:
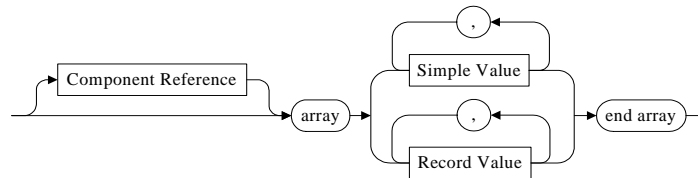
Value Set Definition =

Simple Value =

Record Value =

Array Value =

where:

Depending on whether the value set is related to arguments of an activity or to a reporting data, the Component Reference refers to:

- an argument or a component of a compound argument, or

- a reporting data or a component of a compound parameter.

Activity Call is a call to an activity as defined in Annex B.4.

Reporting Data Reference is a reference to a reporting data as defined in subclause 5.5.

System Element Reference is a reference to a system element as defined in subclause 5.5.

Object Reference, Boolean Constant, Integer Constant, Real Constant, Character String Constant, Absolute Time Constant, Relative Time Constant and Simple Data Type are as defined in subclauses 5.4 and 5.5.

B.9.2   EBNF Representation

Array Value =

 [Component Reference], "**array**",

  ((Simple Value, {"**,**", Simple Value })

  | (Record Value, {"**,**", Record Value })),

  "**end array**";

Component Reference =

 Name;

Constant =

  Object Reference

  | Boolean Constant

  | Integer Constant

  | Real Constant

  | Character String Constant

  | Absolute Time Constant

  | Relative Time Constant

  | Simple Data Type;

Record Value =

 [Component Reference], "**record**", Value Set Definition, "**end record**";

Simple Value =

 [Component Reference, "**:=**"],

 (Constant

 | ("**activity**", Activity Call)

 | (("**reporting data**"|"**parameter**"), Reporting Data Reference)

 | ("**system element**", System Element Reference));

Value Set Definition =

 (Simple Value | Record Value | Array Value),

 {"**,**", (Simple Value | Record Value | Array Value)};

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[14]   *ECSS-E-00   Space engineering – Policy and principles*

[15]   *ECSS-E-50   Space engineering – Communication*

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ECSS Change Request / Document Improvement Proposal

A Change Request / Document Improvement Proposal for an ECSS Standard may be submitted to the ECSS Secretariat at any time after the standard's publication using the form presented below.

This form can be downloaded in MS Word format from the ECSS Website (www.ecss.nl, in the menus: Standards - ECSS forms).

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Organization: e-mail:				2. ECSS Document number: 3. Date:	
4. Number.	5. Location of deficiency clause page (e.g. 3.1 14)	6. Changes		7. Justification	8. Disposition

Filling instructions:

1. **Originator's name -** Insert the originator's name and address

2. **ECSS document number -** Insert the complete ECSS reference number (e.g. ECSS-M-00B)

3. **Date -** Insert current date

4. **Number -** Insert originator's numbering of CR/DIP (*optional*)

5. **Location -** Insert clause, table or figure number and page number where deficiency has been identified

6. **Changes -** Identify any improvement proposed, giving as much detail as possible

7. **Justification -** Describe the purpose, reasons and benefits of the proposed change

8. **Disposition -** not to be filled in

Once completed, please send the CR/DIP by e-mail to: ecss-secretariat@esa.int

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