The Consultative Committee for Space Data Systems

Draft Recommendation for Space Data System Standards

PROXIMITY-1 SPACE LINK PROTOCOL—CODING AND SYNCHRONIZATION SUBLAYER

DRAFT RECOMMENDED STANDARD

CCSDS 211.2-P-2.1

PINK SHEETS

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PREFACE

This document is a draft CCSDS Recommended Standard. Its 'Pink Sheets' status indicates that the CCSDS believes the document to be technically mature and has released it for formal review by appropriate technical organizations. As such, its technical contents are not stable, and several iterations of it may occur in response to comments received during the review process.

Implementers are cautioned **not** to fabricate any final equipment in accordance with this document's technical content.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 211.0-B-1	Proximity-1 Space Link Protocol	October 2002	Original issue, superseded
CCSDS 211.2-B-1	Proximity-1 Space Link Protocol—Coding and Synchronization Sublayer	April 2003	Superseded
CCSDS 211.2-B-2	Proximity-1 Space Link Protocol—Coding and Synchronization Sublayer, Recommended Standard, Issue 2	December 2013	Current issue: This update includes several improvements and clarifications—accomplishing better alignment and consistency with the other Proximity-1 Blue Books—and the addition of an option for Low-Density Parity-Check (LDPC) codes.
CCSDS 211.2-P-2.1	Proximity-1 Space Link Protocol—Coding and Synchronization Sublayer, Draft Recommended Standard, Issue 2.1	March 2019	Current draft update: Updates specification to include applicability to Unified Space Data Link Protocol, CCSDS 732.1-B-1.

1.6 CONVENTIONS AND DEFINITIONS

1.6.1 DEFINITIONS

1.6.1.1 Terms from the Open Systems Interconnection (OSI) Basic Reference Model

This Recommended Standard makes use of a number of terms defined in reference [1]. In this Recommended Standard those terms are used 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 as follows:

a) Data Link Layer;

b) Physical Layer;

c) protocol data unit;

d) real system;

e) service;

f) service data unit.

1.6.1.2 Terms Defined in This Recommended Standard

For the purposes of this Recommended Standard, the following definitions also apply. Many other terms that pertain to specific items are defined in the appropriate sections.

forward link: That portion of a Proximity space link in which the caller transmits and the responder receives (typically a command link).

physical channel: The RF channel upon which the stream of channel symbols is transferred over a space link in a single direction.

PLTU: Proximity Link Transmission Unit, the data unit composed of the Attached Synchronization Marker, the ~~Version-3~~ Transfer Frame, and the attached Cyclic Redundancy Check (CRC)-32.

Proximity link: A full-duplex, half-duplex or simplex link for the transfer of data between Proximity-1 entities in a session.

return link: That portion of a Proximity space link in which the responder transmits and the caller receives (typically a telemetry link).

space link: A communications link between transmitting and receiving entities, at least one of which is in space.

Transfer Frame: The protocol data unit of the protocol sublayer of the Data Link Layer.

NOTE – In this document, 'Transfer Frame' refers exclusively to either a Version-3 (Proximity-1) or a Version-4 (USLP) Transfer Frame.

1.7 REFERENCES

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

[1] *Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model*. 2nd ed. International Standard, ISO/IEC 7498-1:1994. Geneva: ISO, 1994.

[2] *TM Synchronization and Channel Coding*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 131.0-B-2. Washington, D.C.: CCSDS, August 2011.

[3] *Proximity-1 Space Link Protocol—Data Link Layer*. Issue 5. Recommendation for Space Data System Standards (Blue Book), CCSDS 211.0-B-5. Washington, D.C.: CCSDS, December 2013.

[4] *Proximity-1 Space Link Protocol—Physical Layer*. Issue 4. Recommendation for Space Data System Standards (Blue Book), CCSDS 211.1-B-4. Washington, D.C.: CCSDS, December 2013.

[5] *Unified Space Data Link Protocol*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 732.1-B-1. Washington, D.C.: CCSDS, October 2018.

2.2 PHYSICAL LAYER

On the send side, the Physical Layer:

– accepts control variables from the Data Link Layer for control of the transceiver;

– accepts a stream of Proximity-1 coded symbols from the Data Link Layer for modulation onto the radiated carrier.

On the receive side, the Physical Layer

– provides the serial stream output of Proximity-1 coded symbols from the receiver to the Data Link Layer:

– provides status signals (CARRIER_ACQUIRED and SYMBOL_INLOCK_STATUS) to the Data Link Layer.

2.3 DATA LINK LAYER

This subsection provides a brief overview of the Data Link Layer, with emphasis on the features relevant to the C&S Sublayer. Reference [3] contains a more complete description of the overall Proximity-1 system, of the Data Link Layer, and of its sublayers.

On the send side, the Data Link Layer is responsible for providing data to be transmitted by the Physical Layer. On the receive side, the Data Link Layer accepts the serial coded symbol stream output from the receiver in the Physical Layer and processes the protocol data units contained in it.

Within the Data Link Layer, the Medium Access Control (MAC) Sublayer and the Frame Sublayer have interfaces to the C&S Sublayer.

The Medium Access Control (MAC) Sublayer controls the establishment, maintenance and termination of communications sessions for point-to-point communications between Proximity entities. It controls the operational state of the Data Link and Physical Layers, using control variables. It accepts Proximity-1 directives both from the local vehicle controller and across the Proximity link to control its operations. The MAC Sublayer is also responsible for the storage and distribution of the Management Information Base (MIB) parameters.

The Frame Sublayer includes the processing associated with the fields contained in the Frame Header of the ~~Version-3~~ Transfer Frame. On the send side, the Frame Sublayer determines the order of frame transmission and delivers frames to the C&S Sublayer. On the receive side, the Frame Sublayer receives and validates frames from the C&S Sublayer and delivers them to the Data Services Sublayer or to the MAC Sublayer, depending on their contents.

2.4 CODING AND SYNCHRONIZATION SUBLAYER

On the send side, the actions of the C&S Sublayer include:

– constructing PLTUs, where each PLTU contains a ~~Version-3~~ Transfer Frame received from the Frame Sublayer;

– generation of the bitstream for encoding, inserting Idle data as required;

– channel coding;

– provision of the coded symbols stream at a constant rate (R_{cs}), to the Physical Layer for modulation onto the radiated carrier.

On the receive side, the C&S Sublayer actions include:

– reception of the coded symbols stream from the receiver in the Physical Layer at a constant rate (R_{cs});

– channel decoding;

– delimiting of each PLTU, including validation;

– for each valid PLTU, delivering the delimited ~~t~~Transfer ~~f~~Frame to the Frame Sublayer.

On both the send and receive sides, the C&S Sublayer supports Proximity-1 timing services defined in reference [3] by capturing the values of the clock, frame sequence number, Quality of Service (QOS) Indicator, and direction (ingress or egress) associated with each ~~Proximity-1~~ ~~t~~Transfer ~~f~~Frame.

The (simplified) interaction of the Coding & Synchronization Sublayer with the other (sub) layers at the transmitting (i.e., encoding) side of Proximity-1 is shown in figure 2-2.

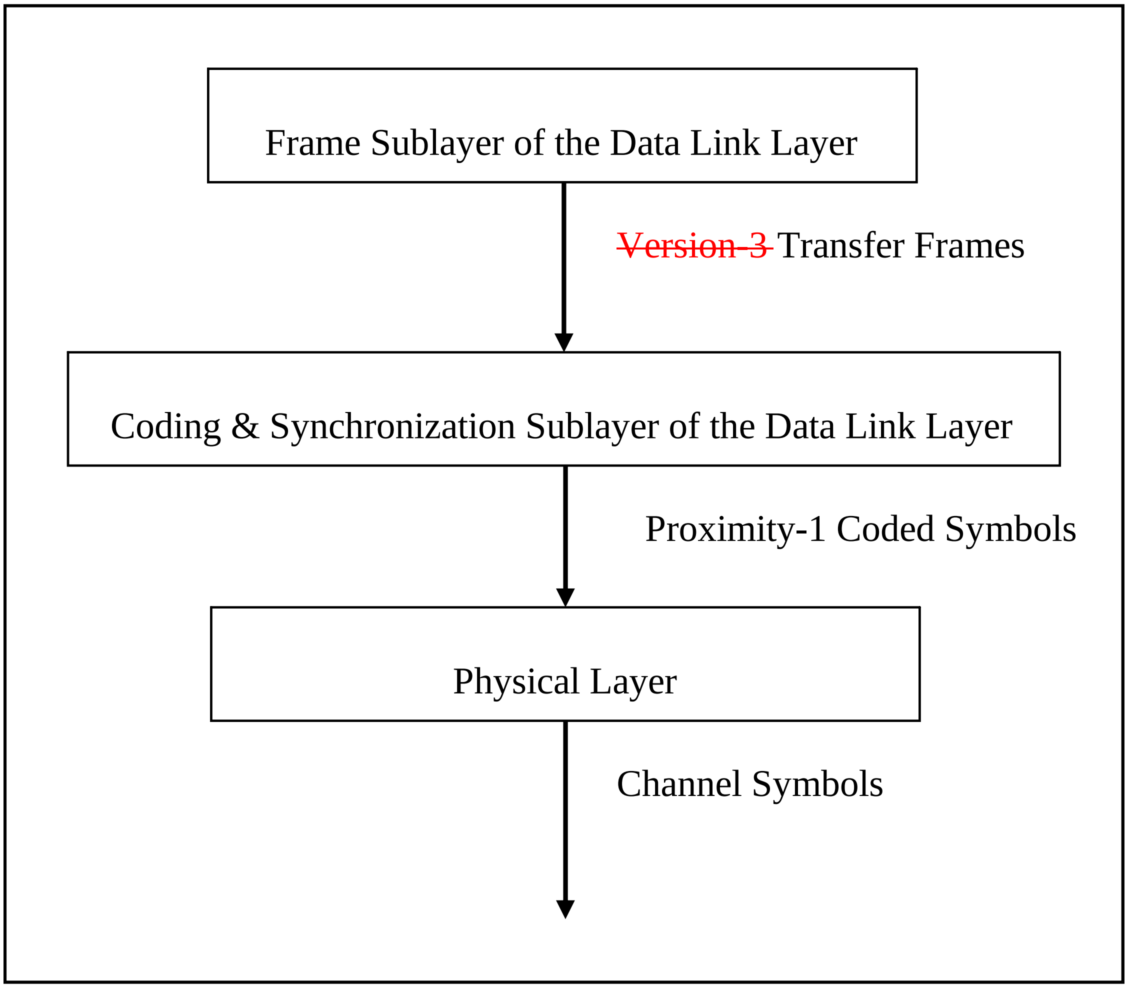

Figure 2-2: Coding & Synchronization Sublayer Send Side Interactions

3 CODING AND SYNCHRONIZATION SUBLAYER

3.1 OVERVIEW

On the send side, the C&S Sublayer generates the output coded symbols stream (including PLTUs and Idle data) to be delivered to the Physical Layer for modulation onto the radiated carrier. The PLTU is specified in 3.2. Each PLTU contains a ~~Version-3~~ Transfer Frame, specified in either reference [3] or reference [5], that also defines an Output Bitstream FIFO, which holds coded symbol-stream data ready for delivery to the Physical Layer.

The PLTUs form a non-continuous serial stream, consisting of a sequence of variable-length PLTUs, which can have a delay between the end of one PLTU and the start of the next. While establishing a Proximity-1 session for a full- or half-duplex link, synchronization is reacquired for each PLTU and Idle data is provided for the acquisition process. When no PLTU is available, Idle data is transmitted to maintain synchronization. Idle data is specified in 3.3. The procedures for the session establishment, data services, and session termination phases of a Proximity-1 session are specified in reference [3].

The channel coding options for Proximity-1 are specified in 3.4. The send side and receive side procedures in the C&S Sublayer are specified in 3.5 and 3.6.

3.2 PROXIMITY LINK TRANSMISSION UNIT (PLTU)

3.2.1 PLTU OVERVIEW

The C&S Sublayer handles the PLTU specified here and the ~~Version-3~~ Transfer Frame specified in reference [3] or reference [5]. The PLTU and the ~~t~~Transfer ~~f~~Frame are variable-length data structures.

For the sending end of a link, the C&S Sublayer constructs PLTUs, where each PLTU contains a ~~t~~Transfer ~~f~~Frame. For the receiving end, the C&S Sublayer processes each PLTU and delimits the ~~t~~Transfer ~~f~~Frame.

3.2.2 PLTU STRUCTURE

A PLTU shall encompass the following three fields, positioned contiguously, in the following sequence:

a) 24-bit Attached Synchronization Marker (ASM);

b) a ~~Version-3~~ Transfer Frame;

c) 32-bit Cyclic Redundancy Check.

NOTES

1 The length of a PLTU depends on the length of the ~~t~~Transfer ~~f~~Frame it contains. ~~A PLTU can have a length up to 2055 octets (3 octets ASM + 2048 octets maximum transfer frame + 4 octets CRC)~~The maximum transfer frame length for a given mission is established by the MIB parameter Maximum_Frame_Length in annex C in reference [3] or in the Managed Parameter Section in reference [5].

2 The structural components of the PLTU are shown in figure 3-1.

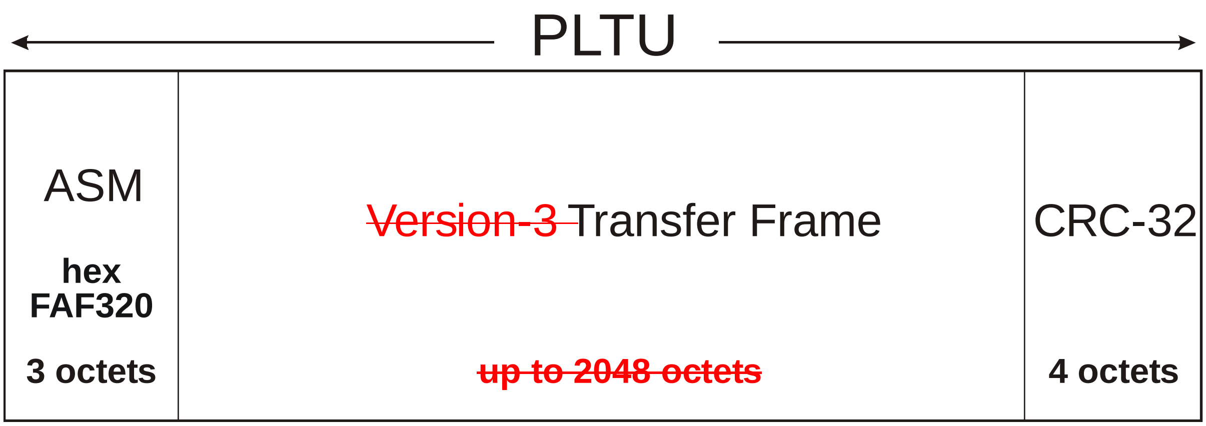

Figure 3-1: Proximity-1 Link Transmission Unit (PLTU)

3.2.3 ATTACHED SYNCHRONIZATION MARKER (ASM)

3.2.3.1 The Attached Synchronization Marker (ASM) shall occupy the first 24 bits of the PLTU.

3.2.3.2 The ASM shall consist of the following bit pattern (in hexadecimal): FAF320.

NOTE – At the receiving end, the ASM is used to detect the start of a PLTU.

3.2.4 ~~VERSION-3~~ TRANSFER FRAME

~~The Version-3 Transfer Frame (defined in 3.2) in a PLTU shall immediately follow the ASM.~~

3.2.4.1 PLTUs shall contain either a Version-3 or a Version-4 Transfer Frame.

3.2.4.2 The Transfer Frame in a PLTU shall immediately follow the ASM.

~~NOTE – Specification of the Version-3 Transfer Frame is contained in reference [3]. The PLTU is not designed for use with any other type of transfer frame.~~

NOTES

1 Transfer Frames with different Version Numbers in the same PLTU stream are not allowed.

2 The Specification of the Version-3 Transfer Frame is contained in reference [3].

3 The Specification of the Version-4 Transfer Frame is contained in reference [5].

3.2.5 CYCLIC REDUNDANCY CHECK (CRC-32)

3.2.5.1 The Cyclic Redundancy Check (CRC-32) shall occupy the last 32 bits of the PLTU.

3.2.5.2 The CRC-32 shall immediately follow the ~~Version-3~~ Transfer Frame.

3.2.5.3 The CRC-32 shall be calculated by applying the encoding procedure specified in annex C to the ~~Version-3~~ Transfer Frame.

3.2.5.4 The ASM shall NOT be a part of the encoded data space of the CRC-32.

NOTE – As shown in figure 3-1, the CRC is part of the PLTU but it is not part of the ~~Version-3~~ Transfer Frame. In this respect, Proximity-1 coding differs from other CCSDS space data link protocols.

3.3 IDLE DATA

3.3.1 OVERVIEW

Idle data are included in the bitstream for encoding:

– for the purpose of data acquisition (Acquisition sequence);

– when no PLTU is available (Idle sequence); and

– prior to terminating transmission (Tail sequence).

A Pseudo-Noise (PN) sequence defines the bit pattern used for the Idle data in each of these sequences. The PN sequence is cyclic and is repeated as needed.

Reference [3] specifies the uses of the Acquisition sequence, Idle sequence, and Tail sequence in the phases of a Proximity-1 session. It also specifies the MIB parameters Acquisition_Idle_Duration and Tail_Idle_Duration, which represent the time that is used to radiate the Acquisition sequence and the Tail sequence.

3.3.2 GENERAL

3.3.2.1 Idle data shall be included in the bitstream for encoding as follows:

NOTE – Some transceivers implement additional channel codes to those defined in the Proximity-1 recommended standards. The additions include a pair of Reed-Solomon codes, which can be enabled or disabled by the SET PL EXTENSIONS directive defined in annex A of reference [3]. The Reed-Solomon codes are not specified in the CCSDS Proximity-1 space link Recommended Standards and their use is not intended for cross-support applications.

3.4.2 CODING OPTIONS

3.4.2.1 The C&S Sublayer shall process the incoming ~~Version-3~~ Transfer Frames and produce a bitstream for encoding (including PLTUs and Idle Data) at data rate R_d.

NOTE – The current data rate is configured using the SET TRANSMITTER PARAMETERS and SET PL EXTENSIONS directives defined in annex A of reference [3] and it is selected among the following discrete data rates, shown in bits per second: 1000, 2000, 4000, 8000, 16000, 32000, 64000, 128000, 256000, 512000, 1024000, 2048000. When LDPC codes are used, these R_d values are approximated and the true values can be found in annex A of reference [3].

3.4.2.2 The C&S Sublayer shall generate the output stream of Proximity-1 coded symbols applying only one of the following coding options:

a) no coding;

b) convolutional code (see 3.4.3);

c) LDPC code (see 3.4.4).

NOTES

1 The convolutional and LDPC codes are optional. The use of the convolutional or LDPC code by the transmitter is configured using the Transmitter Data Encoding field of the SET TRANSMITTER PARAMETERS directive. The use by the receiver is configured ~~by~~using the Receiver Data Decoding field of the SET RECEIVER PARAMETERS directive. The directives are defined in annex A of reference [3]. The MAC Sublayer configures the C&S Sublayer according to received directives.

2 The directives SET TRANSMITTER PARAMETERS and SET RECEIVER PARAMETERS include an option to concatenate the convolutional code with one of the Reed-Solomon codes. Neither the Reed-Solomon code nor the concatenation with the convolutional code is specified here.

Figure 3-2 below shows the principal behavior of the C&S Sublayer.

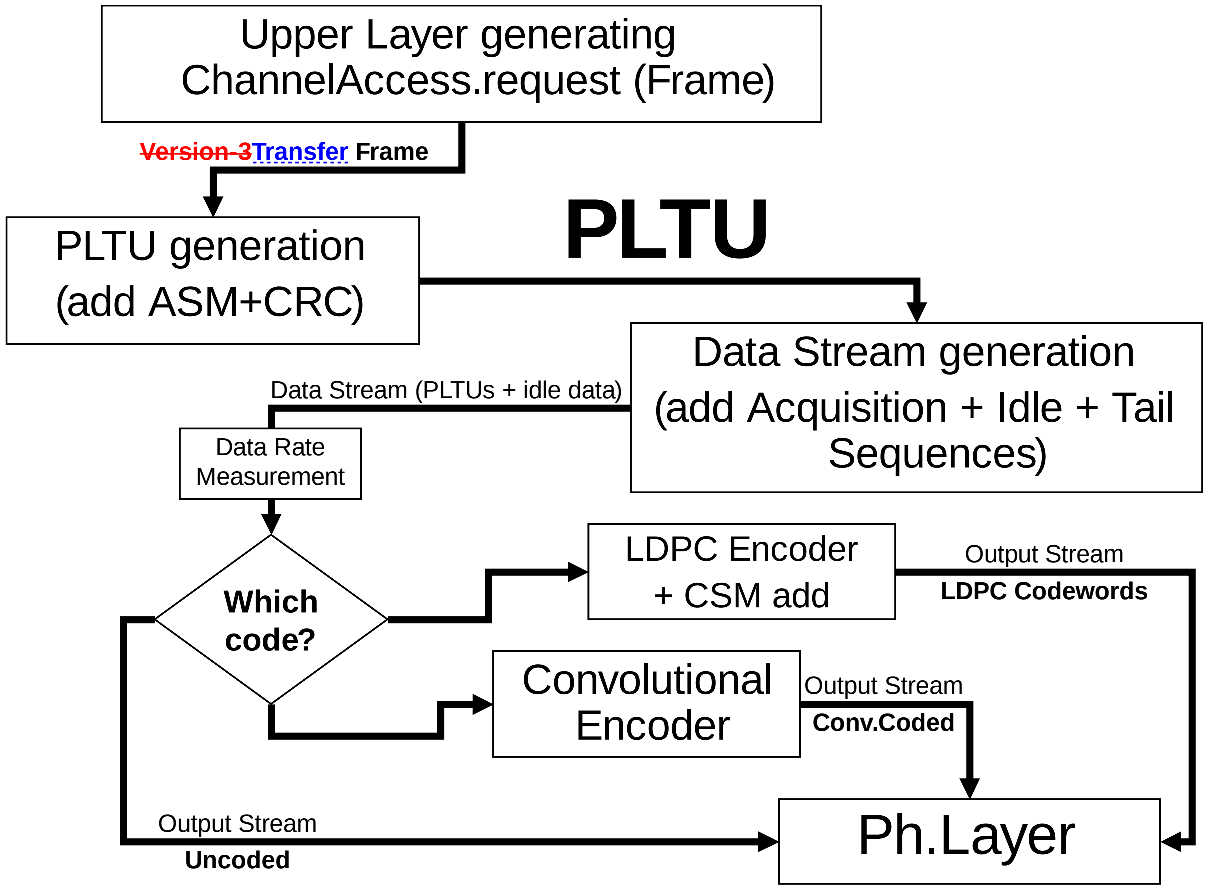

Figure 3-2: Behavior of the C&S Sublayer

3.4.3 CONVOLUTIONAL CODE

3.4.3.1 The convolutional code shall be the rate 1/2, constraint-length 7 convolutional code defined in reference [2].

NOTES

1 The convolutional encoding process does contain symbol inversion on the output path of connection vector G2.

2 Only the non-punctured convolutional code from reference [2] is specified for use on Proximity-1 links.

3.4.3.2 When the convolutional code is applied, all data to be transmitted, i.e., PLTUs and Idle data, shall be convolutionally encoded.

NOTES

1 The format of Idle data is specified in 3.3.

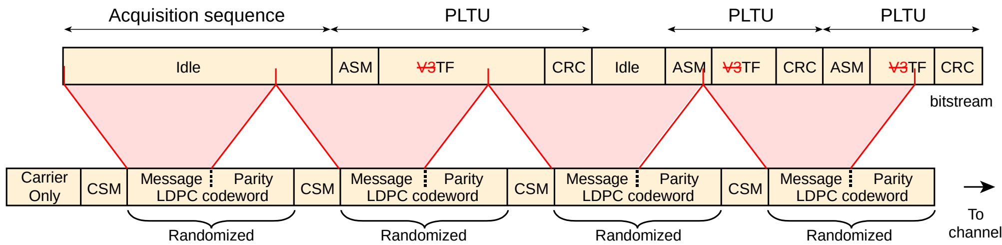

Figure 3-3: LDPC Coding Procedure

3.4.5 RANDOMIZATION OF LDPC CODEWORDS

3.4.5.1 Discussion

Since the LDPC code is quasi-cyclic, the LDPC codewords require randomization in order to minimize the probability of false synchronization due to potential symbol slips. When LDPC coding is used, this is achieved using the pseudo-randomizer defined in this section. When LDPC coding is used, a random sequence is exclusively ORed with the LDPC codewords to increase the frequency of bit transitions. On the receiving end, the same random sequence is exclusively ORed with the decoded LDPC codewords, restoring the original data form. The random sequence is generated by the pseudo-randomizer defined in this section.

3.4.5.2 Requirements

3.4.5.2.1 On the sending end, the pseudo-randomizer shall be applied to the LDPC Codeword.

3.4.5.2.2 On the receiving end the pseudo-randomizer shall be applied to de-randomize the randomized LDPC codewords before decoding.

3.4.5.2.3 The CSM shall be used for synchronizing the pseudo-randomizer.

3.4.5.2.4 The pseudo-random sequence shall be applied starting with the first bit of the LDPC Codeword.

3.4.5.2.5 On the sending end, the LDPC Codeword shall be randomized by exclusive-ORing the first bit of the Codeword with the first bit of the pseudo-random sequence, followed by the second bit of the Codeword with the second bit of the pseudo-random sequence, and so on.

3.4.5.2.6 On the receiving end, the original Codeword shall be reconstructed (i.e., de-randomized) using the same pseudo-random sequence.

3.4.5.2.7 After locating the CSM in the received data stream, the data immediately following the CSM shall be de-randomized.

3.5 SEND SIDE PROCEDURES IN THE C&S SUBLAYER

3.5.1 The C&S Sublayer shall accept ~~Version-3~~ Transfer Frames from the Frame Sublayer.

3.5.2 For each frame, the C&S Sublayer shall construct a PLTU containing the frame.

3.5.3 The C&S Sublayer shall generate the bitstream for encoding by inserting Idle data as required.

3.5.4 The C&S Sublayer shall apply the selected encoding (see 3.4.2.2) and generate the output coded symbol stream.

3.5.5 The C&S Sublayer shall deliver the generated output coded symbol stream to the Physical Layer at a constant rate (R_{cs}).

3.5.6 When time tag collection is active,

a) before computing CRC, the C&S Sublayer shall store the values of the clock, frame sequence number, QOS Indicator, and direction (egress) of each outgoing ~~Version-3~~ Transfer Frame.

b) The captured clock value shall correspond to when the trailing edge of the last bit of the ASM of the outgoing PLTU crosses the clock capture point (defined by the implementation) within the transceiver.

NOTE – The captured clock value is eventually processed to provide a value corresponding to a common reference point as described in reference [3] section 5, Proximity-1 Timing Services.

3.6 RECEIVE SIDE PROCEDURES IN THE C&S SUBLAYER

3.6.1 The C&S Sublayer shall accept the received coded symbols stream from the Physical Layer.

NOTE – The Physical Layer delivers the coded symbols stream at a given rate. Such a rate is configured using the SET RECEIVER PARAMETERS and SET PL EXTENSIONS directives defined in annex A of reference [3].

3.6.2 The C&S Sublayer shall apply the decoding of the selected channel coding option defined in 3.4.2.2.

3.6.3 The C&S Sublayer shall use the ASM to locate the beginning of a PLTU, for frame synchronization with the ~~Version-3~~ Transfer Frame it contains.

NOTE – For the purpose of frame synchronization, an implementation can choose to recognize an ASM with bit errors.

3.6.4 The C&S Sublayer shall use the Frame Length field and the Transfer Frame Version Number (TFVN) in the Transfer Frame Header of the ~~Version-3~~ Transfer Frame to locate the position of the CRC-32 field of the PLTU.

NOTES——

1 The CRC-32 marks the end of the PLTU, which can be followed by Idle data. The C&S Sublayer searches the received coded symbol stream following the end of the PLTU, looking for the ASM of the next PLTU, so any intervening idle bits are discarded.

2 The location as well as the size of the Frame Length field is protocol dependent. (See references [3] or [5] for specific details.)

3.6.5 The C&S Sublayer shall apply the CRC-32 decoding procedure to the received CRC-32 codeword in a PLTU, to check for errors in the received frame.

3.6.6 If the CRC-32 decoding detects any error in the CRC-32 codeword, the C&S Sublayer shall mark the received frame as invalid.

NOTE – As defined in annex B, which provides service definition in the form of primitives, the received frame indication is passed from the service provider to the service user at the receiving end, and frame handling depends on the specific implementation approaches (e.g., the invalid frames may be discarded or not).

3.6.7 The C&S Sublayer shall deliver the received frames to the Frame Sublayer.

3.6.8 When time tag collection is active,

a) after decoding, the C&S Sublayer shall store the values of the clock, frame sequence number, QOS Indicator, and direction (ingress) of each received ~~Version-3~~ Transfer Frame.

b) The captured clock value shall correspond to when the trailing edge of the last bit of the ASM of the received PLTU crosses the clock capture point (defined by the implementation) within the transceiver.

NOTE – The captured clock value is eventually processed to provide a value corresponding to a common reference point as described in reference [3] section 5, Proximity-1 Timing Services.

A2.2 REQUIREMENTS LIST

Item	Description	Reference	Status	Support
1	PLTU structure: ASM, ~~V3~~ Transfer Frame, CRC	3.2	M	
2	Idle data	3.3	M	
3	Coding option: uncoded data	3.4	O.1	
4	Coding option: convolutional	3.4.3	O.1	
5	Coding option: LDPC	3.4.4, 3.4.5	O.1	
6	Time tag support	3.5.6, 3.6.8	O	
7	Handling of invalid received frames	3.6.6	M	

O.1 It is mandatory to support at least one of these items.

ANNEX B

SERVICE

(NORMATIVE)

B1 BACKGROUND

This annex provides service definition in the form of primitives, which present an abstract model of the logical exchange of data and control information between the service provider and the service user. The definitions of primitives are independent of specific implementation approaches.

The parameters of the primitives are specified in an abstract sense and specify the information to be made available to the user of the primitives. The way in which a specific implementation makes this information available is not constrained by this specification. In addition to the parameters specified in this annex, an implementation can provide other parameters to the service user (e.g., parameters for controlling the service, monitoring performance, facilitating diagnosis, and so on).

B2 OVERVIEW OF THE SERVICE

B2.1 The Proximity-1 Synchronization and Channel Coding provides unidirectional (one way) transfer of a sequence of variable-length ~~Version-3~~ Transfer Frames at a variable frame rate over a physical channel across a space link, with optional error detection/correction.

B2.2 Only one user can use this service on a physical channel, and ~~Version-3~~ Transfer Frames from different users are not multiplexed together within one physical channel.

B3 SERVICE PARAMETERS

B3.1 FRAME

The Frame parameter is the service data unit of this service and shall be a ~~Version-3~~ Transfer Frame defined in reference [3] or in reference [5].

~~NOTE The length of Version-3 Transfer Frames transferred on a physical channel is variable, and the maximum length is established by management.~~

B3.2 QUALITY INDICATOR

The Quality Indicator parameter shall be used to notify the user at the receiving end of the service that there is an uncorrectable error in the received ~~Version-3~~ Transfer Frame.

ANNEX C

CRC-32 CODING PROCEDURES

(NORMATIVE)

C1 CRC-32 ENCODING PROCEDURE

C1.1 For the encoding procedure, the (*n*-32)-bit ~~t~~Transfer ~~f~~Frame shall be the information message.

C1.2 The encoding procedure shall accept an (*n*-32)-bit ~~Version 3~~ Transfer Frame and generate a systematic binary (*n*,*n*-32) block code by appending a 32-bit Cyclic Redundancy Check (CRC-32) as the final 32 bits of the PLTU, as shown in figure 3-1.

NOTES

1 The Bit Numbering Convention as specified in 1.6.2 is applicable below.

2 The ASM is NOT used for computing the CRC-32.

C1.3 If M(*X*) is the (*n*-32)-bit information message to be encoded expressed as a polynomial with binary coefficients, with the first bit transferred being the most significant bit M_0 taken as the coefficient of the highest power of *X*, then the equation for the 32-bit Cyclic Redundancy Check, expressed as a polynomial R(*X*) with binary coefficients, shall be:

$$R(X) = [X^{32} \cdot M(X)] \text{ modulo } G(X)$$

where G(*X*) is the generating polynomial given by:

$$G(X) = X^{32} + X^{23} + X^{21} + X^{11} + X^{2} + 1$$

and where the first transferred bit of the Cyclic Redundancy Check is the most significant bit R_0 taken as the coefficient of the highest power of *X*.

C1.4 The *n*-bit CRC-32–encoded block, expressed as a polynomial C(*X*) with binary coefficients, shall be:

$$C(X) = X^{32} \cdot M(X) + R(X)$$

The (*n*-32) bits of the message are input in the order $M_0,\ldots, M_{n-33}$, and the *n* bits of the codeword are output in the order $C_0,\ldots, C_{n-1} = M_0,\ldots, M_{n-33}, R_0,\ldots, R_{31}$.

ANNEX F

ABBREVIATIONS AND ACRONYMS

(INFORMATIVE)

ASM	Attached Synchronization Marker
C&S	Coding and Synchronization
CRC	Cyclic Redundancy Check
CSM	Codeword Sync Marker
FIFO	First In, First Out
ITU	International Telecommunication Union
LDPC	Low-Density Parity-Check
MAC	Medium Access Control
MIB	Management Information Base
OSI	Open Systems Interconnection
PLTU	Proximity Link Transmission Unit
PN	Pseudo-Noise
QOS	Quality of Service
R_{chs}	channel symbol rate
R_{cs}	coded symbol rate
R_d	data rate
RHCP	Right Hand Circular Polarization
SANA	Space Assigned Numbers Authority
SFCG	Space Frequency Coordination Group
USLP	Unified Space Data Link Protocol