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Satelitske zemeljske postaje in sistemi (SES) – Evropsko sodelovanje pri standardizaciji vesoljskih zadev (ECSS) - Satelitski vmesniki za obdelavo programskih podatkov (SSDHI)

Satellite Earth Stations and Systems (SES); European Co-operation for Space Standardization (ECSS); Satellite Software Data Handling Interfaces (SSDHI)

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

National transposition dates	
Date of adoption of this EN:	21 February 2003
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Introduction

Shorter and shorter communications satellites development cycles and compatibility requested with off the shelf equipments requires interface standardization to be able to introduce a new equipment very late in satellite development cycle. The present document will allow the development of On Board Software (OBSW) independently of the choice of satellite equipment. It will be used to standardize the software specifications of the Interface between the application software and the communication services. It shall help the standardization of equipment interface.

The present document addresses ISO OSI application layer services [1].

Currently, no application layer services standard exists for the Data System of geostationary communication satellites. The aim of the present document is to respond to such requirements. Nevertheless, there are complementary agency standards existing or in progress (see bibliography).

Integration or adaptation of new services, due to technology evolution, will be implemented through the maintenance of the present document. The contents of the present document are subject to continuing work within TC-SES and may change following formal TC-SES approval. Should TC-SES modify the contents of the present document it will then be republished by ETSI with an identifying change of release date and an increase in version number as follows:

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- m The second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.
- n The third digit (n) is incremented when editorial only changes have been incorporated in the specification.

1 Scope

The present document applies to Geostationary Communications Satellite architectures based on ISO OSI Reference Model or SOIF Reference Model, but could also be applied to other types of satellites.

The present document sets out the minimum definition, services and interfaces requirements of the satellite communication application layer.

The present document is complementary to Spacecraft Onboard Interfaces (SOIF).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] ISO/IEC 7498-1 (1994): "Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model".

[2] IEEE Standard 754-1985: "IEEE Standard for Binary Floating-Point Arithmetic".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Application Layer Service (ALS): entity which provides application software with a capability to operate devices, with a warranty of performance

application software: on-board software implementing the satellite control functions

NOTE: A service is implemented by hardware and/or software. Application layer services for the control of devices are defined in terms of:

- the functions provided by the service;
- a service access point;
- the management parameters.

autonomy: ability of a system to provide without external intervention, mission services on a given period of time and in a limited context: nominal or under anomaly conditions

NOTE: Three types of autonomy are defined:

- **reflex autonomy:** characterizes the capability to perform predefined actions under triggering events. This kind of autonomy, already in use, is performed through automation mechanisms, with predefined sequences of states and triggering events (failure detection, isolation and recovery, etc.).
- **function autonomy:** characterizes the capability of the satellite to perform automatic function on board, implementing on board closed loops to maintain function performances without ground intervention. Thermal regulation, batteries management, and attitude control are some examples of function autonomy.
- **decision autonomy:** characterizes the capability of the satellite to manage and update its schedule of activities or tasks, taking into account events (expected or not) occurring during the mission (Autonomous navigation, mission (re)scheduling, etc.).

Data Handling System (DHS): on-board system including computers and interface units hosting the application software and providing communications between on-board units and with the ground

devices: devices are the onboard components that onboard application software control in order to perform the operational objectives of the spacecraft

EXAMPLE: Sensors and actuators, Telemetry Command and Ranging (TCR) devices or other mission specific devices.

J2000: earth centred co-ordinate reference system with an epoch of January 1st 2000

primitive: a signal (e.g. a send request) which is passed across the service access point in order to use the service capabilities

NOTE: The primitive may have associated parameters.

Service Access Point (SAP): the interface provided to a service through which users access the capabilities of the service

NOTE: The service access points are defined in terms of a set of primitives.

spacelink interface: ground to satellite communication link for monitoring and control

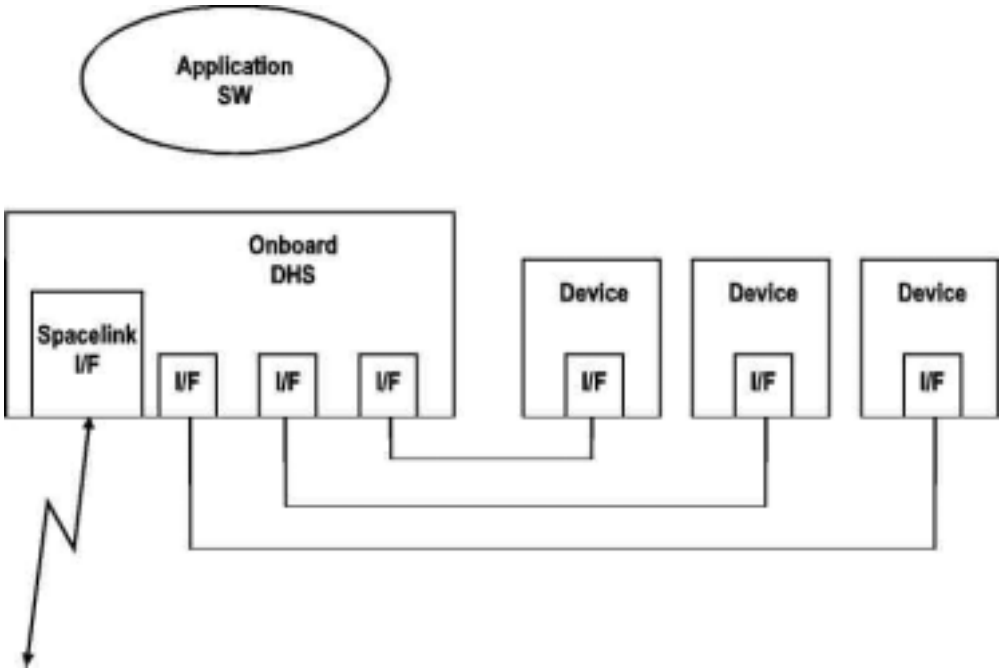

Figure 1: Example of Spacecraft System

Service: Application Layer Service

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ABM	Apogee Boost Motor
ACC	ACCelerometer
ALSS	Application Layer Services Standard
BSV	Bi Stable Valve
CAMP	Channel AMPlifier
DHS	Data Handling System
DTP	Digital Transparent Processor
EEPROM	Electrically Erasable Programmable Read Only Memory
EPC	Encapsulated Power Converter
ES	Earth Sensor
EUC	Engineering Unit Conversion
FDIR	Failure Detection Isolation and Recovery
GYRO	GYROscope
HW	HardWare
ICD	Interface Control Document
ISO	International Standard Organization
MSV	Mono Stable Valve
MT	Magneto Torquer
OBSW	On-Board SoftWare
OSI	Open System Interconnection
PCU	Power Conditioning Unit
PFC	Parameter Format Code
PP	Plasmic Propulsion
PTC	Parameter Type Code
PUS	Packet Utilization Standard
PYRO	PYROtechnic
RAM	Random Access Memory
ROM	Read Only Memory
RW	Reaction Wheel
SAP	Service Access Point
SDB	System Data Base
SM	Stepper Motor
SOIF	Spacecraft Onboard InterFaces
SS	Sun Sensor
SSDHI	Satellite Software Data Handling Interfaces
STR	Star TRacker
SW	SoftWare
TC	Tele Command
TCR	Telemetry, Command and Ranging
TOM	Thruster Orientation Mechanism
TWTA	Travelling Wave Tube Amplifier

4 Applicability

The present document can be applied to all classes of spacecraft including in particular communications satellites.

5 Recommendation guidelines

5.1 Objectives

The main recommendation drivers are:

- Development optimization:
  - Standardization data format.
  - Using common formats for key commands across different data buses.
  - Planning optimization by minimising development time.
  - Cost by reducing engineering process on specification and development of application layer services.
  - Minimising risk basing the development on validated requirements.
  - Increasing potential for flight equipment, software (SW) and test equipment reuse.
  - Overlapping of software development with hardware development:
    - It will be possible to optimize this process by applying the present document which provides requirements independent of any hardware configuration.
    - This concept allows to freeze application layer Interface Control Document (ICD) to guarantee hardware independence.
- Performance constraints:
  - Real time.
  - Memory size.
  - Load of onboard communication data bus.
  - Device Observability.
  - Device Commandability.
  - Number and type of units to interface.
  - Operations complexity.

5.2 Interface covering

Data communication on satellite requires electrical and data interfaces onboard. These interfaces include:

- Hardware interfaces:
  - Electrical interfaces (power, command, acquisition, pyrotechnic, etc.) to devices.
  - Onboard communication data buses.
- Software interfaces:
  - Software drivers controlling devices and communication on data buses.
  - Application software interfaces.

The application layer is the highest layer of the reference OSI [1] and SOIF (see bibliography) models (see figure 2). In the OSI Reference Model, the application software is not included in the reference model application layer, since this software is the user of the communications services provided by the OSI Reference Model.

The present document provides recommendations to interface application services between themselves and to other OSI/SOIF layers. In particular, it defines the services to interface devices with application software independent of lower layer levels (particularly the electrical interface).

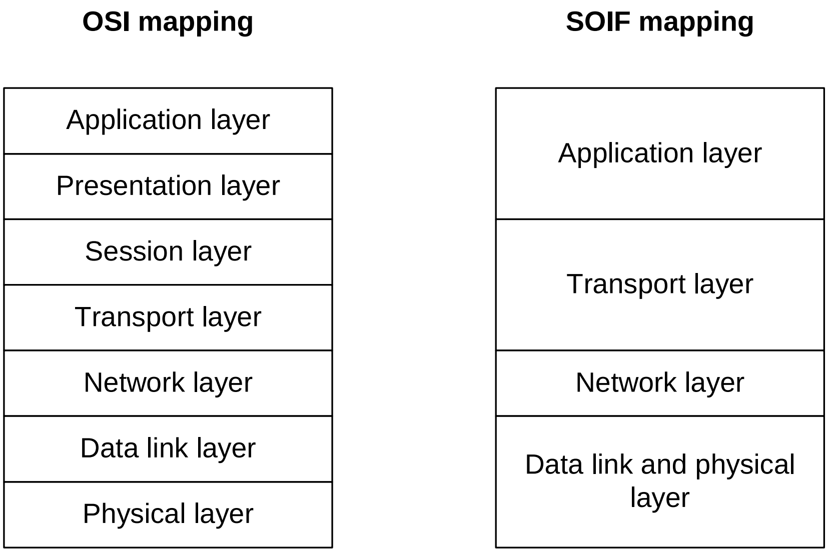

Figure 2: OSI and SOIF layers mapping

5.3 Position of the standard proposed services with respect to other standards

The present document implies the provision of certain underlying services, that could be provided by SOIF (see annex C):

- Command and Data Acquisition service;
- Time service;
- File transfer service.

The present document does not address in particular:

- Task management;
- On-board scheduling;
- Satellite System FDIR.

User Application Layer definition:

This layer contains satellite application services like AOCS management, Control and Data management and FDIR management, unit management, etc. This layer shall be independent of the underneath layers in term of equipment manufacturer and transmission protocol/media. The goal is to provide user application reuse capability.

User application services implementation can call (see figure 3):

- Other user application layer services;
- Application Interface services;
- SOIF or non SOIF application layer services (see annex C);
- Any other lower layer services with exposed Service Access Point.

Application Interface Services definition:

These services provide satellite function or equipment oriented services with an interface independent of the equipment manufacturer or of the transmission protocol/physical link.

The service implementation requires the equipment database in order to make the link between the standardized interface and the equipment function.

Although the service implementation is equipment dependent, the objective is to use common services provided by e.g. the SOIF application layer.

These services can call:

- Other application interface services;
- SOIF or non SOIF application layer services;
- Any other lower layer services with exposed Service Access Point.

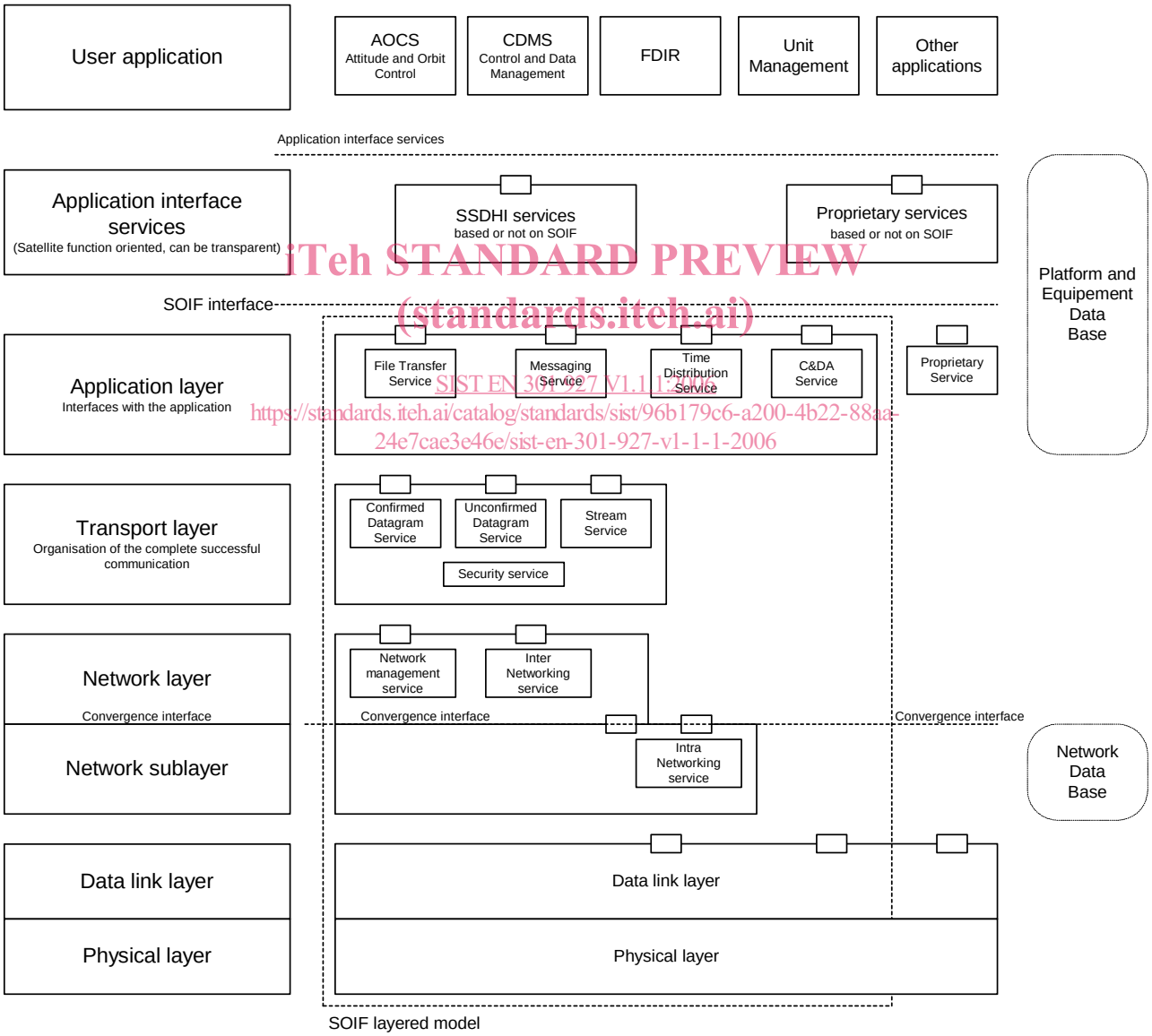

Figure 3: SSDHI position with respect to. other services

6 Service specification

6.1 Introduction

This service specification covers all onboard satellite applications.

Generic services are provided according to onboard satellite complexity increase: memory management, etc.

Specific services cover Platform and Payload devices. These services are equipment functionality dependent. They are defined according to the state of the art.

Evolution of these services will be done according to the integration of new equipment.

Simple device services are used for low level command (Pulse) or low level acquisition (Pressure, Temperature, Current, Voltage, Frequency, etc.).

For raw data acquisition it is recommended to use directly Command and Acquisition services, or eventually File Transfer provided by SOIF, or proprietary services.

Units redundancy concepts and management are performed in the User Application Layer, and thus it is not addressed in the present document.

6.2 Conventions

6.2.1 Service primitive naming

Inside a service one or more primitive can be defined.

These primitives provide data exchange between the application software and the service.

The following naming convention suffixes are used according to the transaction direction:

- XXXXX_RQ: Request primitive issued by the service user to the service provider.
- XXXXX_IND: Indication primitive issued by the service provider to the service user. This primitive may be associated to a previous request primitive.

The following naming convention prefixes can be used for a better primitive understanding:

- SET: Prefix for a configuration primitive: equipment configuration setting, command execution, device switch on or off.
- GET: Prefix for an acquisition primitive: data acquisition, status acquisition.

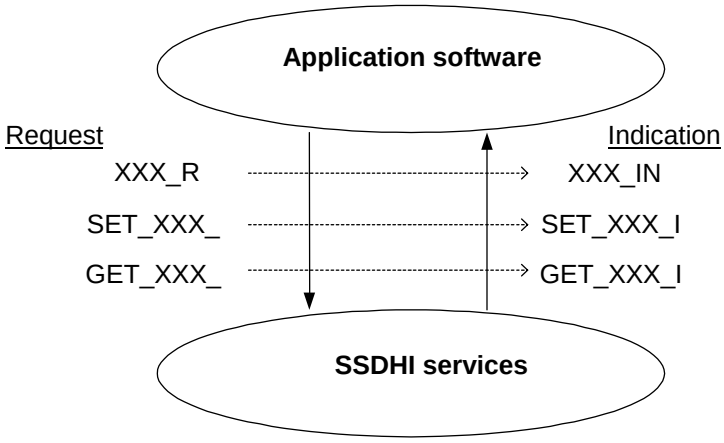

Figure 4: Primitives naming

6.2.2 Parameter type and format abbreviations

Parameter types are those defined in the PUS Packet Utilization Standard (see bibliography). A summary is given in annex D.

Within the specification of a service, the following abbreviations are used.

Table 1: Parameter type

Parameter type	Abbreviation
Boolean parameter	'Boolean'
Enumerated parameter	'Enumerated'
Integer parameter Unsigned Integer Signed Integer	 'Unsigned Integer' 'Signed Integer'
Real Parameter	'Real'
Bitstring Parameter Fixed length bit string Variable length bit string	 'Fixed BitString' 'Variable BitString'
OctetString Parameter Fixed length octet string Variable length octet string	 'Fixed OctetString' 'Variable OctetString'

For each parameter type (PTC) the present document specifies the parameter type (PTC) and format (PFC).

6.3 Standard services

The standard services listed in table 2 are described in the following clauses.

Table 2: SSDHI standard services

Service name/Primitive name	Request and Indication primitives
Memory Management Service	
Load memory using base plus offset	LOAD_MEMORY_BO_RQ LOAD_MEMORY_BO_IND
Dump memory using base plus offset	DUMP_MEMORY_BO_RQ DUMP_MEMORY_BO_IND
Check memory using base plus offset	CHECK_MEMORY_BO_RQ CHECK_MEMORY_BO_IND
Device power switch on service	
Device power switch ON	SET_DEVICE_POWER_ON_RQ SET_DEVICE_POWER_ON_IND
Device power switch off service	
Device power switch OFF	SET_DEVICE_POWER_OFF_RQ SET_DEVICE_POWER_OFF_IND
Device reset service	
Device reset	SET_DEVICE_RESET_RQ SET_DEVICE_RESET_IND
Device arming service	
Device arming	SET_DEVICE_ARMING_RQ SET_DEVICE_ARMING_IND
Device disarming	SET_DEVICE_DISARMING_RQ SET_DEVICE_DISARMING_IND
Function enabling service	
Device function enabling	SET_DEVICE_FUNCTION_ENABLE_RQ SET_DEVICE_FUNCTION_ENABLE_IND
Device function disabling	SET_DEVICE_FUNCTION_DISABLE_RQ SET_DEVICE_FUNCTION_DISABLE_IND
Accelerometer service	
Incremental speed acquisition	GET_ACC_INC_RQ GET_ACC_INC_IND