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Reference EEIG : 97E2675B | Distribution date : 31/07/98
Document version : 5-

ODOMETER FFFIS

Comments:

VERSIONS & MODIFICATIONS

Version Nb	Date of distribution	Comments on the modification	Responsible for the modification
0A	22/05/97	Preliminary version	Interop team
0B	11/06/97	Included remarks and suggestions by JLD	PG
0C	17/06/97	Comments by HM,	PG
1-	25/7/97	Comments from 3rd Onboard Architecture meeting	PG
2	30/7/97	Comments from 4th Onboard Architecture meeting and JLD	PG
2-	14/8/97	Distribution version	PG
3	12/09/97	Comments from DB AG	PG
3a	30/10/97	Comments from SNCF (97e661), DB-AG and discussion with JLD	PG
3b	20/1/98	Included comments from Industry-NPM meeting	PG
4-	20/3/98	Includes amendment 2239, 1558	PG
4A	xx/6/98	Includes amendments 2491, 2619	AP
4B	xx/6/98	Updating to be in compliance with the last versions of the other EEIG documents	ET
5-	31/07/98	Last revision and correction by the EEIG to be in compliance with the last versions of the other ERTMS Users Group specifications	ET

APPROVAL

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1. GENERAL DESCRIPTION

1.1 DOCUMENT REFERENCES

[1] System Requirements Specification
Ref EEIG : 96e236
Version : 4A
Date : 14/7/97

[2] FFFIS for external STM
Ref: ERTMS/EUROSIG/WP3124/SAS015
Version : 3.0.1
Date : 14/07/97

[3] ERTMS Performance
Ref EEIG : 96e166
Version : 2-
Date : 20/03/98

[4] Functional Requirements Specification
Ref A200 FRS
Version : 4.00
Date : 27/08/96

1.2 ABBREVIATIONS

ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FFFIS	Form Fit Functional Interface Specification
FIS	Functional Interface Specification
FMS	Functional Module Specification
STM	Specific Transmission Module

1.3 INTRODUCTION

The odometer is a device that processes the measurement of the train movement along the track and is used for speed and distance measurement as well as acceleration and running direction.

The objective of this document is to define the Form Fit Functional Interface Specification between the ERTMS Kernel and the Odometer Unit.

In addition, the main functions of the Odometer Unit and of the Kernel related to odometric processing are identified, but only as pertains to the interoperable behaviour of the system.

The functions required to allow the odometer to function in a national area, for example, are not part of this European FFFIS.

The architectural solution (see next figure) envisions an Odometer Unit external to the ERTMS kernel, sophisticated enough to perform measurements, estimate the related errors, effect self-calibration and exchange information with the kernel via a standardized high level interface.

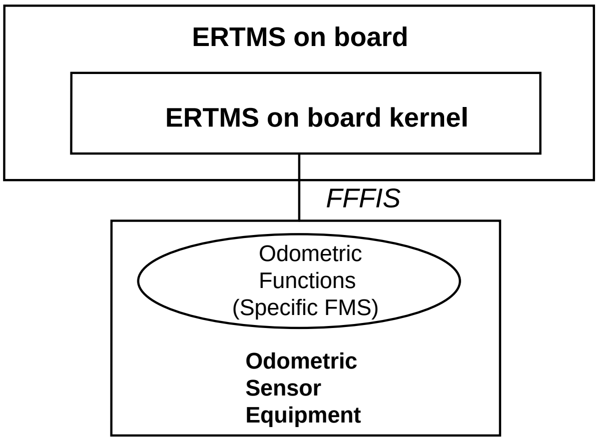

Figure 1 - architecture

Objective of the described solution is to permit the use of approved components produced by different manufacturers and to provide flexibility needed to take into account the rapid technical development.

As a remark, the function “Cold vehicle movement detection”, does not belong to the odometer, being fulfilled by a device connected to the TIU.

In the next figure we sketch the allocation of the functions, the interactions and the information flow between the kernel and the odometer, listing the data exchanged and the functions involved:

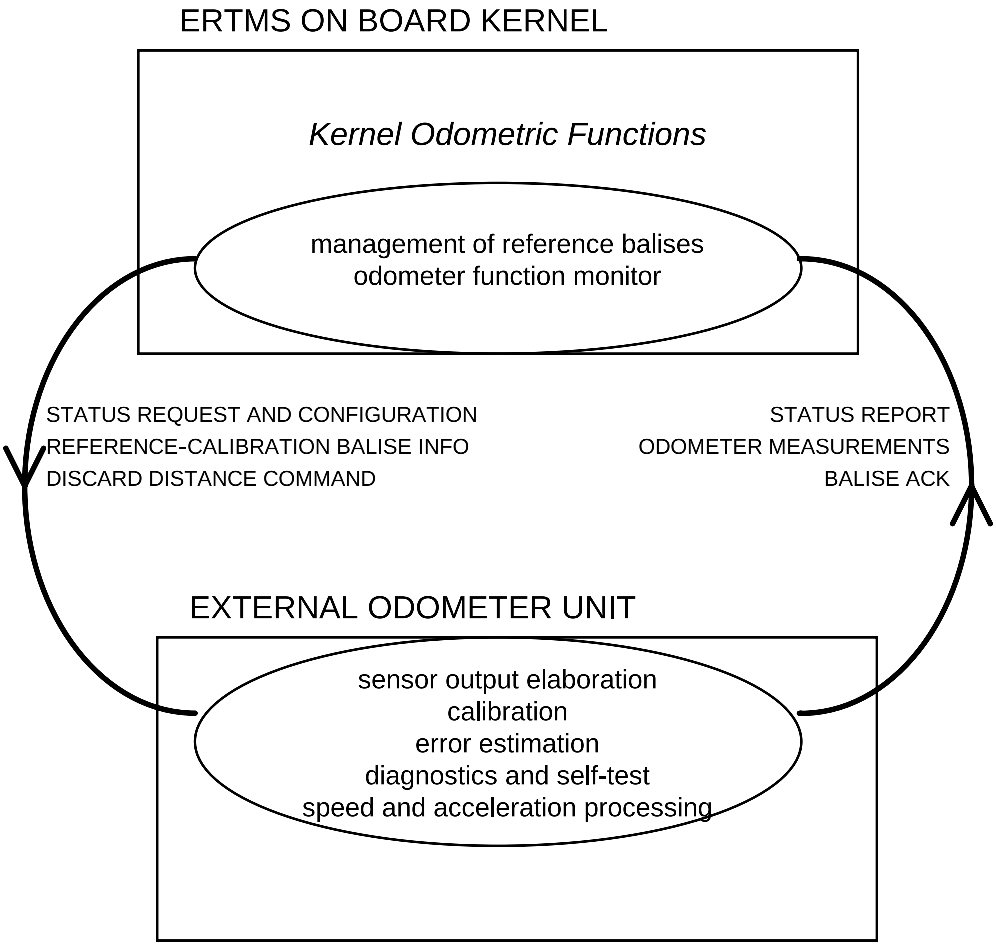

Figure 2 - functional structure

Though out of scope for a FFFIS, we outline in the following, for the sake of clarity, the description of the odometer-related functions and their allocation to the Kernel or to the Odometer.

1.4 FUNCTIONS ALLOCATED TO THE ODOMETER

The approach proposed relies on the Odometer to relieve the kernel of all of the processing chores, requiring only a minimal set of management functions.
The main odometric functions are:

1.4.1 SENSOR OUTPUT ELABORATION

The sensors can be able to give their output in various formats according to the technology adopted. A number of sensors with different technologies may be employed (accelerometers, sonic wheel, etc.) and their outputs have to be combined. Aim of the function is to elaborate such outputs, filter and combine different pieces of information and prepare the relevant data in a format useful to the on board kernel. Also, indirect measures can be derived from real ones, like speed and acceleration derived from space measurements.
The main mandatory output is the cyclic distance counter (with roll-over). The evaluation of the distances from balises for position reports etc. shall be performed by the relevant kernel functions.

1.4.2 ODOMETER CALIBRATION AND ERROR ESTIMATION

On the basis of the linking information received from the on board kernel, the Odometer functions perform the calibration of the Odometer parameters.
If one or more of the linked balises are not received from the kernel, it shall direct the odometric function to discard the relevant stored information.
The odometer provides the distance measure along with the actual confidence interval. The kernel provides information about reference balises to the odometer unit, which will reset the actual confidence interval in these reference points. The odometer unit can reset the confidence interval by itself, if it has more reference information.
The odometer will provide the speed and the other values also without reference balises (e.g. outside an ERTMS area); this will only affect the confidence interval of the measures.

1.4.3 DIAGNOSTIC SELF-TEST

According to the maximum possible variation of the errors of the device, a self test analysis is continuously performed and the relevant result are reported to the kernel on request.

1.4.4 POWER-ON SELF-TEST AND ODOMETER INFORMATION

Upon start-up, the odometer must perform the required self tests to ensure that it is working according to its specifications. It will then inform the kernel of the successful completion of the tests and of its nominal accuracy.

1.5 ODOMETRIC FUNCTIONS ALLOCATED IN THE KERNEL

On the other side the kernel must be able to manage the linking and the running information in such a way to select the data to be sent to and received from the External Odometer Function.

The main kernel functions relevant to the Odometer data elaboration are:

1.5.1 SPACE COUNTER ELABORATION

The Kernel receives periodically the distance counter. The value is processed to obtain the position referred to the balise co-ordinate system according to a black box philosophy.

1.5.2 MANAGEMENT OF REFERENCE BALISES

Reference balises are used as reference for the estimation of the confidence interval, and for giving a reference distance to the odometer to possibly recalibrate internal parameters. The kernel provides the odometer with the balise identity, the linking distance and the accuracy of this distance between balises. The odometer makes internal decision on how to use this information for calibration purposes, taking into account its own accuracy.

1.5.3 ODOMETER FUNCTION MONITORING

according to the SRS “Odometer Function Monitor Function” in chapter 4 of [1] to fulfil FRS 4.3.4

1.6 INFORMATION FOR ADVANCED ODOMETER PLATFORM

Advanced odometer platforms may be able to process more information foreseen in the previous sections. It is foreseen to have the following information provided by the kernel:

- tractive force Y/N, braking Y/N
  This information comes from the TIU to the kernel.
  It can be used to improve measurements.

- gradient information
  This information comes from the track description inside the actual movement authority. It is given similar to packet 21 for the same track section.
  It can be used to improve measurements.

- setting initial values

There can be situations, where the on-board ERTMS system is awakening, and the kernel has valid information about the confidence interval (eg. from the RBC or from another on-board ERTMS system that was master before cab change).For this case, the kernel is able to set the confidence interval to a given value. This will be the starting value for the odometer unit to calculate the actual confidence interval.

1.7 STRUCTURE OF THE DOCUMENT

This document is split in two parts :

I. Definition of Functional Interface Specification (FIS) based on the use of a standardised language called ERTMS-Odometer language.

With an approach consistent with the ERTMS-STM Language definition, described in the FFFIS for External STM document [2], this language is based on the ERTMS language.

Within Chapter 3 the list of data requirements is introduced and the translation into the ERTMS-Odometer language is explained.

The ERTMS-Odometer language is based on the same approach of chapter 7 of SRS document (Paragraph 7.1).

II. Definition of safety, communication and physical layer between Odometer and ERTMS on board system.

These layers are specified in accordance with the FFFIS for the External STM [2].

2. ODOMETER SPEED AND SPACE ACCURACY

The requirements for accuracy are outside the scope of this document, that deals only with the definition of the interface; they should be specified in other documents, along with RAMS requirements. The reference for performance requirements is the document “ERTMS Performance” [3] in particular paragraph 2.5 and 2.6.

3. FIS

The objective of this chapter is to define the elements of a high-level standardized information exchange, in accordance with the SRS chapter 7 approach.

3.1 DATA REQUIREMENTS

The information exchanged between kernel and odometer, excluding the advanced packets for advanced odometer platforms (Forces, Gradients, Initialization of Values), is summarized as follows:

- At start-up, or when necessary, the Kernel sends to the Odometer the configuration parameters (cycle time and max. acceleration).
- The odometer answers with information about its characteristics, its status and an indication that it was able to comply with the configuration request;
- afterwards, with the defined cycle time, the odometer will periodically send its measurements to the kernel.
- When passing a balise that can be used for calibration or location reference , its identity is communicated to the odometer, along with an indication whether the distance error must be reset from this balise or not. If the distance information to the next balise(s) can be used for calibration, this information is also communicated;
- the odometer acknowledges the message.
- If a balise is missed, or if it will not be encountered due to a change of route, etc. the kernel directs the odometer to discard the information related to that balise by communicating its identity;
- the odometer acknowledges the message.

3.2 PACKET OVERVIEW

The data and command exchange listed above is carried out by means of six different packets between the Kernel and the Odometer:

KERNEL to ODOMETER:

- STATUS REQUEST and CONFIGURATION is used by the kernel to start up the communication protocol and to inform the Odometer about the required cycle time for the measurement packets, or when it wants to request a status update: the Odometer will reply with the packet STATUS REPORT.
- REFERENCE AND CALIBRATION BALISE INFORMATION is used by the Kernel to inform the Odometer about the balise or balise group encountered that can be used for calibration and/or location reference.
- DISCARD COMMAND: the kernel uses this packet to direct the odometer to delete, from its internal memory, any information related to the balise(s) listed in the packet, because they have been missed, or the train changes its route, etc.
- FORCES: to inform the odometer about traction/braking actions
- GRADIENT PROFILE: to inform the odometer about the gradient of the line
- ODOMETER INITIALIZATION: to reset odometer readings to specific values

ODOMETER to KERNEL:

- STATUS REPORT the Odometer sends this packet in reply to STATUS REQUEST AND CONFIGURATION from the kernel. It contains information about self test status, nominal accuracy, current configuration and the completion code (successful or not) related to the cycle time configuration.
- ODOMETER MEASUREMENT contains the measurements and the confidence interval computed by the odometer; it is sent periodically after the odometer has been configured. The period is configurable.
- BALISE ACK is used by the Odometer to acknowledge the receipt of REFERENCE AND CALIBRATION BALISE INFORMATION or DISCARD COMMAND from Kernel.

The packets introduced above are exchanged according to the protocol exemplified in the next two figures:

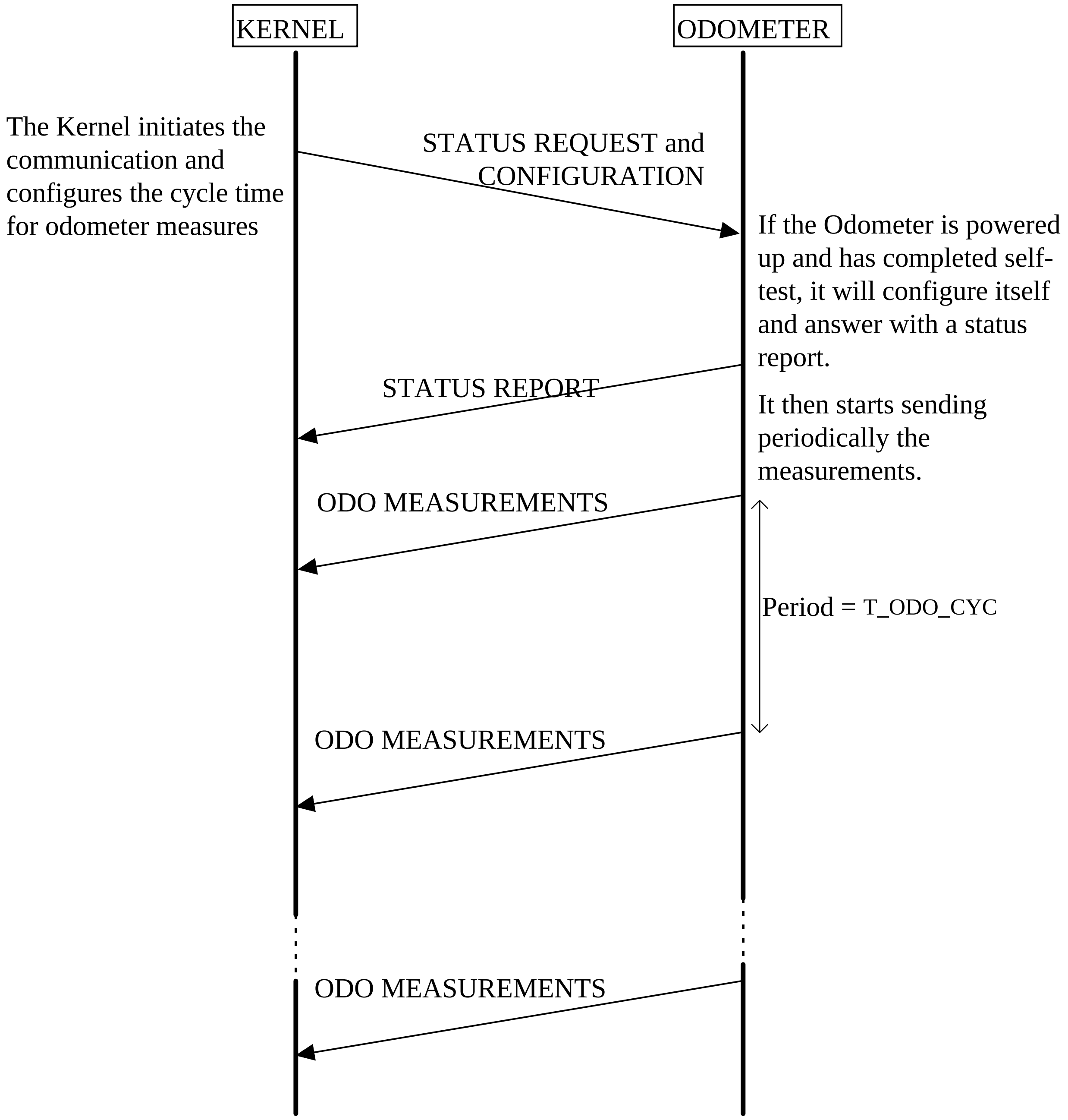

Figure 3 - Start-up and periodic measurements communication diagram

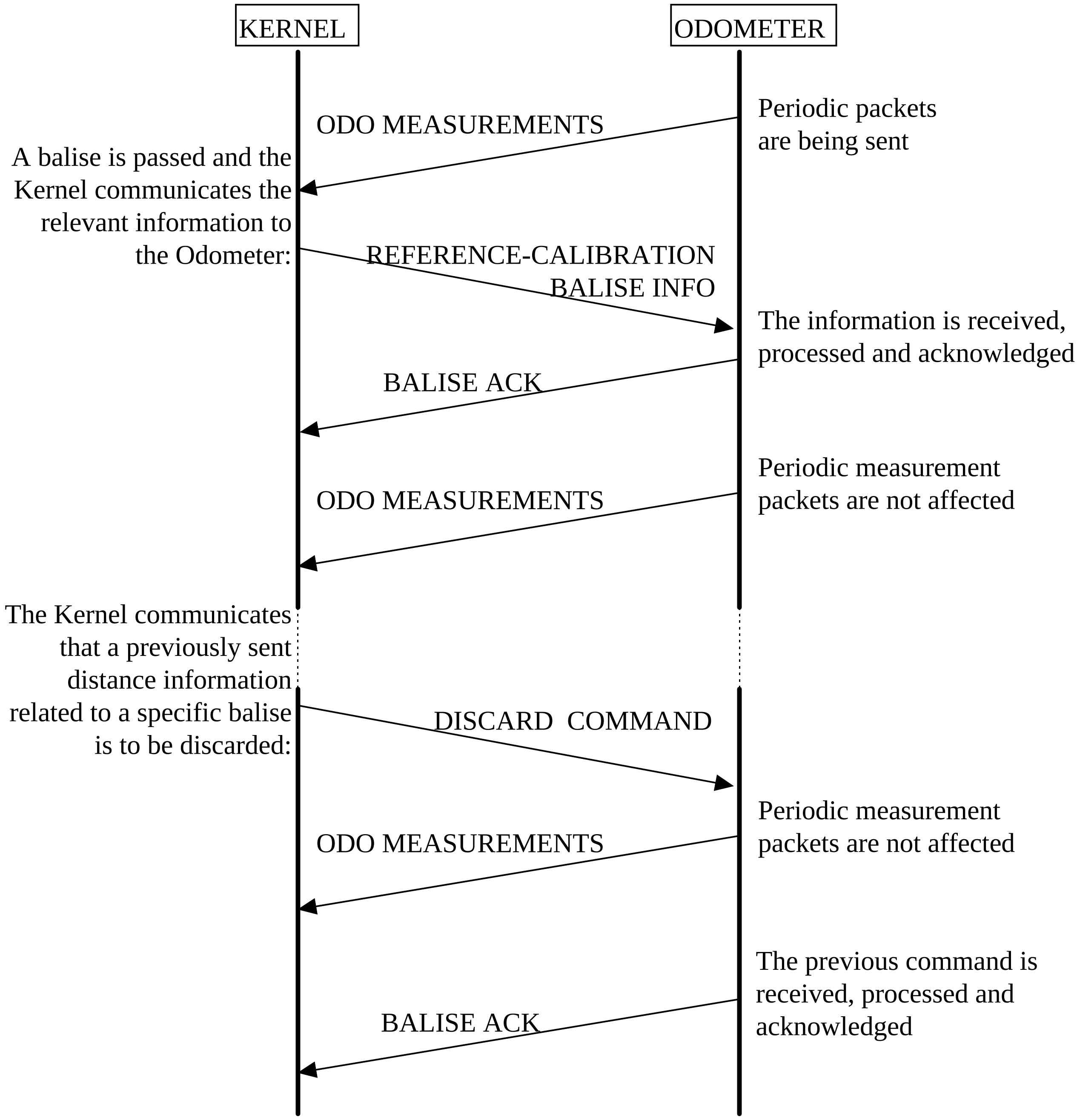

Figure 4 - Balise information and discard packets

The next drawing gives an example of the use of packet REFERENCE-CALIBRATION INFO when encountering balises along the track; in particular, it marks the difference between balises used for reference and a couple of balises used only for calibration:

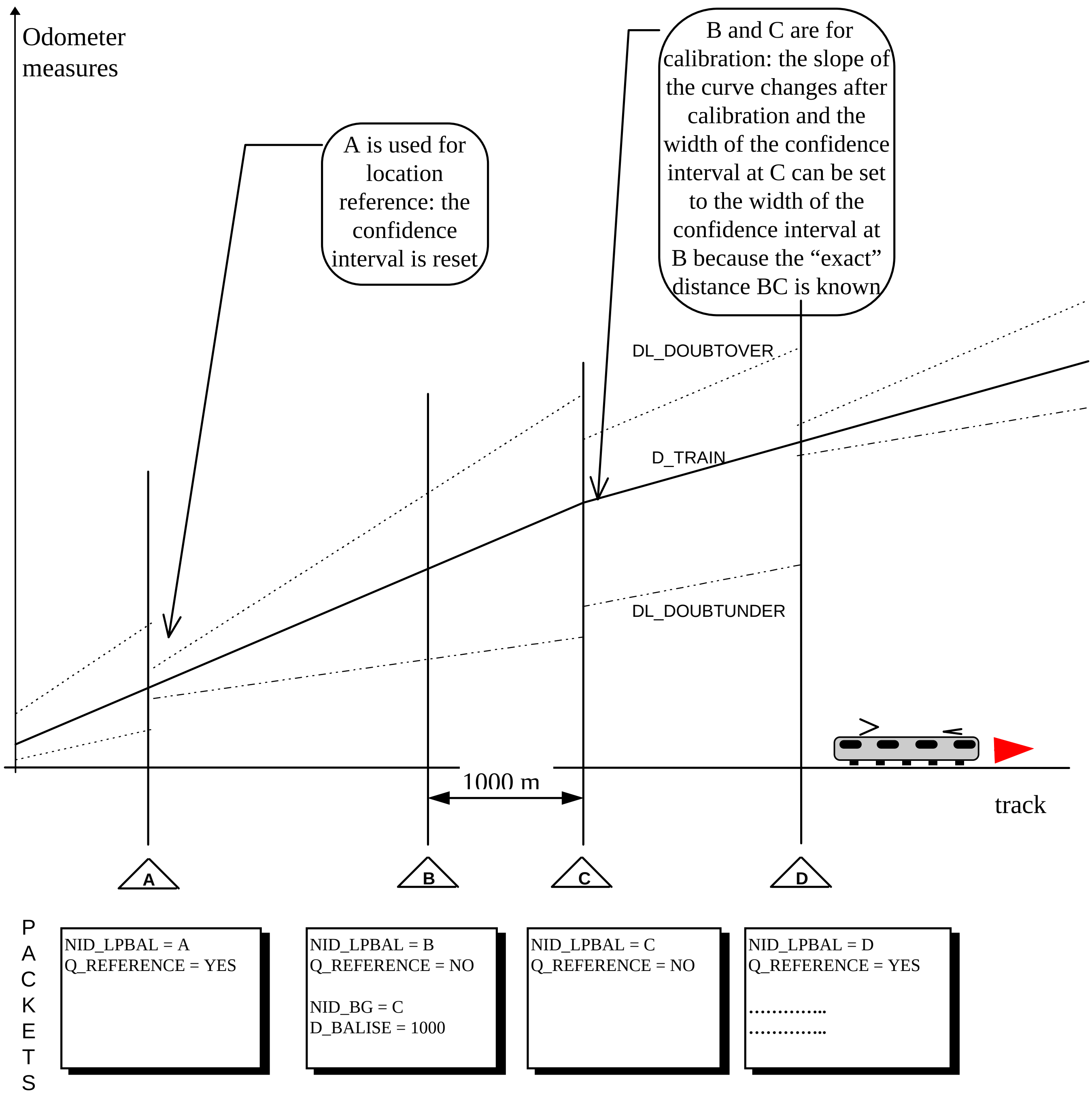

Figure 5

In this example all balises are linked in a single chain, but the linking distances are known with different degrees of accuracy: the distance between the two balises used for

calibration B and C is known with high accuracy, but their relative distance within A and D is not very accurate.
When passing balise C the width of the confidence interval can be set to the width of the confidence interval at balise B because the “exact” distance BC is known
The determination of the actual confidence interval is a complex task of the odometer, which has to take into account the accuracy of the reference point, environmental conditions, the status of the sensor equipment, vehicle parameters and other information. Therefore, the confidence intervals can be reset by the odometer even if no balise is encountered but other reference information is available; while its growth depends on a number of different conditions.

3.3 PACKETS USED FROM KERNEL TO ODOMETER

The kernel is the master of the communication protocol, that starts when the kernel sends the packet STATUS REQUEST and CONFIGURATION; in the following, the Kernel can send the packet REFERENCE AND CALIBRATION BALISE INFORMATION at any time to inform the Odometer about identity and parameters encountered balises and their distance. If later on the kernel determines that one or more balises will not be met or have been lost, it informs the odometer via the DISCARD COMMAND.
All the variable listed in chapter 3.5 are transmitted to/from ERTMS/ETCS with Odometer packets. Odometer packets are split into two parts:

- a header used to define type, producer, receiver, and time of production of the packet; this header is given by means of packet 84 defined in chapter 7 of [1].
- a body which contains the exchanged information and uses the packets defined in the following chapters.

The correspondence between packet and numbering is given for each packet by specifying the value of M_PACKETUSER.

3.3.1 STATUS REQUEST AND CONFIGURATION

M_PACKETUSER = 01h

Periodicity: sporadic, when the kernel needs to start up the communication protocol with the odometer, or to change the T_ODO_CYC period, or to communicate a new value for the maximum acceleration/deceleration that can be used by the odometer for checking the consistency of the measures (plausibility check) or to ask for the self test results.

Description	To initiate the communication or change parameters or ask for the current status of the odometer. T_ODO_CYC contains the time period to be used afterwards by the odometer to send the measurements packets.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER T_ODO_CYC A_MAX A_DMAX	8 16 8 8 **Total : 40**

3.3.2 REFERENCE AND CALIBRATION BALISE INFORMATION

M_PACKETUSER = 02h

Periodicity: sporadic, every time a balise or a balise group is met that can be used by the odometer either to calibrate itself or to reset the confidence interval.

Description	Transmission of the identity of encountered balise and its type (reference and/or calibration); optionally distance(s) of linked balise(s) which can be used for calibration. • T_TRAIN contains the time at which the balise NID_LPB was encountered. • Q_REFERENCE indicates whether the confidence interval has to be reset from the encountered balise The optional part of this packet is only necessary for calibration.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER L_PACKET T_TRAIN NID_LPB Q_REFERENCE	8 8 32 24 1
optional part	NID_C NID_BG D_BALISE Q_DACC … NID_C NID_BG D_BALISE Q_DACC padding if required	10 14 15 4 … 10 14 15 4

3.3.3 DISCARD COMMAND

M_PACKETUSER = 03h

Periodicity: sporadic, whenever the kernel can determine that one or more balises - whose identity and distance information was already sent to the odometer- should not be used (missed balise, change of route, etc...)

Description	Transmission of the identity of balise(s) whose information was already transmitted, that must be disregarded.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER L_PACKET NID_C NID_BG … NID_C NID_BG padding if required	8 8 10 14 … 10 14

3.3.4 FORCES

M_PACKETUSER = 04h

Periodicity: sporadic, when the kernel detects a change in the state of brakes or traction

Description	Information about traction and braking forces for intelligent odometer platforms	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER M_FORCE	8 4 **Total : 12**

3.3.5 GRADIENT PROFILE

M_PACKETUSER = 05h

Periodicity: sporadic, when the kernel receives such information

Description	D_GRADIENT(1) is the distance to the first next gradient change. **This distance starts from the reference position of the balise transmitted in this packet**.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER L_PACKET NID_C NID_BG Q_SCALE Q_GRDMTD G_A(0)(NB) D_GRADIENT(1)(NB) G_A(1)(NB) ………….. padding if required	8 8 10 14 2 1 7 15 7 **Total :**

This packet is introduced based on packet 21 of the SRS for gradients. All the variables inside this packet are specified in the SRS chapter 7 if not differently specified in this document. Since in packet 21 the reference position is different according to the fact that the information is received by radio or by balise, the kernel must perform the transformation of the starting position to coincide with one of the last ones (this will introduce a requirement on the number of “past” balises which must be “remembered” by the odometer unit).

3.3.6 ODOMETER INITIALIZATION

M_PACKETUSER = 6h

Periodicity: sporadic, when the kernel needs to initialise the odometer reading to specific values.

Description	This packet contains the Odometer values that the kernel wants to initialise	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER D_TRAIN NID_C NID_BG DL_DOUBTOVER DL_DOUBTUNDER padding	8 27 10 14 16 16 1 **Total: 91**

The kernel can force the confidence interval, the distance reading and the reference balise to an arbitrary value by means of this packet
The advanced odometer platform will reply with a success/fail code Q_CMD_OK contained in packet 82h (STATUS REPORT).

3.4 PACKETS USED FROM ODOMETER TO KERNEL

These packets are composed in the same way as described in chapter 3.3.

3.4.1 ODOMETER MEASUREMENTS

M_PACKETUSER = 81h

Periodicity: periodic (T_ODO_CYC).

Description	Odometer measured and evaluated data to be passed to the kernel.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER	8
	Q_CONTROL	9
	D_TRAIN	27
	V_TRAIN	10
	A_TRAIN	11
	NID_C	10
	NID_BG	14
	DL_DOUBTOVER	16
	DL_DOUBTUNDER	16
	V_DOUBTPOS	8
	V_DOUBTNEG	8
	Q_DIRECTION	2
		Total: 139

3.4.2 STATUS REPORT

M_PACKETUSER = 82h

Periodicity: sporadic, in reply to STATUS REQUEST AND CONFIGURATION message from kernel.

Description	Start-up completion and odometer characteristics. It contains information about self test status, nominal accuracy, current configuration and the completion code (successful or not) related to the configuration command.	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER Q_CMD_OK M_ODOACC M_VACC NID_LPB Q_CONTROL padding	8 1 24 20 24 9 1 **Total: 87**

3.4.3 MESSAGE ACKNOWLEDGEMENT [CS 2619]

M_PACKETUSER = 83h

Periodicity: sporadic, in reply to the message REFERENCE AND CALIBRATION BALISE INFO and DISCARD COMMAND from the kernel.

Description	Confirmation of reception and processing of message. • T_TRAIN has the same value as in the original message from kernel, to allow matching the acknowledge with its command	
Reference	**Variable**	**Number of bits**
	M_PACKETUSER T_TRAIN Q_CMD_OK padding	8 32 1 1 **Total: 42**

3.5 VARIABLES

3.5.1 A_MAX

It is the maximum expected value of acceleration and it is used for plausibility check. As described in chapter 7 of [1].

3.5.2 A_DMAX

It is the maximum expected value of deceleration and it is used for plausibility check. As described in chapter 7 of [1].

3.5.3 A_TRAIN

Description	Train acceleration in the longitudinal axis of the train in the running direction. The first bit indicates the sign of the acceleration (1=negative; 0=positive)		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
11 bits	-3 m/s^2	3 m/s^2	0.003 m/s^2
Special/Reserved Values	x1111101001 x1111101010 .... x1111111111 10000000000 11111111111	out of range not used …… not used not used not available	

3.5.4 D_BALISE

Description	Differential distance between balises NID_LPB and the balise NID_BG which precedes D_BALISE itself.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
15 bits	0	3276.7 m	10cm
Special/Reserved Values	000000000000000	not to be used	

3.5.5 D_TRAIN

Unsigned cyclical distance counter, will wrap-around when reaching the maximum value; it can have an arbitrary value when the odometer unit is put into service. It will always be incremented, regardless of running direction.

Description	On board incremental position space counter measured at the time given in T_TRAIN.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
27 bits	0 cm	134 217 727 cm	1cm
Special/Reserved Values			

3.5.6 Q_SCALE

Used in the “gradient profile” packet.

It is the same variable as defined in chapter 7 of [1].

3.5.7 DL_DOUBTOVER

The absolute upper bound width of the confidence interval of the odometer distance, computed over the measurement from the last passed balise with the Q_REFERENCE qualifier set to 1.

Description	Absolute distance over reading error.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
16 bits	0 cm	6553.4 m	0.1m
Special/Reserved Values	0000000000000000 1111111111111111	unknown out of range	

3.5.8 DL_DOUBTUNDER

The absolute lower bound width of the confidence interval of the odometer distance, computed over the measurement from the last passed balise with the Q_REFERENCE qualifier set to 1.

Description	Absolute distance under reading error.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
16 bits	0 cm	6553.4 m	0.1m
Special/Reserved Values	0000000000000000 1111111111111111	unknown out of range	

3.5.9 V_DOUBTNEG

Velocity under-reading error. It is the same variable as defined in chapter 7 of the SRS. Length: 8 bits

3.5.10 V_DOUBTPOS

Velocity over-adding error. It is the same variable as defined in chapter 7 of the SRS. Length: 8 bits

3.5.11 L_PACKET

Variable to determine the length of the packet: format value and formula in accordance with the variable in the SRS [1] chapter 7.

3.5.12 M_FORCE

Description	state of brakes/traction the two LSB bits are for brake state the two MSB are for traction state		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
4 bits			
Special/Reserved Values	xx00 xx01 xx1y 00zz 01zz 10zz	not braking braking brake state unknown no traction traction on traction state unknown	

Note: there must be a performance specification setting the thresholds for clearly deciding when the brakes and traction are to be considered “ON/OFF”.

3.5.13 M_ODOACC

Variable used by the odometer to inform the kernel about its own nominal accuracy for distance reading. M_ODOACC is a set of three values.
In accordance with [1] chapter 7.

3.5.14 M_VACC[1]

Odometer nominal accuracy for speed measurements (per thousand). The accuracy is given according to the diagram in [3] 2.6
M_VACC is a set of two values.

Description	Speed accuracy. • The first 10 bits refer to the accuracy for speed readings under 30 km/h 10 bits (d0) • The last 10 bits are the accuracy for differential speed over 30 km/h 10 bits (d1) M_VACC = (d0, d1)		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
20 bits	0.0 %	100.0 %	0.1%
Special/Reserved Values	1111101001 1111111111	reserved .... reserved	

3.5.15 NID_BG

Balise identity according to [1] chapter 7.

[1] The speed accuracy is needed to fulfil the FRS 4.3.5 [4]. A corresponding variable could be used in packet 8 of the SRS vers. 5.

3.5.16 NID_C

Country/region identifier for the balises according to [1] chapter 7.

3.5.17 NID_LPB

Identity of the last passed balise. Format, values and meaning are the same as the variable NID_LRBG defined in [1] chapter 7.

3.5.18 Q_CMD_OK

Description	Acknowledge qualifier from Odometer related to the last Kernel message.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
1 bit			
Special/Reserved Values	0 1	OK the command did not complete successfully.	

3.5.19 Q_CONTROL

Description	Qualifier for all odometer data and results of self-test. It is a set of three bit-field, relative to acceleration, velocity, and space measurements. It can be used for maintenance or driver warning		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
9 bits			
Special/Reserved Values	xxx xxx 000 xxx xxx 001 xxx xxx 010 xxx xxx 011 xxx xxx 100 xxx xxx 101 ………. xxx xxx 111 xxx 000 xxx xxx 001 xxx xxx 010 xxx xxx 011 xxx xxx 100 xxx xxx 101 xxx ………. xxx 101 xxx 000 xxx xxx 001 xxx xxx 010 xxx xxx 011 xxx xxx 100 xxx xxx 101 xxx xxx ………. 111 xxx xxx	Space: Nominal mode Space: Nominal but degraded redundancy Space: Degraded accuracy mode Space: Failure Mode Space: Not available Space: reserved …… Space: reserved Speed: Nominal mode Speed: Nominal but degraded redundancy Speed: Degraded accuracy mode Speed: Failure Mode Speed: Not available Speed: reserved …… Speed: reserved Acceleration: Nominal mode Accel.: Nominal but degraded redundancy Accel.: Degraded accuracy mode Accel.: Failure Mode Accel.: Not available Accel.: reserved …... Accel.: reserved	

3.5.20 Q_DACC

Description	In case the distance can be used for calibration purposes, this variable

	gives the accuracy per 1000 meters of the distance given in real meters. This one is used for the odometer.			
Length of variable	**Minimum Value**	**Maximum Value**		**Resolution/formula**
4 bits	0.1 per 1000	1.5 per 1000		1.5 per 1000
Special/Reserved Values	1111	worse than 1.5 per 1000		

3.5.21 Q_DIRECTION

Name	direction of movement		
Description	Qualifier to indicate whether the loco/train moves with cab A first or vice-versa.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
2 bits			
Special/Reserved Values	00 01 10 11	stationary cab A leading cab B leading unknown	

3.5.22 Q_REFERENCE

Description	The kernel requests the odometer to reset the confidence interval.		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
1 bit			
Special/Reserved Values	0 1	no reset requested reset the confidence interval.	

3.5.23 T_ODO_CYC

Description	Interval time for the cyclical sending of the odometer measurement packet		
Length of variable	**Minimum Value**	**Maximum Value**	**Resolution/formula**
16 bits	0	65535 ms	1 ms
Special/Reserved Values			

3.5.24 V_TRAIN

Train speed measured at the time given in T_TRAIN. This is the same variable as defined in chapter 7 of the SRS, but only for the numerical values (the non-numerical values are not available for the odometer).

4. SAFETY LAYER

See chapter 3 of FFFIS for external STM [2]. The information about the required cycle time for the periodic packets sent by the odometer could be used at the communication safety layer to verify the presence of such periodic traffic.

4.1 INITIALIZATION AND SYNCHRONIZATION

The applicable procedures and requirements are set forth in section 3.1.5 of the document FFFIS for External STM [2]. The Kernel is the master timer for the odometer clock.

5. COMMUNICATION PROTOCOL

HDLC (High Data Link Control) as described in chapter 4 of FFFIS for external STM [2].

6. CONNECTOR AND PHYSICAL LAYER

The reference link is a point to point connection RS 485; this connection must be assessed on all three national test sites. For national purposes, it is also allowed to test additional links, like bus solutions.