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Space data and information transfer systems — Licklider transmission protocol (LTP) for CCSDS

Données spatiales et systèmes de transfert d'information - Protocol de transmission Licklider (LTP) pour CCSDS

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ISO 21080 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 734.1-B-1, May 2015) 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*.

DEDICATION

This book is dedicated to Adrian Hooke, whose end-to-end sensibilities and tireless advocacy for standardization of space data systems directly contributed to the formation of the Consultative Committee for Space Data Systems in 1982. His unique combination of technical skill, management abilities, and vision served CCSDS well for over 30 years. During that time CCSDS solidified the standardization of Physical and Data Link Layer protocols, and developed standards and technologies that had important and wide-ranging impacts in both the space and terrestrial communications industries. In the late 1990s, Adrian envisioned a new era for space communications leveraging a confluence of terrestrial internetworking and space-based data transport technologies. This led to the development of a concept that has come to be known as the Solar System Internetwork (SSI), of which the Licklider Transmission Protocol described here is a part.

Adrian will be missed, by CCSDS for the scope of his technical contributions and his leadership, and by his colleagues and friends for the greatness of his spirit and his wit. But his legacy to the space community remains. CCSDS will continue to provide useful and innovative solutions to space communication challenges so that Adrian's vision of an interoperable, standards-based communication system that reduces mission development time, cost, and risk will eventually be realized.

AUTHORITY

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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 documents is detailed in *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-4), and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the e-mail address below.

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STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of its members. 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 **Recommended Standards** and are not considered binding on any Agency.

This **Recommended Standard** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommendation** is entirely voluntary. Endorsement, however, indicates the following understandings:

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FOREWORD

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Questions relating to the contents or status of this document should be sent to the CCSDS Secretariat at the e-mail address indicated on page i.

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DOCUMENT CONTROL

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1 INTRODUCTION

1.1 PURPOSE

This document defines a Recommended Standard for the CCSDS Licklider Transmission Protocol (LTP) and associated service for application in the space environment. LTP provides optional reliability mechanisms on top of an underlying (usually data link) communication service.

1.2 SCOPE

LTP is intended for use over the current and envisaged packet delivery services used in the space environment, including:

– CCSDS conventional packet telecommand;

– CCSDS conventional packet telemetry.

For space data links, LTP will typically be deployed over a CCSDS data link that supports CCSDS Encapsulation Packets so that one LTP segment can be encapsulated in a single Encapsulation Packet. LTP may also operate over a wide variety of ground-network services including those specified by the CCSDS for cross-support purposes.

1.3 ORGANIZATION OF THE DOCUMENT

This Recommended Standard is organized as follows:

a) Section 2 contains a descriptive overview of LTP operation as well as a brief history of the protocol's heritage. Users not already familiar with LTP may want to start with this section.

b) Section 3 contains a profile of RFC 5326 (reference [3]) for use by CCSDS.

c) Section 4 contains the abstract service specification for LTP.

d) Section 5 specifies the services that LTP requires from the underlying system.

e) Section 6 contains conformance requirements for the CCSDS profile of LTP.

f) Section 7 defines a client operations service that allows multiple layer-(N+1) SDUs to be aggregated into a single LTP block in order to improve efficiency.

g) Annex A contains the Protocol Implementation Conformance Statement (PICS) proforma.

h) Annex B specifies how to layer LTP over the CCSDS Space Packet Service or the CCSDS Encapsulation Service.

i) Annex C contains the Management Information Base (MIB) for the protocol.

j) Annex D discusses security, SANA, and patent considerations related to the specification.

k) Annex E is a list of informative references.

l) Annex F is a list of abbreviations and acronyms that appear in the document.

1.4 CONVENTIONS AND DEFINITIONS

1.4.1 TERMS

1.4.1.1 Definitions from OSI Basic Reference Model

This Recommended Standard makes use of a number of terms defined in reference [1]. The use of those terms in this Recommended Standard is to be understood in a generic sense, i.e., in the sense that those terms are generally applicable to any of a variety of technologies that provide for the exchange of information between real systems. Those terms are:

– entity;

– Protocol Data Unit (PDU);

– service;

– Service Access Point (SAP);

– Service Data Unit (SDU).

Figure 1-1 illustrates the relationship of the LTP protocol defined in this document and protocols at the layers above and below LTP. From the point of view of protocols above LTP (e.g., Bundle Protocol), the service LTP provides is optionally reliable delivery of layer-(N+1) PDUs across a link. For LTP, the interface to the data link is via either direct encapsulation in CCSDS Space Packets or via the CCSDS Encapsulation Service.

Figure 1-1 illustrates the general service user-service provider relationships among layers. For the specific case of LTP in the CCSDS stack, the LTP service sits between the Data Link Layer and the Network Layer.

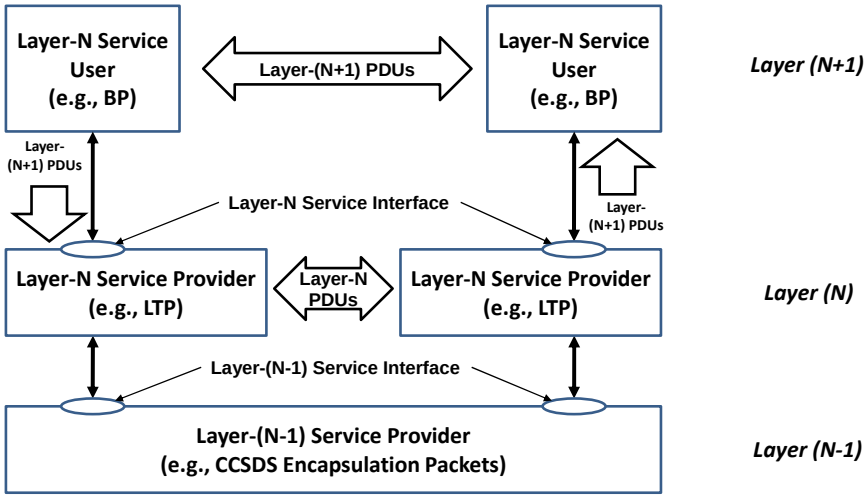

Figure 1-1: LTP's Relationship to Neighboring Protocols

1.4.1.2 Definitions from Open Systems Interconnection (OSI) Service Definition Conventions

This Recommended Standard makes use of a number of terms defined in reference [2]. The use of those terms in this Recommended Standard is to be understood in a generic sense, i.e., in the sense that those terms are generally applicable to any of a variety of technologies that provide for the exchange of information between real systems. Those terms are:

- indication;
- primitive;
- request;
- response.

1.4.1.3 Definitions from RFC 5326

This Recommended Standard makes use of a number of terms defined in reference [3]. Some of the definitions needed for section 2 of this document are reproduced here for convenience.

engine ID: An integer that uniquely identifies a given LTP engine, within some closed set of communicating LTP engines.

NOTE – When LTP is operating underneath the Delay-Tolerant Networking (DTN) Bundle Protocol (BP), the convergence layer adapter mediating the two will be responsible for translating between DTN endpoint IDs and LTP engine IDs in an implementation-specific manner.

block: An array of contiguous octets of application data handed down by the upper layer protocol (typically BP) to be transmitted from one LTP client service instance to another.

Any subset of a block comprising contiguous octets beginning at the start of the block is termed a 'block prefix', and any such subset of the block ending with the end of the block is termed a 'block suffix'.

red-part: The block prefix that is to be transmitted reliably, i.e., subject to acknowledgment and retransmission.

green-part: The block suffix that is to be transmitted unreliably, i.e., not subject to acknowledgments or retransmissions. If present, the green-part of a block begins at the octet following the end of the red-part.

session: A thread of LTP protocol activity conducted between two peer engines for the purpose of transmitting a block. Data flow in a session is unidirectional: data traffic flows from the sending peer to the receiving peer, while data-acknowledgment traffic flows from the receiving peer to the sending peer.

sender: The data-sending peer of a session.

receiver: The data-receiving peer of a session.

client service instance: A software entity, such as an application or a higher-layer protocol implementation, that is using LTP to transfer data.

segment: The unit of LTP data transmission activity. It is the data structure transmitted from one LTP engine to another in the course of a session. Each LTP segment is of one of the following types: data segment, report segment, report-acknowledgment segment, cancel segment, cancel-acknowledgment segment.

end of block, EOB: The last data segment transmitted as part of the original transmission of a block. This data segment also indicates that the segment's upper bound is the total length of the block (in octets).

end of red-part, EORP: The segment transmitted as part of the original transmission of a block containing the last octet of the block's red-part. This data segment also indicates that the segment's upper bound is the length of the block's red-part (in octets).

checkpoint: A data segment soliciting a reception report from the receiving LTP engine. The EORP segment must be flagged as a checkpoint, as must the last segment of any retransmission; these are 'mandatory checkpoints'. All other checkpoints are 'discretionary checkpoints'.

client service ID: Numeric identifier of the upper-level service to which the segment is to be delivered by the receiver. It is functionally analogous to a TCP port number. If multiple