SLOVENSKI STANDARD
SIST EN 16603-50:2014

01-november-2014

Vesoljska tehnika - Komunikacije

Space engineering - Communications

Raumfahrttechnik - Kommunikation

Ingénierie spatiale - Communications

Ta slovenski standard je istoveten z: **EN 16603-50:2014**

ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

SIST EN 16603-50:2014 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16603-50

September 2014

ICS 49.140

English version

Space engineering - Communications

Ingénierie spatiale - Communications

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This European Standard was approved by CEN on 1 March 2014.

CEN-CENELEC Management Centre:
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Foreword

This document (EN 16603-50:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-50:2014) originates from ECSS-E-ST-50C.

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of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.

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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).

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Introduction

This standard specifies requirements for the development of the end-to-end data communication system for spacecraft. Implementation aspects are defined in both ECSS-E-ST-50 Level 3 standards and CCSDS standards.

The complete set of standards to define a complete communication link is project dependent and cannot be specified here. ECSS-E-HB-50 provides some guidance on this aspect, and gives some practical examples.

1
Scope

This Standard specifies the requirements for the development of the end-to-end data communications system for spacecraft.

Specifically, this standard specifies:

- The terminology to be used for space communication systems engineering.
- The activities to be performed as part of the space communication system engineering process, in accordance with the ECSS-E-ST-10 standard.
- Specific requirements on space communication systems in respect of functionality and performance.

The communications links covered by this Standard are the space-to-ground and space-to-space links used during spacecraft operations, and the communications links to the spacecraft used during the assembly, integration and test, and operational phases.

Spacecraft end-to-end communication systems comprise components in three distinct domains, namely the ground network, the space link, and the space network. This Standard covers the components of the space link and space network in detail. However, this Standard only covers those aspects of the ground network that are necessary for the provision of the end-to-end communication services.

NOTE Other aspects of the ground network are covered in ECSS-E-ST-70.

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

3
Terms, definitions and abbreviated terms

3.1 Terms defined in other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following term:

function

3.2 Terms specific to the present standard

3.2.1 channel

combination of protocol and medium that provides a physical layer service from end-to-end

NOTE This is the transfer of the unstructured bitstream from point-to-point.

3.2.2 communication service

service that provides the capability of moving data between users.

NOTE At least two users are involved when a communication service is used, one sending data and the other(s) receiving data.

3.2.3 cross support

use by one party of part of another party's data system resources to complement its own system

3.2.4 entity

active element within a system

3.2.5 interface

description of the connection between real or abstract objects

3.2.6 isochronous service

service providing for the transfer of data with a defined maximum deviation from a nominal delay from end to end

3.2.7 protocol

set of rules and formats (semantic and syntactic) that determine the communication behaviour of layer entities in the performance of communication functions

3.2.8 service

capability of a layer, and the layers beneath it (a service-provider), that is provided to service-users at the boundary between the service-provider and the service-users

NOTE The service defines the external behaviour of the service-provider, independent of the mechanisms used to provide that behaviour. Layers, layer entities, and application-service-elements are examples of components of a service-provider.

3.2.9 service data unit

amount of information whose identity is preserved when transferred between peer entities in a given layer and which is not interpreted by the supporting entities in that layer

3.2.10 service-provider

abstract representation of the totality of those entities which provide a service to service-users

NOTE A service provider includes entities in the layer at which the service is provided, and in the layers beneath it.

3.2.11 service-user

entity in a single system that makes use of a service

NOTE The service-user makes use of the service through a collection of service primitives defined for the service.

3.2.12 simplex

communicating in one direction from data source to data sink

3.2.13 source

entity that sends service-data-units, using a service provider

3.2.14 sink

entity that receives service-data-units from a service provider

3.2.15 telecommand

communication link from ground to space by which a spacecraft is commanded

3.2.16 telemetry

housekeeping data and payload data

NOTE Housekeeping telemetry is usually transmitted at low rate, but payload data can be transmitted at a very high rate.

3.2.17 telemetry link

link from spacecraft to ground over which data generated on the spacecraft is provided to ground

3.2.18 user

service-user

3.2.19 user application

application that makes use of data handling system services

NOTE An application can be a software entity or a non-software entity which is controlling an onboard system.

3.3 Abbreviated terms

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

Abbreviation	Meaning
AIT	assembly, integration, and test
AR	acceptance review
ARQ	automatic repeat request
BER	bit error rate
CCITT	Consultative Committee for International Telegraph and Telephone
CCSDS	Consultative Committee for Space Data Systems
CDMU	central data management unit
CDR	critical design review
CSAD	communication system analysis document
CSADD	communication system architectural design document
CSBD	communication system baseline definition
CSDDD	communication system detailed design document
CSOM	communication system operations manual
CSPD	communication system profile document
CSRD	communication system requirements document
CSVP	communication system verification plan
DRD	document requirements definitions
EIRP	equivalent isotropically radiated power
EMC	electromagnetic compatibility
ISO	International Organization for Standardization

ITU	International Telecommunication Union
ITU-R	ITU – Radiocommunication
ITU-RR	ITU – Radio Regulations
LEOP	launch and early operations phase
MEC	mission experiment centre
OSI	open system interconnection
OCC	operational control centre
PDR	preliminary design review
PFD	power flux density
QR	qualification review
RF	radio frequency
SDU	service data unit
SRR	system requirements review
TT&C	telemetry, tracking and command

4 Space communications engineering principles

4.1 Context

Space communications engineering is concerned with the provision of end-to-end communication services to and from spacecraft. Communication links are generally between the spacecraft and ground. However, this Standard also addresses spacecraft-to-spacecraft links, e.g. in spacecraft constellations, and can be applied to links between spacecraft and landed elements such as orbiter-lander or orbiter-lander-rover configurations.

End-to-end communication is used both to control the operation of the spacecraft, and to transfer data, such as payload data. However, the requirements on the communications system for controlling the spacecraft differ from those for payload data transfer. For control operations, the communication system objective is to provide guaranteed delivery of commands in the order of transmission. Commands can be repeated, but not lost. By contrast, the requirement for payload data transfers is to transfer as much data as possible. Some loss of data may be acceptable, and delivery order is generally unimportant, provided the data can be reconstituted.

In addition to the end-to-end transfer of commands and data, some additional services are provided across space communication links, such as time correlation and ranging. Time correlation is used to accurately relate the local time maintained at each end of the communication link in order to determine the absolute time relationship between events. Ranging is used to determine the distance to the spacecraft, e.g. between a ground station antenna and the spacecraft, or between two spacecraft, and is used for orbit determination.

The goals of standardization for space communication systems are:

- to ensure efficient use of the RF spectrum allocated to the space infrastructure in a non-interfering manner;
- to ensure that the RF links to and from the spacecraft can be used for orbit determination and ranging;
- to ensure reliable and error free end-to-end communication between ground stations and the spacecraft;
- to enable the use of the same ground segment infrastructure by different spacecraft;