

# BINARY SPACE

## RELIABLE SPACE SYSTEMS

## Definition of the Telemetry Parameter Exchange Protocol

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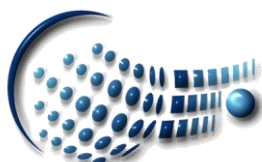
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### Document Change Log

Issue	Revision	Date	Affected	Reason for change
1	1-5	August 1996	All	New document
1	6	July 1998	All	Support for ARTEMIS
1	7	December 1998	All	Protocol extensions
1	8	August 1999	Chapter 3ff	Changed time key format and parameter status codes
1	9	October 1999	Chapter 3ff	Time key description



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### 1. Introduction

This document provides a description of the **Telemetry Parameter Exchange Protocol** (TPEP) that **BINARY SPACE** uses with its products in order to distribute preprocessed telemetry data and related information within a (heterogeneous) network. It operates on top of the TCP/IP protocol suite, a de-facto standard for this kind of communication.

### 2. Conventions

The following conventions are used throughout this document:

#### 2.1. Client/Server Definition

By following the convention, the provider of telemetry data and other related services is always called the 'server'. The 'client', on the other hand, requests and consumes the supplied information.

#### 2.2. Sessions

The time period between a successful initial connection (on the transport protocol level) and termination of such between a client and server is called a session.

#### 2.3. Endianity

Since the information quantities exchanged within the TPEP are all based on characters there is no need for special action to be taken due to a possibly different endian. This implies that even integer or floating-point numbers are expressed as an array of characters.

#### 2.4. Future Extensions

Some parts of the TPEP specification are subject to future extensions.

### 3. Telemetry Parameter Exchange Protocol (TPEP)

The subsequent content of this paper is divided up in two parts: A description of the various possible protocol phases on one hand and a listing of all available related messages on the other one.

#### 3.1. Protocol Phases

A session can be grouped into three basic phases:

##### 3.1.1. Service Start

Due to simplicity reasons TPEP directly relies on the TCP/IP primitives **connect** (on the client side) and **accept** (on the server side) respectively for a service initiation.



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### 3.1.2. Data Distribution

A successful service start is followed by the data distribution phase that is initiated through a data distribution request from the client. Two types of links between the client and server can be established by such a request described as **hot** (permanent) or **cold** connections. In the case of hot links the server continuously sends data messages (containing the requested preprocessed telemetry data) to the client without any further data distribution requests until either side terminates the service. Cold links on the other side instruct the server to just return one data message. For the second type of communication link several data distribution requests may be issued during a session.

### 3.1.3. Service End

A service can be terminated by either side through the TCP/IP primitive **closesocket**. The following figure illustrates the various protocol phases:

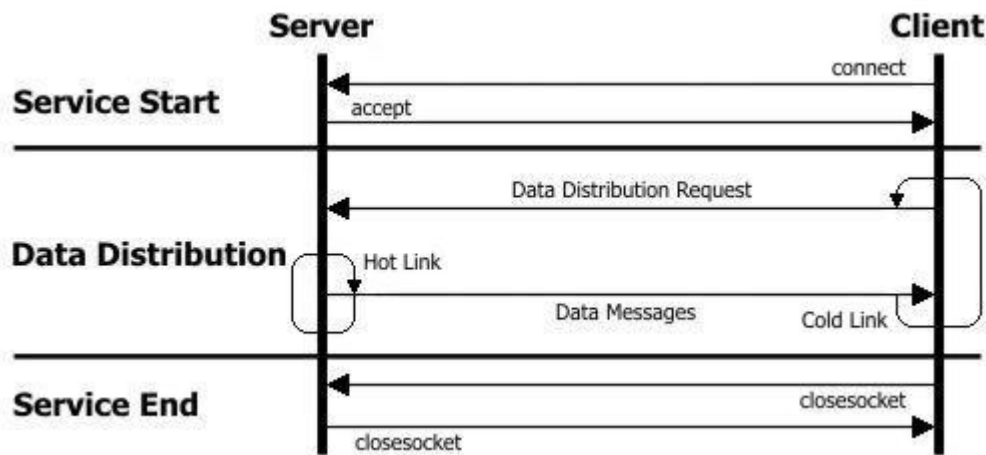
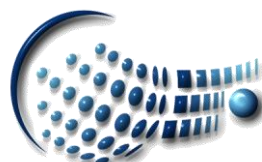


Figure 3.1-1 Protocol Phases

A connection must be re-established by the lower level primitives used in the service start phase in the event of a failure on the TCP/IP level. In case of problems on the TPEP level the client must issue a new data distribution request whenever the previous one was not accepted due to syntax errors. In all other cases (e.g. system problems or errors during the distribution phase) the socket is always closed after an error occurred.



## 3.2. Basic Message Structure

All TPEP data messages are built upon the same basic structure:



Figure 3.2-1 Basic Data Message Structure

These parts need to be explained in more detail:

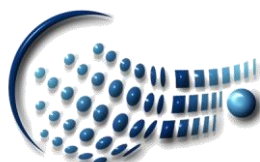
### 3.2.1. Header

The header contains a number of fields that are used to identify and further interpret the message:

Size	Usage
Variable	<b>Message Identification</b> Identifies the message type
Fixed	<b>Delimiter</b> (SPACE)
Variable	<b>Message Sequence Count*</b> Allows the detection of incontinences in the message through an incremental counter
Fixed	<b>Delimiter*</b> (SPACE)
Variable	<b>Error Code*</b> Indicates any occurred error as well as the quality of the enclosed data
Fixed	<b>Delimiter*</b> (SPACE)
Variable	<b>Synchronization Status*</b> Indicates the current synchronization status of the telemetry data provider
Fixed	<b>Delimiter*</b> (SPACE)

Remarks:

- Sizes are expressed in character positions (not bytes)
- Marked fields (\*) appear in header of data messages only



### 3.2.2. Data Field

The variable length data field contains the requested telemetry data information. The formatting within this area depends on the message but in general at least one or more of the following information entities are provided:

- Telemetry Unit Identifier
- Time tags identifying the correlated time
- Parameter Information Entities (PIEs) or raw data

### 3.2.3. Trailer

The optional trailer is reserved for future use.

### 3.3. Message Descriptions

The minimal set of message types required in order to perform the described functionality is now explained in more detail:

#### 3.3.1. Data Distribution Requests

Several types of requests are allowed depending on the kind of information required.

##### 3.3.1.1. Telemetry Packets

Part	Field	Values
Header	Message Identification	PACKETS
	Reserved	SPACE
Data Field	Spacecraft Identifier	1 (= ARTEMIS)
	Reserved	SPACE
	Number of Telemetry Packets	1...n
	Reserved	SPACE
	1 <sup>st</sup> Telemetry Packet Identifier	<i>Packet-Tag</i>
	Reserved	SPACE
	2 <sup>nd</sup> Telemetry Packet Identifier	<i>Packet-Tag</i>
	Reserved	SPACE
	n <sup>th</sup> Telemetry Packet Identifier	<i>Packet-Tag</i>
	Reserved	SPACE
	Telemetry Data Mode	1 (= Real time) 2 (= Historical) 3 (= Random)
	Reserved	SPACE
	Telemetry Data Link	1 (= Cold) 2 (= Hot)
	Reserved	SPACE
	Parameter Information Entity Type (PIE)	0 (= Raw data) 1...n (= PIE type)



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Reserved	<b>SPACE</b>
Trigger Mode  <u>Comments:</u> This mode applies to real time and historical mode, hot links and PIEs > 0 only	<b>1</b> (= Always) <b>2</b> (= Parameters changed)  <u>Comments:</u> Data messages can be triggered by the reception of the specified telemetry packet or when at least one of the contained parameters changed its value
Reserved	<b>SPACE</b>
Sample Limit  <u>Comments:</u> This limit applies to PIEs > 0 only	<b>0</b> (= No limit) <b>n</b> (= Maximal n samples)
Reserved	<b>SPACE</b>
Start Time  <u>Comments:</u> This field applies to historical mode only	Character-based <b>UTC Time</b> (or <b>0</b> )  <u>Format:</u> YYYY/MM/DD hh:mm:ss
Reserved	<b>SPACE</b>
Stop Time  <u>Comments:</u> This field applies to historical mode only	Character-based <b>UTC Time</b> (or <b>0</b> )  <u>Format:</u> YYYY/MM/DD hh:mm:ss
Reserved	<b>SPACE</b>
Replay Speed  <u>Comments:</u> This field applies to historical mode and hot links only	<b>1...10</b> (or <b>0</b> )  <u>Comments:</u> <b>1</b> (= Slow),..., <b>10</b> (= Fast)
Reserved	<b>LF</b> (Linefeed)



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### 3.3.1.2. Telemetry Parameters

Part	Field	Values
Header	Message Identification	PARAMETERS
	Reserved	SPACE
Data Field	Spacecraft Identifier	1 (= ARTEMIS)
	Reserved	SPACE
	Number of Parameters	1...n
	Reserved	SPACE
	1 <sup>st</sup> Parameter Identification	<i>Parameter-Tag</i>
	Reserved	SPACE
	2 <sup>nd</sup> Parameter Identification	<i>Parameter-Tag</i>
	Reserved	SPACE
	n <sup>th</sup> Parameter Identification	<i>Parameter-Tag</i>
	Reserved	SPACE
	Telemetry Data Mode	1 (= Realtime) 2 (= Historical) 3 (= Random)
	Reserved	SPACE
	Telemetry Data Link	1 (= Cold) 2 (= Hot)
	Reserved	SPACE
	Parameter Information Entity Type (PIE)	1...n (= PIE type)
	Reserved	SPACE
	Trigger Mode	1 (= Parameters updated) 2 (= Parameters changed)
	<u>Comments:</u> This mode applies to real time and historical mode, hot links and PIEs > 0 only	<u>Comments:</u> Data messages can be triggered by updated or changed parameters values
	Reserved	SPACE
	Sample Limit	0 (= No limit) n (= Maximal n samples)
	<u>Comments:</u> Limits the number of samples per parameter returned to n (with respect to a telemetry packet)	
Reserved	SPACE	



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Start Time	Character-based <b>UTC Time</b> (or <b>0</b> )
<u>Comments:</u> This field applies to historical mode only	<u>Format:</u> YYYY/MM/DD hh:mm:ss
Reserved	<b>SPACE</b>
Stop Time	Character-based <b>UTC Time</b> (or <b>0</b> )
<u>Comments:</u> This field applies to historical mode only	<u>Format:</u> YYYY/MM/DD hh:mm:ss
Reserved	<b>SPACE</b>
Replay Speed	<b>1...10</b> (or <b>0</b> )
<u>Comments:</u> This field applies to historical mode and hot links only	<u>Comments:</u> <b>1</b> (= Slow),..., <b>10</b> (= Fast)
Reserved	<b>LF</b> (Linefeed)

### 3.3.2. Data Messages

All data distribution requests result in a returned associated data message containing the requested information.

#### 3.3.2.1. Telemetry Packets

Part	Field	Values
Header	Message Identification	<b>PACKET_DATA</b>  <u>Comments:</u> <b>DATA</b> is returned when an identification of the packet type is not possible
	Reserved	<b>SPACE</b>
	Message Sequence Count	<b>1...2<sup>32</sup>-1</b> (incremented for hot links)
	Reserved	<b>SPACE</b>
	Error Code	<b>0</b> (= No error) <b>100-199</b> (= Illegal request) <b>200</b> (= Bad data) <b>300</b> (= No more data available) <b>400</b> (= Service not available) <b>500</b> (= Service access denied) <b>600</b> (= Server shutdown) <b>700</b> (= Server failure)
	<u>Comments:</u> See detailed error codes in a later chapter	



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	Reserved	SPACE
	Synchronization Status	0 (= Good) 1 (= Bad) 2 (= N/A)
	Comments: This status flag is applicable for real time mode only	
	Reserved	SPACE or LF (Linefeed)
Data Field	Telemetry Packet Identifier	<b>Packet-Tag</b>
	Reserved	SPACE
	Time Tag (Date & Time)	Character-based <b>UTC Time</b>  Format: YYYY/MM/DD hh:mm:ss.xxx
	Reserved	SPACE
	On-Board Reference Time (OBRT)	0...2 <sup>32</sup> -1
	Reserved	SPACE
	Parameter Information Entity Type (PIE)	0 (= Raw data) 1...n (= PIE type)
	Reserved	SPACE
	Size of Raw Data or number of following PIEs	6...128 or 0...n
	Reserved	SPACE
	Raw Data (16-bit quantities) or n PIEs separated by spaces	<b>Hexadecimal Value</b> or <b>PIE</b>
Reserved	LF (Linefeed)	

### 3.3.2.2. Telemetry Parameters

Part	Field	Values
Header	Message Identification	PARAMETER_DATA  Comments: DATA is returned when an identification of the packet type is not possible
	Reserved	SPACE
	Message Sequence Count	1...2 <sup>32</sup> -1 (incremented for hot links)
	Reserved	SPACE



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	Error Code  <u>Comments:</u> See detailed error codes in a later chapter	0 (= No error) 100-199 (= Illegal request) 200 (= Bad data) 300 (= No more data available) 400 (= Service not available) 500 (= Service access denied) 600 (= Server shutdown) 700 (= Server failure)
	Reserved	SPACE
	Synchronization Status  <u>Comments:</u> This status flag is applicable for real time mode only	0 (= Good) 1 (= Bad) 2 (= N/A)
	Reserved	SPACE or LF (Linefeed)
Data Field	Telemetry Packet Identifier	<b>Packet-Tag</b>  <u>Comments:</u> Identifies the telemetry packet that caused the data message to be sent. For cold links or snapshots N/A is always returned
	Reserved	SPACE
	Time Tag (Date & Time)	Character-based <b>UTC Time</b>  <u>Format:</u> YYYY/MM/DD hh:mm:ss.xxx  For cold links or snapshots N/A N/A is always returned
	Reserved	SPACE
	On-Board Reference Time (OBRT)	0...2 <sup>32</sup> -1  <u>Comments:</u> For cold links or snapshots N/A is always returned
	Reserved	SPACE
	Parameter Information Entity Type (PIE)	1...n (= PIE type)
	Reserved	SPACE
	Number of following PIEs	0...n
	Reserved	SPACE
	n PIEs separated by spaces	PIE
	Reserved	LF (Linefeed)



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## 3.4. Parameter Information Entities

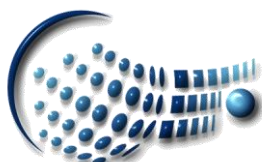
The various *Parameter Information Entities* (PIEs) define a set of information related to a parameter value. Only one type of PIE can be specified within a specific data distribution request.

### 3.4.1. Type 1

Field	Values
Parameter Identification	<i>Parameter-Tag</i>
Reserved	SPACE
Parameter Quality	0 (= Unchanged) 1 (= Updated) 2 (= Changed) 3 (= Bad data) 4 (= No data)
Reserved	SPACE  <u>Comments:</u> A PIE may end after the parameter quality field when no data is available
Parameter Value ( <i>calibrated</i> )	<i>Floating Point</i> <u>Format:</u> {space}{sign}{digit}{.}{digit}([d   D   e   E]{sign}{digit}) <i>(Unsigned) Integer</i> <u>Format:</u> {space}{sign}{digit} Width: 32 bits <i>String</i> <u>Format:</u> [']{character}[']

### 3.4.2. Type 2

Field	Values
Parameter Identification	<i>Parameter-Tag</i>
Reserved	SPACE
Parameter Quality	0 (= Unchanged) 1 (= Updated) 2 (= Changed) 3 (= Bad data) 4 (= No data)
Reserved	SPACE  <u>Comments:</u> A PIE may end after the parameter quality field when no data is available



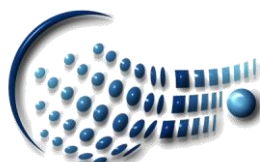
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Parameter Value ( <i>calibrated</i> )	<b>Floating Point</b> <u>Format:</u> $\{\text{space}\}\{\text{sign}\}\{\text{digit}\}\{.\}\{\text{digit}\}\{[d   D   e   E]\}\{\text{sign}\}\{\text{digit}\}$ <b>(Unsigned) Integer</b> <u>Format:</u> $\{\text{space}\}\{\text{sign}\}\{\text{digit}\}$ Width: 32 bits <b>String</b> <u>Format:</u> $[\ ]\{\text{character}\}[\ ]$
Reserved	SPACE
Parameter Status Code	<b>Out-of-Limit Code:</b> 1 (= No out-of-limit) 2 (= Soft limit) 3 (= Hard limit) 4 (= Delta limit)  <b>Validity Code:</b> 16 (= Valid) 32 (= Invalid)  <u>Comments:</u> Code = Out-of-limit code + Validity code

### 3.4.3. Type 3

Field	Values
Parameter Identification	<b>Parameter-Tag</b>
Reserved	SPACE
Parameter Quality	0 (= Unchanged) 1 (= Updated) 2 (= Changed) 3 (= Bad data) 4 (= No data)
Reserved	SPACE  <u>Comments:</u> A PIE may end after the parameter quality field when no data is available
Parameter Value ( <i>calibrated</i> )	<b>Floating-Point</b> <u>Format:</u> $\{\text{space}\}\{\text{sign}\}\{\text{digit}\}\{.\}\{\text{digit}\}\{[d   D   e   E]\}\{\text{sign}\}\{\text{digit}\}$ <b>(Unsigned) Integer</b> <u>Format:</u> $\{\text{space}\}\{\text{sign}\}\{\text{digit}\}$ Width: 32 bits <b>String</b> <u>Format:</u> $[\ ]\{\text{character}\}[\ ]$
Reserved	SPACE



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Parameter Value (raw, coded)	<b>Floating-Point</b> Format: {space}{sign}{digit}{.}{digit}([d   D   e   E]{sign}{digit}) <b>(Unsigned) Integer</b> Format: {space}{sign}{digit} Width: 32 bits
Reserved	SPACE
Parameter Status Code	<b>Out-of-Limit Code:</b> 1 (= No out-of-limit) 2 (= Soft limit) 3 (= Hard limit) 4 (= Delta limit)  <b>Validity Code:</b> 16 (= Valid) 32 (= Invalid)  Comments: Code = Out-of-limit code + Validity code
Reserved	SPACE
Last Change Packet Tag	<b>Packet-Tag</b>
Reserved	SPACE
Last Change Time Tag	Character-based <b>UTC Time</b>  Format: YYYY/MM/DD hh:mm:ss.xxx
Reserved	SPACE
Last Update Packet Tag	<b>Packet-Tag</b>
Reserved	SPACE
Last Update Time Tag	Character-based <b>UTC Time</b>  Format: YYYY/MM/DD hh:mm:ss.xxx

Later versions of the TPEP specification may contain further types of PIEs.

### 3.5. Error Codes

Code	Description
0=NO ERROR	No error
100=ILLEGAL SYNTAX	A delimiter character is missing or the data distribution request packet has an illegal length.
101=ILLEGAL MESSAGE ID	A data distribution request packet cannot be identified because the message keyword is illegal or missing.
102=ILLEGAL SPACECRAFT ID	The supplied spacecraft identification tag is illegal.
103=ILLEGAL NUMBER OF PACKETS	The supplied number for the packets requested is illegal.
104=ILLEGAL NUMBER OF PARAMETERS	The supplied number for the parameters requested is illegal.



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105=ILLEGAL PACKET ID	One or more packet identification tags supplied are illegal.
106=ILLEGAL PARAMETER ID	One or more parameter identification tags supplied are illegal.
107=ILLEGAL DATA MODE	The requested data mode is either illegal or does not apply.
108=ILLEGAL DATA LINK	The requested data link type is either illegal or does not apply.
109=ILLEGAL DATA TYPE	The requested data type is either illegal or does not apply.
110=ILLEGAL TRIGGER MODE	The requested trigger mode is either illegal or does not apply.
111=ILLEGAL SAMPLE LIMIT	The supplied number of parameter samples requested is either illegal or does not apply.
112=ILLEGAL RETRIEVE STARTTIME 113=ILLEGAL RETRIEVE STOPTIME	The supplied retrieve time is illegal or does not apply.
114=ILLEGAL RETRIEVE SPEED	The requested retrieve replay speed is illegal or does not apply.
200=BAD DATA	The data returned may be invalid.
300=NO DATA	No or no more data is currently available. Data may exist at a later time when one of the specified packets is processed.
400=SERVICE NOT AVAILABLE	The service is currently not available.
500=SERVICE ACCESS DENIED	The service denies any access at all or at least at the moment.
600=SERVER SHUTDOWN	The server is shutdown or the service port number has changed.
700=SERVER FAILURE	The server has an internal problem.



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## A. Appendix

### A.1. Lower Level Communication Layers

The TPEP relies on the TCP/IP protocol suite implemented in LAN/WAN environments that can base on several possible physical nets such as Ethernet or IEEE 802.3 and others. Streamed sockets are used for the implementation of TPEP.

### A.2. Implementation Issues

#### A.2.1. Limited Services

All features of TPEP are now implemented.

#### A.2.2. Telemetry Data Links

##### A.2.2.1. Cold Links

Cold data links are used to peek the current value of a set of telemetry parameters.

##### A.2.2.2. Hot Links

Hot data links need to be established when a continued delivery of telemetry packets or parameter values is required. Whenever such a link is initiated, a snapshot (identical to the data returned by a cold data link) may be returned as first data message. No initial snapshots are generated when telemetry packets are delivered.

#### A.2.3. Special Telemetry Data Processing Modes

No special telemetry data processing modes are supported.

#### A.2.4. Timeouts

An average time delay of up to one second between a data distribution request and the receipt of the corresponding data message(s) must be allowed. When historical telemetry data is required the delay may even be more than that.

## B. Acceptance

This document has been read and accepted by ESA.

