

Space data and information transfer systems — Packet telemetry services

ICS 49.140

National foreword

This British Standard reproduces verbatim ISO 17433:2003 and implements it as the UK national standard.

The UK participation in its preparation was entrusted by Technical Committee ACE/68, Space systems and operations, to Subcommittee ACE/68/-/7, Space data and information transfer systems, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 11 June 2003

Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii and iii, a blank page, pages 1 to 83 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 11 June 2003

ISBN 0 580 42045 0

INTERNATIONAL STANDARD

ISO
17433

Second edition
2003-02-15

Space data and information transfer systems — Packet telemetry services

*Systèmes de transfert des informations et données spatiales —
Services de télémesure par paquets*



Reference number
ISO 17433:2003(E)

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Foreword

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International Standard ISO 17433 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 103.0-B-2, June 2001) and was adopted (without modifications except those stated in Clause 2 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.

This second edition cancels and replaces the first edition (ISO 17433:2001), which has been technically revised.

Space data and information transfer systems — Packet telemetry services

1 Scope

This International Standard specifies the requirements for packet telemetry services in space data and information transfer systems. The purpose of this document is to establish common requirements for the services provided between protocol layers of the space to ground link. It does not define the extension of these services across distributed components of the spacecraft or ground data systems.

The scope and field of application are furthermore detailed in subclauses 1.2 and 1.3 of the enclosed CCSDS publication.

2 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

CCSDS 103.0-B-2, June 2001, *Recommendation for space data system standards — Packet telemetry service specification*.

For the purposes of international standardization, the modifications outlined below shall apply to the specific clauses and paragraphs of publication CCSDS 103.0-B-2.

Pages i to v

This part is information which is relevant to the CCSDS publication only.

Page 1-4:

Add the following information to the references indicated:

- [1] Document CCSDS 102.0-B-5, November 2000, is equivalent to ISO 13419:2003.
- [2] Document CCSDS 101.0-B-5, June 2001, is equivalent to ISO 11754:2003.

Page B-1

Update the following references as indicated:

- [B4] ISO 7498-3:1989 has been cancelled and replaced by ISO/IEC 7498-3:1997.
- [B5] ISO/IEC 10731 (1991 DIS) has been published as ISO/IEC 10731:1994.

3 Revision of publication CCSDS 103.0-B-2

It has been agreed with the Consultative Committee for Space Data Systems that Subcommittee ISO/TC 20/SC 13 will be consulted in the event of any revision or amendment of publication CCSDS 103.0-B-2. To this end, NASA will act as a liaison body between CCSDS and ISO.

***Consultative
Committee for
Space Data Systems***

RECOMMENDATION FOR SPACE
DATA SYSTEM STANDARDS

**PACKET TELEMETRY
SERVICE
SPECIFICATION**

CCSDS 103.0-B-2

BLUE BOOK

June 2001



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CCSDS RECOMMENDATION FOR PACKET TELEMETRY SERVICE SPECIFICATION

AUTHORITY

Issue:	Blue Book, Issue 2
Date:	June 2001
Location:	Oxfordshire, UK

This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS Recommendations is detailed in reference [B1], and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

This Recommendation is published and maintained by:

CCSDS Secretariat
Program Integration Division (Code MT)
National Aeronautics and Space Administration
Washington, DC 20546, USA

CCSDS RECOMMENDATION FOR PACKET TELEMETRY SERVICE SPECIFICATION

STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of member space Agencies. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommendations** and are not considered binding on any Agency.

This **Recommendation** is issued by, and represents the consensus of, the CCSDS Plenary body. Agency endorsement of this **Recommendation** is entirely voluntary. Endorsement, however, indicates the following understandings:

- o Whenever an Agency establishes a CCSDS-related **standard**, this **standard** will be in accord with the relevant **Recommendation**. Establishing such a **standard** does not preclude other provisions which an Agency may develop.
- o Whenever an Agency establishes a CCSDS-related **standard**, the Agency will provide other CCSDS member Agencies with the following information:
 - The **standard** itself.
 - The anticipated date of initial operational capability.
 - The anticipated duration of operational service.
- o Specific service arrangements shall be made via memoranda of agreement. Neither this **Recommendation** nor any ensuing **standard** is a substitute for a memorandum of agreement.

No later than five years from its date of issuance, this **Recommendation** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or, (3) be retired or canceled.

In those instances when a new version of a **Recommendation** is issued, existing CCSDS-related Agency standards and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each Agency to determine when such standards or implementations are to be modified. Each Agency is, however, strongly encouraged to direct planning for its new standards and implementations towards the later version of the Recommendation.

CCSDS RECOMMENDATION FOR PACKET TELEMETRY SERVICE SPECIFICATION

FOREWORD

This document is a technical **Recommendation** for use in developing packetized telemetry systems and has been prepared by the **Consultative Committee for Space Data Systems** (CCSDS). The Packet Telemetry Services described herein are intended for spacecraft-to-ground data communication within missions that are cross-supported between Agencies of the CCSDS.

This **Recommendation** establishes a common framework and provides a common basis for the data services of spacecraft telemetry systems. It allows implementing organizations within each Agency to proceed coherently with the development of compatible derived Standards for the flight and ground systems that are within their cognizance. Derived Agency Standards may implement only a subset of the optional features allowed by the **Recommendation** and may incorporate features not addressed by the **Recommendation**.

Through the process of normal evolution, it is expected that expansion, deletion or modification to this document may occur. This **Recommendation** is therefore subject to CCSDS document management and change control procedures which are defined in reference [B1].

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At time of publication, the active Member and Observer Agencies of the CCSDS were:

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- United States Geological Survey (USGS)/USA.

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DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 103.0-B-1	Packet Telemetry Services, Issue 1	May 1996	Original Issue (supeseded)
CCSDS 103.0-B-2	Packet Telemetry Service Specification, Issue 2	June 2001	Current Issue: adds specifications to support use of the CCSDS Version-1 Telemetry Transfer Frame to transport other types of packets in addition to CCSDS Version-1 Packets, including CCSDS Network Protocol (NP) Packets and Internet Protocol (IP) packets.

NOTE – Substantive changes from the previous issue are flagged with change bars in the inside margin.

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this Recommendation is to define the services of a packet telemetry system. To do so, it establishes a layered model of Packet Telemetry protocols and defines Packet Telemetry Services by specifying the behavior at the service interfaces to each layer. The layered model and services are based on the CCSDS Recommendations for *Packet Telemetry* and *Telemetry Channel Coding*, references [1] and [2]. These referenced Recommendations define the formats of the protocol-data-units used to transfer telemetry from spacecraft to ground or spacecraft to spacecraft, as well as the protocol procedures that support that transfer.

NOTE – Definitions of ‘service’, ‘layer’, and other terms used in this Recommendation are provided in 1.6, and are further explained in 2.2.

1.2 SCOPE

This Recommendation defines only the services provided between protocol layers of the CCSDS space to ground link. It does not define the extension of these services across distributed components of the spacecraft or ground data systems.

1.3 APPLICABILITY

This Recommendation applies to the creation of Agency standards and to the future exchange of Packet Telemetry between CCSDS Agencies in cross-support situations. The Recommendation includes comprehensive specification of the services that can be provided by remote space vehicles (spacecraft) for telemetering to space mission data processing facilities (which are usually located on Earth). The Recommendation does not attempt to define the architecture or configuration of these data processing facilities, except to describe assumed data processing services which affect the selection of certain on-board formatting options.

1.4 RATIONALE

The rationale for Packet Telemetry is presented in reference [B2].

1.5 DOCUMENT STRUCTURE

The remainder of this document is organized as follows:

- section 2 provides an overview of this Recommendation, including a layered model of packet telemetry services;
- section 3 describes the data that is transferred from data sources in space to data sinks on the ground by the packet Telemetry Services;

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- section 4 defines Space Transfer services, which support the transfer of data units (created by applications) by means of Virtual Channels;
- section 5 defines Virtual Channel Access services, which provide for the transfer of Virtual Channel, and certain application data units, in a single stream of fixed-length Transfer Frames;
- section 6 defines Channel Access Coding services, which support the transfer of a stream of Transfer Frames over a noisy channel;
- annex A lists acronyms and abbreviations used in this text along with their definitions;
- annex B lists informative references;
- annex C provides a brief tutorial on OSI service terminology.

1.6 CONVENTIONS AND DEFINITIONS

1.6.1 DEFINITIONS FROM REFERENCED DOCUMENTS

The definitions below were adapted from references [B3], [B4], and [B5]. Concepts related to these terms are discussed in section 2 and in annex C of this Recommendation.

association: a cooperative relationship among entities in the same layer.

blocking: a protocol function that maps multiple service-data-units into one protocol-data-unit.

multiplexing: a protocol function that uses one association in the layer below to support more than one association for users of the protocol.

one-way communication: data communication in one pre-assigned direction.

primitive, service primitive: an abstract, atomic, implementation-independent representation of an interaction between a service-user and its service-provider.

protocol: a set of rules and formats (semantic and syntactic) which determines the communication behavior of layer entities in the performance of communication functions.

protocol-data-unit (PDU): a unit of data specified in a protocol and consisting of protocol-control-information and possibly user data.

segmentation: a protocol function that maps one service-data-unit into multiple PDUs.

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

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

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service-access-point (SAP): the point at which services are provided by an entity in a layer to an entity in the layer above.

service-data-unit (SDU): an 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.

service-provider: an abstract representation of the totality of those entities which provide a service to service-users; i.e., a layer, and the layers beneath it.

service-user: an 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.

sink: an entity that receives SDUs from a service provider.

source: an entity that sends SDUs, using a service provider.

symmetric service: in a symmetric service, the local views at the service interfaces in two systems are the same. See annex C and reference [B5] for further discussion.

unconfirmed service: in an unconfirmed service, the sending end does not receive confirmation that data that it sends has reached the receiving end.

1.6.2 TERMS DEFINED IN THIS RECOMMENDATION

The terms defined below are used throughout this Recommendation. Many other terms that pertain to specific services are defined in the appropriate sections.

aperiodic: not occurring at a *constant rate* (see below).

asynchronous: not *synchronous* (see below).

constant rate; periodic: a sequence of events in which each event occurs at a fixed time interval (within specified tolerance) after the previous event in the sequence.

synchronous: a sequence of events occurring in a fixed time relationship (within specified tolerance) to another sequence of events. Note that ‘synchronous’ does not necessarily imply ‘constant rate’.

user-optional: a qualification of a service capability indicating that the entity using the service may choose to use, or not to use, the capability. The service provider is presumed to provide the capability if requested, but also to be able to provide service that does not include the user-optional capability.

NOTE – An example of a user-optional capability is a Data-Quality Flag that a receiving user may choose not to receive.

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1.6.3 USE OF BOLDFACE

Boldface characters are used for names of Packet Telemetry data units, layers and services.

1.7 REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommendation are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS Recommendations.

- [1] *Packet Telemetry*. Recommendation for Space Data System Standards, CCSDS 102.0-B-5. Blue Book. Issue 5. Washington, D.C.: CCSDS, November 2000.
- [2] *Telemetry Channel Coding*. Recommendation for Space Data System Standards, CCSDS 101.0-B-5. Blue Book. Issue 5. Washington, D.C.: CCSDS, June 2001.
- [3] *CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures*. Recommendation for Space Data System Standards, CCSDS 320.0-B-2. Blue Book. Issue 2. Washington, D.C.: CCSDS, October 1998.
- [4] *Space Link Identifiers*. Draft Recommendation for Space Data System Standards, CCSDS 135.0-R-1. Red Book. Issue 1. Washington, D.C.: CCSDS, November 2000.

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2 OVERVIEW

2.1 PACKET TELEMETRY SERVICES

This Recommendation complements the CCSDS Recommendations for *Packet Telemetry* (reference [1]), and *Telemetry Channel Coding* (reference [2]). The Packet Telemetry and Telemetry Channel Coding Recommendations

- define data units for telemetry systems;
- define formats of these data units;
- define rules and procedures for creation and use of these data units.

These Recommendations, however, do not specify the interface between a data source or sink and the entity providing transfer of data units from space to ground, nor do they explicitly define the characteristics of the transfer process, from the viewpoint of a data source or sink.

This Recommendation for Packet Telemetry Services

- defines a layered model of a packet telemetry system consistent with references [1] and [2];
- defines services provided by each layer;
- provides parameters and conditions for use of each service.

This Recommendation *does not* alter or redefine reference [1] or [2].

2.2 RELATIONSHIP TO OSI

This Recommendation defines Packet Telemetry Services in the style established by the OSI Basic Reference Model (reference [B3]), which describes communications services as being provided by layers of protocols, each layer providing a service interface to users of the service in the layer above, as shown in figure 2-1. The concepts and terminology of the OSI Basic Reference Model are summarized in annex C.

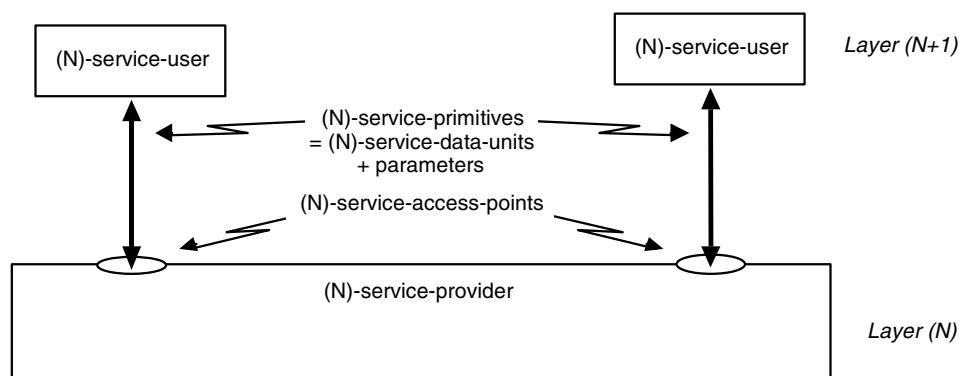


Figure 2-1: OSI Service Concept

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A service interface is defined in terms of ‘primitives’, which present an abstract model of the exchange of data structures and control information between the layer and the service user. The primitives are independent of specific implementation approaches, and so do not specify aspects of the service interface that might vary from one implementation to another. These local issues include handshaking and flow control across the service interface (i.e., between the service user, in one layer, and the protocol entity in the layer below).

A ‘service user’ is not a mission user, such as a scientific investigator or spacecraft operator. A service user is typically a software process that is part of an instrument, subsystem, or data handling system on a spacecraft, or part of a data capture or data processing system on the ground.

2.3 PACKET TELEMETRY LAYERS

Although this Recommendation uses OSI concepts to define services, the services of Packet Telemetry are not structured into the same seven layers as are OSI services. Further, because a key design goal of Packet Telemetry is efficient use of limited space link resources, the Packet Telemetry PDUs are structured differently from those of OSI protocols. Because of these differences, the Packet Telemetry layers are identified by letters (A through D) rather than numbers (1 to 7), to avoid confusion with the seven OSI layers. Figure 2-2 illustrates the Packet Telemetry layers, and table 2-1 summarizes the services that these layers provide.

The services specified in this Recommendation are unidirectional services: one end (the spacecraft) can send, but not receive, data through the protocols providing the service, while the other end (on the ground) can receive, but not send.

These services are also *unconfirmed* services: the sending end (spacecraft) does not receive confirmation that data it sends has been received. This is a consequence of the design of the space link protocols, which avoid the delays involved in confirmed services.

These services can be implemented as asymmetrical services, in which the local view in one system is not the same as that in another system. That is, the implementation of the layers in one set of subsystems in space need not be structured in the same way as another set of subsystems on the ground.

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Table 2-1: Summary of Packet Telemetry Services

Layer	Services	Service Capabilities
D Space Transfer layer	i. Packet Transfer Service ii. Privately Defined Data Service iii. Virtual Channel Frame Secondary Header Service iv. Virtual Channel Operational Control Field Service	Transfer of a sequence of variable-length PACKETS from a source application in space to one or more sink applications on the ground. Transfer of a sequence of PRIVATELY DEFINED DATA units of fixed length, along with status fields, from an on-board source to data sinks on the ground. Synchronous transfer of fixed-length FRAME SECONDARY HEADER in each frame on the VIRTUAL CHANNEL. Synchronous transfer of a fixed-length OPERATIONAL CONTROL FIELD in each frame of the VIRTUAL CHANNEL.
C Virtual Channel Access layer	i. Virtual Channel Frame Service ii. Master Channel Frame Secondary Header Service iii. Master Channel Operational Control Field Service	Transfer of Transfer FRAMES from each of one to eight VIRTUAL CHANNELS over one MASTER CHANNEL. Synchronous transfer of a fixed-length FRAME SECONDARY HEADER in each frame on a MASTER CHANNEL. Synchronous transfer of a fixed-length OPERATIONAL CONTROL FIELD in each frame of the MASTER CHANNEL.
B Channel Access layer	Channel Access Service	Constant-rate transfer of fixed-length TRANSFER FRAMES, with optional error detection/correction.
A Physical Access layer	Physical Access Service	Provision of a modulated radio link from spacecraft to ground. This service is not within the scope of this Recommendation, but is shown in this model since it provides the foundation for services defined here.

The emphasis in this Recommendation is on descriptions of a single instance of a type of service. It does not treat system engineering issues (such as relationships among various users of a particular data transfer service, or among those system elements that provide these services). Such issues are discussed in the Packet Telemetry Concepts and Rationale Report (reference [B2]).

This Recommendation makes no assumptions concerning the allocation of services, or the functions that provide services, to particular systems, subsystems or components, either on board a spacecraft, or in a ground system. Thus this Recommendation provides a design-independent description of services that could be provided, reserving for each mission the choice of which services to implement, and how to do so.

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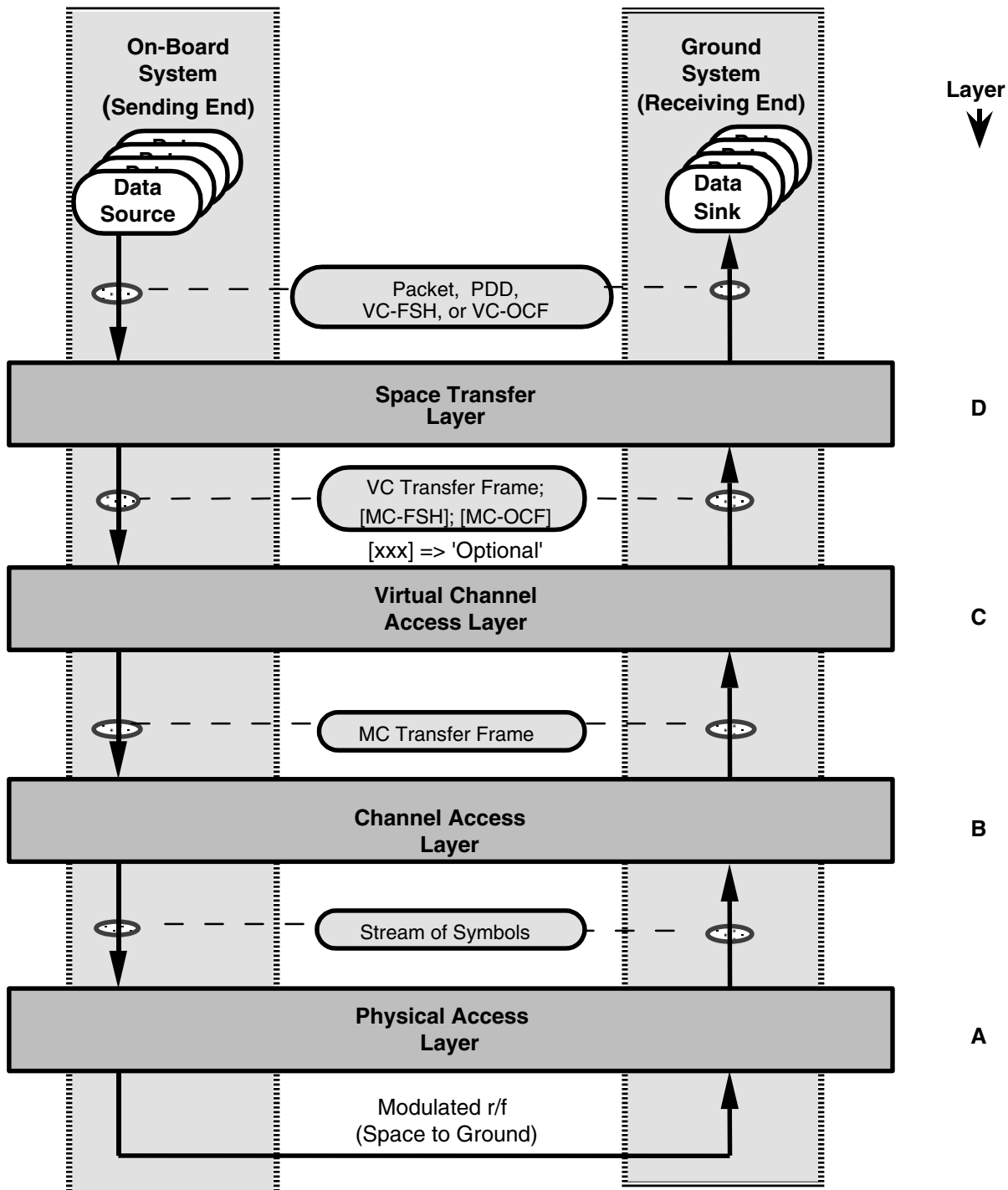


Figure 2-2: CCSDS Packet Telemetry Layers

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2.4 QUEUED VERSUS BUFFERED SERVICE

Packet Telemetry Services are of two types: queued and buffered.

Queued service—In queued service (figure 2-3), each SDU from a sending user is placed in a queue, the contents of which are sent to a receiving user (or users) in the order in which they were presented. Although transmission errors may prevent delivery of some data units, the service provider attempts to transfer all data units provided by the user exactly once. The distinctive feature of queued service is that all of the data units from the sending user are transferred, and transferred only once.

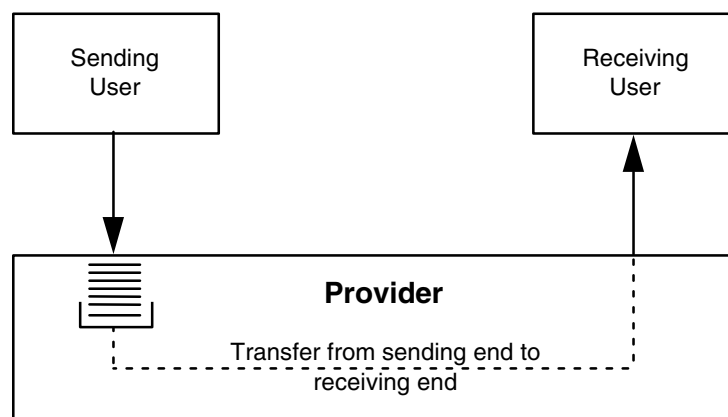


Figure 2-3: Queued Service Model

Buffered service—In buffered service (figure 2-4), each SDU from a sending user is placed in a buffer that can hold only one SDU; the contents of the buffer are sent to a receiving user (or users) at a time determined by the service (but usually known to the user). The timing may be constant rate (e.g., in every Transfer Frame sent by a spacecraft), or aperiodic (e.g., in every Transfer Frame of a Virtual Channel that produces frames at irregular intervals depending on the arrival of packets). The distinctive feature of buffered service, which is essentially time-division multiplexing, is that the timing of data transfer is driven by the service provider, not by the user. Thus a particular data unit from a user might be sent once, several times (if the ‘new’ value is not placed in the buffer soon enough), or not at all (if one value is replaced by a second before the service provider can send it).