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Space engineering - Test and operations procedure language

Raumfahrttechnik - Sprache für Test- und Bedienprozeduren

Ingénierie spatiale - Language de procedure pour les essais et des operations

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Foreword

This document (EN 16603-70-32:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-70-32:2014) originates from ECSS-E-ST-70-32C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The procedure is the principal mechanism employed by the end-user to control the space system during pre-launch functional testing and post-launch in-orbit operations.

This Standard identifies the requirements to be satisfied by any language used for the development of automated test and operation procedures.

It also defines a reference language that fulfils these requirements. This language is called the “procedure language for users in test and operations (PLUTO)”.

1
Scope

This Standard specifies:

- The capabilities of the language used for the definition of procedures for space system testing and operations.
- The PLUTO language.

Clause 4 defines the context in which procedures operate.

Clause 5 contains the requirements for the procedure language.

Annex A specifies the PLUTO language. This includes:

- The "building blocks" that constitute procedures and the role that each of these building blocks plays in achieving the overall objectives of the procedure.
- The dynamic aspects of procedures i.e. the execution logic of each building block and execution relationships between these blocks.
- The syntax and semantics of the language itself.

Annex B specifies the engineering units to be supported by the procedure language.

Annex C specifies the mathematical, time and string functions to be supported by the procedure language.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

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.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
	ISO/IEC 14977	Information technology - Syntactic metalanguage – Extended BNF

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.

3.2 Terms specific to the present standard

3.2.1 activity

space system monitoring and control function

3.2.2 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**.

3.2.3 confirmation body

part of a **procedure** (or **step**) whose purpose is to assess whether or not the objective of the **procedure** (or **step**) has been achieved

3.2.4 continuation test

language construct used to define how the execution of a **procedure** (or **step**) proceeds after a constituent **step** (or **activity**) has been executed

3.2.5 event

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

3.2.6 initiation

act of requesting the execution of a **step** or an **activity**

3.2.7 main body

part of a **procedure** (or **step**) dedicated to achieving the objectives of the **procedure** (or **step**)

3.2.8 parameter

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

3.2.9 preconditions body

part of a **procedure** dedicated to ensuring that the **procedure** only executes if or when pre-defined initial conditions are satisfied

3.2.10 procedure

means for interacting with the space system in order to achieve a given objective or sequence of objectives

3.2.11 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).

3.2.12 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**

3.2.13 statement

element of the **procedure** language which, together with other elements, implements the goal of a **procedure** (or **step**)

3.2.14 step

component of a **procedure** that achieves a well-defined sub-goal

3.2.15 system element

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

3.2.16 watchdog body

part of a **procedure** (or **step**) which manages contingency situations that can arise during the execution of the **procedure** (or **step**)

3.2.17 watchdog step

component of the **watchdog body** dedicated to detecting the occurrence of a particular contingency condition and executing corrective actions

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AIV	assembly, integration and verification
EBNF	extended Backus-Naur form
EGSE	electrical ground support equipment
EMCS	EGSE and mission control system
FCP	flight control procedure
FOP	flight operations plan
MMI	man-machine interface
PLUTO	procedure language for users in test and operations
SCOE	special check-out equipment
SSM	space system model

4
Context of the procedure language

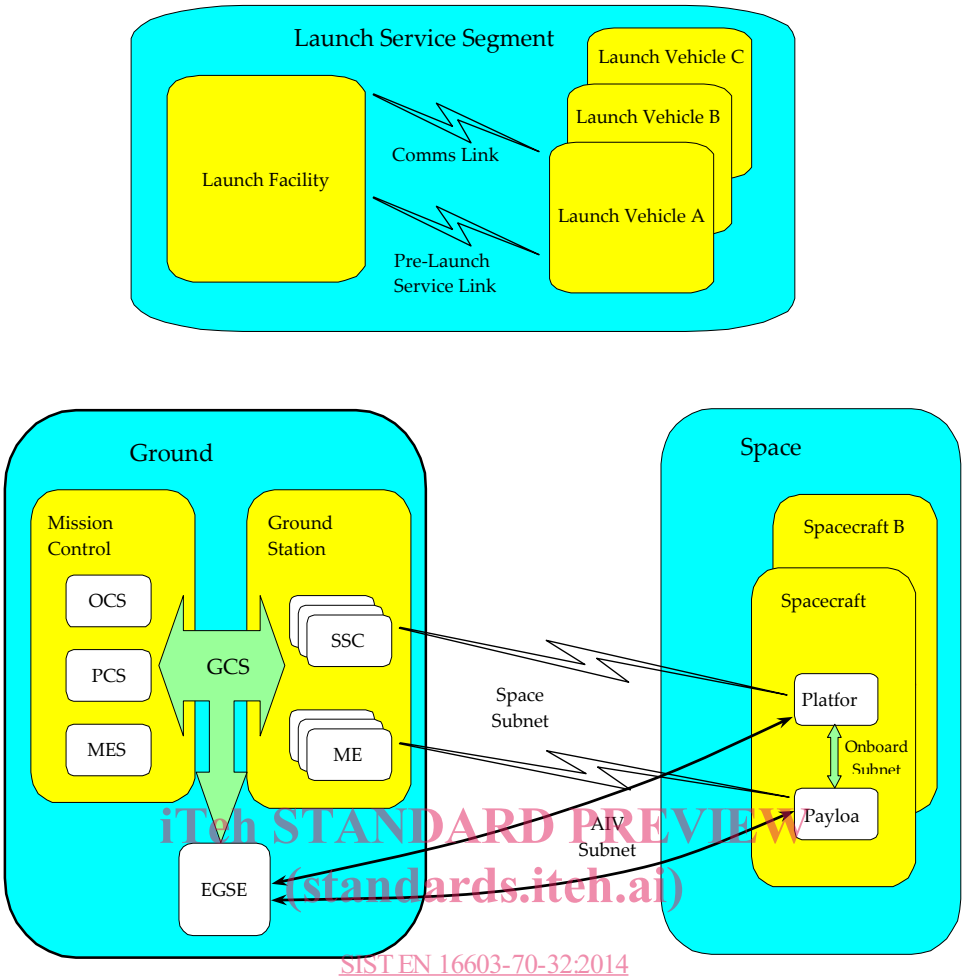
4.1 Introduction

4.1.1 The space system

ECSS-S-ST-00 defines the overall space system as comprising a space segment, a ground segment and a launch service segment.

An example of the elements of a space system is shown in Figure 4-1. The space system elements shown in this figure are operational at different times:

- the electrical ground support equipment (EGSE) during the development phase;
- the launch service segment during the pre-launch and launch phases;
- the mission control and ground station systems during the mission operations phase.



Key: OCS: Operation control system
PCS: Payload control system
MES: Mission exploitation system
AIV: Assembly, integration and verification
SSC: Space segment control station
ME: Mission exploitation station
GCS: Ground communications subnet

Figure 4-1: Example of space system elements

4.1.2 Satellite testing

ECSS-E-ST-10, ECSS-E-ST-10-02 and ECSS-E-ST-10-03 define the requirements for space system engineering, verification and testing.

This Standard does not prescribe the levels of integration and test at which procedures are used. This is considered to be a decision taken when the verification approach for a specific mission is defined. However, automated procedures are generally employed from the subsystem level upwards.

The re-use of test procedures at different levels of integration implies standardization of the functionality of the EGSE. Furthermore, the re-use of these procedures in the mission operations domain implies the harmonisation of the requirements for EGSE and mission control systems.