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Vesoljska tehnika - Krmilni postopki na plovilih

Space engineering - On-board control procedures

Raumfahrttechnik - Bordseitige Kontrollprozeduren

Ingénierie spatiale - Procédures automatiques de contrôle bord

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Space engineering - On-board control procedures

Ingénierie spatiale - Procédures automatiques de contrôle bord

Raumfahrtproduktsicherung - Bordseitige Kontrollprozeduren

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Foreword

This document (EN 16603-70-01:2015) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16603-70-01:2015) originates from ECSS-E-ST-70-01C.

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of an identical text or by endorsement, at the latest by July 2015, and conflicting national standards shall be withdrawn at the latest by July 2015.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

On-board control procedures (OBCPs) have been implemented on an ad-hoc basis on several European missions over the last 25 years, so the validity and utility of the concept has been amply demonstrated.

The purpose of the present Standard is to define an OBCP concept that can be applied for any mission and which:

- fulfils the needs of all categories of user (system engineers, on-board software engineers, AIT engineers, operations engineers);

- ensures that OBCPs have a development lifecycle that is independent of the remainder of the on-board software (OBSW);.

- conforms with, and extends, existing ECSS monitoring and control standards, namely ECSS-E-70-41 and ECSS-E-ST-70-31.

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1
Scope

This Standard defines the concept for an OBCP system, identifying the on-board functionality for OBCP execution and the ground functionality for OBCP preparation and subsequent control.

This Standard also defines the development lifecycle for OBCPs and identifies the relationships of this lifecycle with the overall space system, and in particular with the other elements of the on-board software.

This Standard assumes that missions implementing OBCPs are also compliant with ECSS-E-70-41, since a number of services contained therein are invoked in support of the operation of OBCPs and their interaction with the ground.

This Standard may be tailored for the specific characteristic 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 revision 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 more 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
EN 16603-40	ECSS-E-ST-40	Space engineering - Software
EN 16603-70	ECSS-E-ST-70	Space engineering - Ground systems and operations
EN 16603-70-31	ECSS-E-ST-70-31	Space engineering - Ground systems and operations - Monitoring and control data definition
EN 16603-70-41	ECSS-E-70-41	Space engineering - Ground systems and operations - Telemetry and telecommand packet utilization

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3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-ST-00-01, ECSS-E-ST-70, ECSS-E-ST-70-31 and ECSS-E-70-41 apply, in particular for the following terms:

activity

event

event reporting service

ground system

on-board parameter

operations procedure

space project

spacecraft

3.2 Terms specific to the present standard

3.2.1 automation

replacement of manual operations by computerized mechanisms

3.2.2 on-board control procedure

software program designed to be executed by an OBCP engine, which can easily be loaded, executed, and also replaced, on-board the spacecraft

> NOTE Depending on the context, OBCP can refer to an OBCP in program source code form, or in OBCP code.

3.2.3 OBCP code

complete representation of an OBCP, in a form that can be loaded on-board for subsequent execution

> NOTE 1 In previous missions, such code is typically referred to as token code, executable code or bytecode depending on the implementation of the relevant OBCP engine.

NOTE 2   In service 18 of ECSS-E-70-41A, OBCP code is referred to as procedure code.

3.2.4   OBCP engine

application of the on-board software handling the execution of OBCPs

NOTE   OBCP operations are initiated by means of ECSS-E-70-41 Service 18 telecommands.

3.2.5   OBCP language

programming language in which OBCP source code is expressed by human programmers

3.2.6   OBCP system

the entire machinery for the creation (in the ground system), uplinking, and on-board handling of OBCPs

3.2.7   OBCP step

sequence of OBCP source code statements constituting the smallest operational unit within an OBCP

3.2.8   on-board software

software hosted and executed by any programmable on-board computer or processor

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3.2.9   scheduling

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controlling the allocation of OBSW processor (CPU) time for execution of the various OBSW functions, according to a predefined algorithm

NOTE   OBSW functions include the OBCP engine and execution of OBCPs.

3.2.10   survival mode

configuration of a spacecraft in which it can remain safely without ground segment intervention for a specified period

NOTE   Survival mode is also commonly known as safe mode. In survival mode, typically all non-essential on-board units or subsystems are powered off, either to conserve power or to avoid interference with other subsystems, and the spacecraft can be (automatically) oriented to a particular attitude with respect to the sun.

3.3   Abbreviated terms

The following abbreviations are defined and used within this standard:

Abbreviation	Meaning
AIT	assembly, integration and test

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AOCS	attitude and orbit control subsystem
AR	acceptance review
CDR	critical design review
CPDU	command pulse distribution unit
CPU	central processor unit
DDR	detailed design review
EBNF	extended Backus-Naur form
EEPROM	electrically erasable programmable read-only memory
EGSE	electrical ground support equipment
FDIR	failure detection, isolation and recovery
I/O	input/output
MCS	mission control system
OBAP	on-board application procedure
OBCP	on-board control procedure
OBOP	on-board operations procedure
OBSW	on-board software
PDR	preliminary design review
QR	qualification review
RAM	random access memory
SDE	software development environment
SRR	system requirements review
TRR	test results review

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4
The OBCP concept

4.1 Introduction

The OBCP concept is that of a procedure to be executed on-board, which can easily be loaded, executed, and also replaced, on-board the spacecraft without modifying the remainder of the on-board software.

4.2 Stakeholders and application areas for OBCPs

4.2.1 Stakeholders

Several categories of OBCP stakeholder are identified, each of whom has a distinct role in a space project, with corresponding responsibilities:

- System engineers (spacecraft and payload);

- On-board software engineers;

- AIT engineers;

- Operations engineers.

There is continuous interaction and cooperation between these stakeholders throughout the development and operation lifecycle of a space system, for example:

- during the spacecraft design phase, operations engineers are involved to ensure the operability of the overall space system;

- during in-orbit operations, system and software engineers support commissioning and troubleshooting activities. The system or software responsibility may be transferred from the satellite prime contractor to the operations organization at some predetermined time after launch (e.g. in the case of long-duration missions).

The potential uses for OBCPs are therefore categorized in clause 4.2.2 according to the domain of application rather than stakeholder category.