SLOVENSKI STANDARD
SIST EN 14776:2005

01-januar-2005

Vesoljska tehnika – Zemeljski sistemi in delovanje – Uporaba telemetrije in daljinskega vodenja podatkovnih paketov

Space engineering - Ground systems and operations - Telemetry and telecommand packet utilization

Raumfahrttechnik - Bodensysteme und Bodenbetrieb - Telemetrie und Telekommando

Ingénierie spatiale - Systemes au sol et opérations - Utilisation de la télémétrie et de la télécommande par paquets

Ta slovenski standard je istoveten z: **EN 14776:2004**

ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

SIST EN 14776:2005 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14776

August 2004

ICS 49.140

English version

Space engineering - Ground systems and operations - Telemetry and telecommand packet utilization

Ingénierie spatiale - Systèmes au sol et opérations - Utilisation de la télémétrie et de la télécommande par paquets

Raumfahrttechnik - Bodensysteme und Bodenbetrieb - Anwendung des Telemetrie- und Telekommando-Datenpackets

This European Standard was approved by CEN on 30 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 14776:2004: E

Contents

page

Figures

Tables

Foreword

This document (EN 14776:2004) has been prepared by CEN.

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 February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

It is based on a previous version[1)] originally prepared by the ECSS Working Group for Ground Systems and Operations, reviewed by the ECSS Engineering Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (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.

This European Standard is one of the series of space standards intended to be applied together for the management, engineering and product assurance in space projects and applications.

Requirements in this European 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 European Standard takes into account the existing EN ISO 9000 family of documents.

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

1) ECSS-E-70-41

Introduction

ECSS-E-50 and the CCSDS recommendations for packet telemetry and telecommand address the end-to-end transport of telemetry and telecommand data between user applications on the ground and application processes on-board the satellite, and the intermediate transfer of these data through the different elements of the ground and space segments.

This packet utilization standard (PUS) complements these standards by defining the application-level interface between ground and space, in order to satisfy the requirements of electrical integration and testing and flight operations.

1 Scope

This document addresses the utilization of telecommand packets and telemetry source packets for the purposes of remote monitoring and control of subsystems and payloads.

This document does not address mission-specific payload data packets, but the rules contained herein can be extended to suit the requirements of any mission.

This document does not address audio and video data as they are not contained within either telecommand or telemetry source packets.

This document is structured as follows. Firstly a set of operational concepts is identified, covering all the fundamental requirements for spacecraft monitoring and control during satellite integration, testing and flight operations. A set of services that satisfy these operational concepts is then defined. The detailed specification of these services includes the structure and contents of the associated service requests (telecommand packets) and service reports (telemetry source packets).

This document is applicable to any mission, no matter what its domain of application, orbit or ground station coverage characteristics. However, it is not the intention that the PUS is applicable to a given mission in its entirety. The operational concepts and corresponding services contained in this document cover a wide spectrum of operational scenarios and, for a given mission, only a subset of these operational concepts and services is appropriate.

Choices are made early in the design phase of a new mission resulting in the need to tailor the PUS to suit the requirements of the particular mission. These choices include:

a) The on-board system design and architecture, in terms of the number of on-board application processes, their on-board implementation (e.g. the allocation to on-board processors) and their roles (i.e. which functions or subsystems or payloads they support).

b) Which PUS services are supported by each application process.

NOTE Tailoring is a process by which individual requirements or specifications, standards and related documents are evaluated and made applicable to a specific project by selection, and in some exceptional cases, modification of existing or addition of new requirements (ECSS-M-00-02A, clause 3 (Reference [11])).

Each mission should document the results of this design and selection process in a space-ground interface control document (SGICD).

Some missions implement a centralized architecture with a small number of application processes, whilst others have a highly-distributed architecture within which a correspondingly larger number of application processes are distributed across several on-board processors.

The specification of services in this document is adapted to the expectation that different missions require different levels of complexity and functionality from a given service. To this end, all services are optional and a given service can be implemented at one of several distinct levels, corresponding to the inclusion of one or more capability sets. The minimum capability set corresponds to the simplest possible level, which also remains sensible and coherent. At least this set is included in every implementation of a given service.

The PUS should be viewed as a “Menu” from which the applicable services and service-levels are selected for a given mission. This selection process is repeated for each on-board application process, since each application process is designed to provide a specific set of tailored services.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13701:2001, *Space systems — Glossary of terms.*

EN 14737-1:2004, *Space engineering — Ground systems and operations — Part 1: Principles and requirements.*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13701:2001, EN 14737-1:2004 and the following apply.

3.1.1
additional capability set
set of service capabilities, service requests and reports that a service may optionally provide

3.1.2
application process
entity, uniquely identified by an application process ID (APID), capable of generating telemetry source packets and receiving telecommand packets

NOTE 1 Application processes are the providers of the services defined within this document.

NOTE 2 An application process can be implemented in software, firmware or hardware.

NOTE 3 There are no restrictions on the mapping between application processes and the usual functional subdivision of a satellite into subsystems and payloads. In a simple satellite, there can be a centralized application process which provides a number of "dumb" platform subsystems with collection of housekeeping data, the distribution of device commands, on-board operations scheduling or on-board monitoring. In a more complex satellite, each subsystem and payload can be served by its own independent application process.

NOTE 4 A microprocessor can host one or more application processes. An application process (presumably a rather complex one) can be distributed across two or more microprocessors.

3.1.3
control loop
mechanism to maintain a parameter, or set of parameters, within defined limits

NOTE A control loop is comprised of a set of measurements and responses (commands) related according to a function, algorithm or set of rules. In the case of a satellite, if the characteristic dynamic behaviour of the parameter(s) being controlled is such that the measurement frequency is high and the control response time short, then these control loops are implemented on-board (e.g. attitude control).

3.1.4
device command
telecommand which is routed to and executed by on-board hardware, e.g. a relay-switching telecommand or a telecommand to load an on-board register

3.1.5
memory
on-board memory area, either main memory or mass memory

3.1.6
minimum capability set
set of service capabilities, service requests and reports that are supported by all implementations of a service

3.1.7
parameter
lowest level of elementary data item on-board

NOTE 1 A parameter has a unique interpretation.

NOTE 2 Traditionally, each distinct telemetry parameter is assigned a "parameter ID" for ground identification purposes. Within this document, the concept of "parameter number (#)" is introduced for the on-board "identification" of parameters. The parameter# is unique across a given spacecraft and there is a one-to-one correspondence between parameter ID and parameter#.

3.1.8
parameter validity
Boolean value (true or false) that determines whether a parameter value is meaningful

NOTE A parameter is valid if the appropriate well-defined conditions prevail under which it is meaningful to interpret its telemetered value.

EXAMPLE The angular output of a gyro can only have a valid engineering meaning if the power to the gyro is "on"; at other times the output can be random (or should not be relied upon). Such a parameter is deemed conditionally valid, with its validity determined from the power status.

3.1.9
platform subsystem or payload
combination of units within the satellite platform or the payload that fulfils a well-defined and self-contained set of on-board functions

3.1.10
service
set of on-board functions offered to a service user that can be controlled and monitored (e.g. by a ground system) through a well-defined set of service requests and reports

NOTE 1 A service can interact with other on-board functions for the execution of its activities.

NOTE 2 See minimum capability set.

NOTE 3 See additional capability set.

3.1.11
service data unit
packet data field part of a service request, response or indication, i.e. the complete packet excluding the packet header fields

3.1.12
service provider
on-board application process which executes the service activities and which is the destination of the service requests and the source of the service reports

NOTE 1 Distinct instances of one and the same service can be provided by several on-board application processes.

NOTE 2 A given application process can provide several services.

3.1.13
service report
data exchange between a service provider (the report initiator) and a service user to provide information either relating to the execution of an activity initiated by the user (e.g. notification of completion of execution) or

relating to a meaningful event which occurred during the internal execution of a continuous service activity (in the latter case, the report is a provider-initiated report)

NOTE 1 The initiation of a service report by an on-board service provider results in the sending of one or more telemetry source packets to a service user.

NOTE 2 When the only purpose of a service request is to obtain some service data, the service report used to pass the data is called a "service response". In all other cases, the service report is called a "service indication". A service indication is used to report on the progress or completion of the execution of a user-initiated activity and on events occurring during the execution of a continuous service activity.

NOTE 3 Clause 22 contains a summary of requests, responses and indications for the standard services defined in this document.

3.1.14
service request
data exchange between a service user (the request initiator) and a service provider to initiate the execution of a particular activity

NOTE 1 The invocation of an activity by a service user results in the transmission of one or more telecommand packets to the service provider, the reception of which initiates the corresponding activity.

NOTE 2 If several users can interact with a service, then additional information is passed to the recipient service provider to identify the user invoking the activity. This information is used by the service provider to route the related service report(s) back to the user who invoked the activity.

NOTE 3 All user-initiated activities are optionally confirmed.

3.1.15
service user
entity (e.g. a ground system) that initiates the service requests and receives the service reports

NOTE The specification of the activities performed by a service user (e.g. to process a service report) is beyond the scope of this document.

3.1.16
software function
software entity implementing a mission-specific on-board function that can be controlled by commands from the ground

3.1.17
sub-schedule
distinct subset of an on-board command schedule in the sense that it can be independently started and stopped

NOTE Commands within the same sub-schedule can be interlocked with each other.

3.1.18
supporting service
service used only in the context of another service, i.e. its service requests are invoked as a consequence of executing the user-initiated or continuous activities of the supported service

3.1.19
telecommand
data packet transported by a telecommunications system to give instruction or data to equipment located on-board a spacecraft

NOTE In line with common usage within the space domain, the terms command and telecommand are used interchangeably within this document.

3.1.20
telecommand function
operationally self-contained control action which can comprise, or invoke, one or more lower-level control actions

3.1.21
vital telecommand
telecommand which is not hazardous, but which, if not executed at the expected time, can cause a significant degradation to the mission

3.2 Abbreviated terms

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

Abbreviation	Meaning
Ack	acknowledgement
AD	applicable document
ADT	aborted data transfer
AOCS	attitude and orbit control system
AOS	acquisition of signal
APID	application process ID
ASCII	American Standard Code for Information Interchange
CCSDS	Consultative Committee for Space Data Systems
CDS	CCSDS day segmented
CLCW	command link control word
CLTU	command link transfer unit
CPDU	command pulse distribution unit
CRC	cyclic redundancy code
CUC	CCSDS unsegmented code
EGSE	electrical ground support equipment
ESA	European Space Agency
GPS	global positioning system
ISO	International Organization for Standardization
LEO	low Earth orbit
LOS	loss of signal
LSB	least significant bit
MAP	multiplexed access point
MSB	most significant bit
OBT	on-board time
PAC	packet assembly controller
PC	parameter code
PCS	packet check sequence
PEC	packet error control