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Interface Requirements Specification
enhanced Location Dependent Addressing

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EVOLUTION SHEET

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1.0B	January 2002	ELDA Working Group	Interim draft for information
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1.0	November 2002	ELDA Working Group	Post meeting #13 comments included
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4.2	January 20007	OG Chair	Update of references
5.0	February	OG & IG	Final approved fifth version

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1. INTRODUCTION

1.1. Scope

This Interface Requirements Specification specifies the interface requirements for enhanced Location Dependent Addressing (eLDA). It forms part of the specification for Technical Interoperability.

The implementation of eLDA is optional. If implemented, this specification is mandatory.

eLDA is applicable to mobile originated point to point voice and data calls initiated by a EIRENE mobile station that provides eLDA location information as specified in this document.

enhanced Location Dependent Addressing (eLDA) is to be provided by train-based equipment, which may consist of GPS, balise readers, odometry, etc., transmitted over a GSM-R bearer.

Track-side location systems (such as train describers (track circuit derived) and transponders in tracks) transmitting location information over a fixed data network may, in addition be used to provide eLDA. However, due to the proprietary nature of these systems, its specification is outside of the scope of this document.

To ensure interoperability between railways, this document defines:

1. The interface between train-borne location systems and the entity which is responsible for processing received location information and routing of eLDA calls. This includes the specification of:

    a. The type of GSM-R data service, used for the transport of train-borne location information to the fixed network.

    b. The content, format and structure of the messages, which are exchanged on the interface.

2. A list of train-borne location systems which may be applied and a specification of the information which each location system should provide.

3. The parameters passed between train-borne location systems and the EIRENE mobile station.

In order to achieve the objectives of the eLDA FRS, conceptual ground based architectures responsible for processing received location information and routing of eLDA calls are described.

1.2. Background

Train drivers need to be able to contact controllers and other staff at the push of a single button. As the train moves through different areas, the required points of contact are liable to change. As a consequence it is necessary to provide a means of addressing calls from a train to certain functions based on the location of the train.

Within GSM-R, the basic means of determining the location of a train for the purpose of location dependent addressing is based on cell dependent routing. The EIRENE FRS and SRS mandate the minimum requirements for the current solution of LDA in FRS section 11.4 and SRS section 11.7.

It is recognised that the accuracy of cell dependent addressing is not sufficient for all operational scenarios. Several railways have therefore indicated that an enhanced system is required. To provide a greater degree of accuracy, additional information from (external) location information sources is necessary.

1.3. References

Ref.	Document Title	Document Number	Issue	Date	Author
Ref. 1	EIRENE FRS	MDA 029D009	7	May 2006	UIC GSM-R FG
Ref. 2	EIRENE SRS	MDA 029D010	15	May 2006	UIC GSM-R OG
Ref. 3	FFFS for Location Dependent Addressing	F 10 T 6001	4	January 2007	OG & IG
Ref. 4	FIS for Location Dependent Addressing	F 12 T 6001	3	January 2007	OG & IG
Ref. 5	Usage of UUIE in the GSM-R Environment	H 22 T 0001	3	January 2007	OG & IG
Ref. 6	Digital cellular telecommunications system (GSM); Core network protocols	TS 124.008	4.5.0	January 2002	ETSI
Ref. 7	Digital cellular telecommunications system (GSM); Man-Machine Interface (MMI) of the User Equipment	TS 122.030	4.0.0	April 2001	ETSI
Ref. 8	Military Standard WGS84 Metric	MIL-STD-2401	-	January 1994:	Department of Defence World Geodetic System
Ref. 9	eLDA Functional Requirements Specification	LDA_WG161	4.0	December 2002	eLDA Working Group

1.4. Abbreviations and Definitions

BCD	Binary Coded Decimal
BTS	Base Transceiver Station
BSC	Base Station Controllerenhanced Location Dependent Addressing
eLDA	enhanced Location Dependent Addressing
ERTMS	European Rail Traffic Management System
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM-R	GSM for Railways
IE	Information Element
IN	Intelligent Network
MSC	Mobile Switching Centre
NSS	Network Sub-System
SDC	Short Dialling Code
RBC	Radio Block Centre
UUS	User to User Signalling
UUS1	User to User Service 1
UUIE	User to User Information Element
WGS84	World Geodetic System 1984

a.

2. SYSTEM REQUIREMENTS ELDA

2.1. Definitions

a. For the definition and overview of the functional requirements of eLDA refer to the eLDA Functional Requirements Specification. (I)

b. The time of calling or call initiation is defined as the moment when the mobile user initiates a dialling command. (I)

2.2. eLDA General Concept

a. If eLDA is applied, it shall follow the principles below: (I)

   1. For correctly routing an eLDA call, train-borne and/or track-side location information is used;

   2. The use of train-borne location information sources is optional;

   3. There are two ways to transfer train-borne location information which can be used separately or together:

      a. at call setup conveyed in a UUS1 message (e.g. GPS, odometry);

      b. at call setup using the last two digits (based on balise- or train-borne equipment information) of the SDC.

b. It is up to each railway whether or not to process (i.e. interpret) incoming train-borne location information data. The acceptance of such data (without causing malfunction) is however mandatory. (M)

c. Table 2-1 shows the different train-borne location information systems and requirements (M or O) on the mobile equipment, air interface and the network:

System	***Mobile***	***Air Interface***	***Network (Location Processing)***
GPS	**O**	**M** (data format 1)	**M** (acceptance of data) **O** (processing of data)
Future pan-European location system	**O**	**M** (data format 1)	**M** (acceptance of data) **O** (processing of data)
SDC (last two digits)	**O**	**M** (data format 2)	**M** (acceptance of data) **O** (processing of data)
Odometry	**O**	**M** (data format 1)	**M** (acceptance of data) **O** (processing of data)
Other location systems	**O**	**M** (data format 1 or 2)	**M** (acceptance of data) **O** (processing of data)

Table 2-1 eLDA Message Formats (M)

Note

Data format 1 is defined in section 4.2.3.

Data format 2 is defined in section 4.1.

2.3. eLDA system behaviour

a. All possible scenarios for interaction of location information are shown in Table 2-2. For each scenario the eLDA system behaviour is described. (M)

b. Where location information is not processed, this may be due to absence of location information, corruption of location information or the network which is not configured to process location information. (I)

c. No GPS quality indication is transmitted to the network. The train-borne equipment is responsible for controlling the quality. (M)

Scenario	*Presence of train-borne location information*			*Description*	*System behaviour*
	GPS	*Odometry*	*Last two digits of SDC (associated with a balise or train-borne equipment)*		
1	No	No	No	-	The call is routed using cell information and SDC.
2	No	Yes	No	This scenario is not applicable. Odometry information without a reference point cannot be used and is ignored.	-
3	No	No	Yes	-	The call is routed using cell information and SDC, incorporating the last two digits associated with a balise or train-borne equipment.
4	No	Yes	Yes	This scenario is not applicable. Odometry information without a reference point cannot be used and is ignored.	-
5	Yes	No	No	-	The call is routed using GPS information and SDC.
6	Yes	Yes	No	Odometry information indicates the distance traveled between transmitted GPS location and the location at call initiation.	The call is routed using GPS information, odometry information and SDC.
7	Yes	No	Yes	-	The call is routed using GPS information and SDC, incorporating the last two digits associated with a balise or train-borne equipment.
8	Yes	Yes	Yes	Odometry information indicates the distance traveled between transmitted GPS location and the location at call initiation.	The call is routed using GPS information, odometry information and SDC, incorporating the last two digits associated with a balise or train-borne equipment.

Table 2-2 eLDA system behaviour

2.4. eLDA System Architecture

a. There are two fixed network options to provide routing to the requested eLDA point of contact using eLDA information. (I)

2.4.1. Two Stage eLDA call routing - Secondary Routing Provided External to NSS

a. The NSS provides the primary routing function based on cell identification. Where eLDA information is available the call is routed to the Secondary Routing and Location Processing Function, along with the eLDA information. Where a network includes more than one Secondary Routing and Location Processing Function, the NSS may use the cell identification to route to the appropriate one. (I)

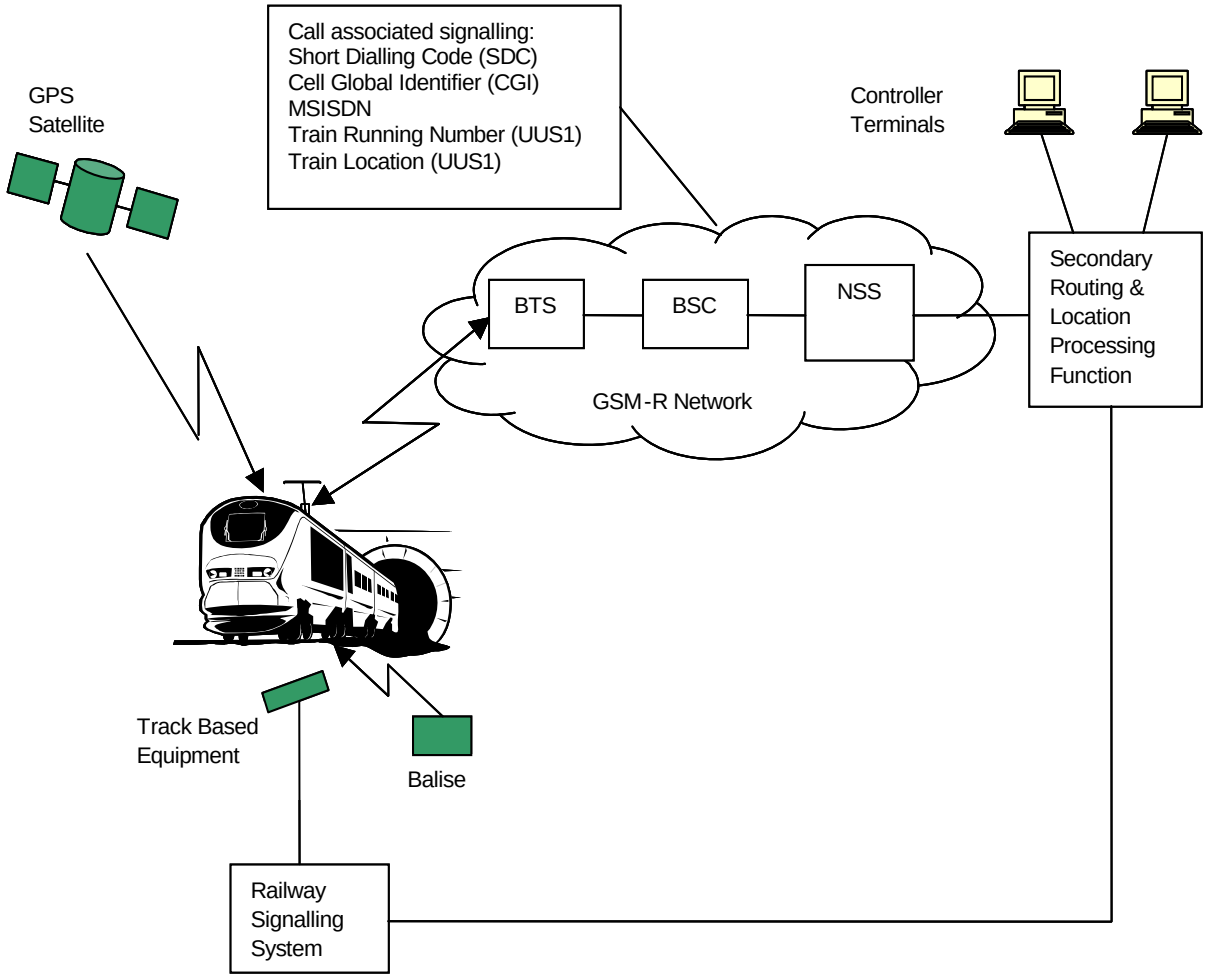

Figure 2-1 Secondary Routing Provided External to NSS

b. The Secondary Routing and Location Processing Function may contain a switch (PABX) and a processor to perform the eLDA function. On receipt of a call with eLDA information the Secondary Routing and Location Processing Function determines the called party number and routes the call to the appropriate eLDA point of contact terminal based on the eLDA information. (I)

c. To enable the Secondary Routing and Location Processing Function to provide a fallback cell based routing function in the event of insufficient or corrupt eLDA information the cell identity is passed to the Secondary Routing and Location Processing Function. (I)

d. The secondary routing and location processing function may also receive location information from track-side location systems and use this location information to route the call to the appropriate eLDA point of contact. (I)

2.4.2. Single Stage eLDA call routing - Primary and Secondary Routing Provided by NSS

a. The NSS provides the primary routing function based on cell identification. Where eLDA information is available it is sent, by the NSS, to the Location Processing Function. (I)

b. The Location Processing Function determines the eLDA point of contact area and sends this information to the NSS. The NSS determines the called party number and performs secondary routing, by routing the call to the appropriate eLDA point of contact terminal. (I)

c. The Location Processing Function may also receive location information from track-side location systems and use this location information to determine the point of contact to which the call is to be routed. (I)

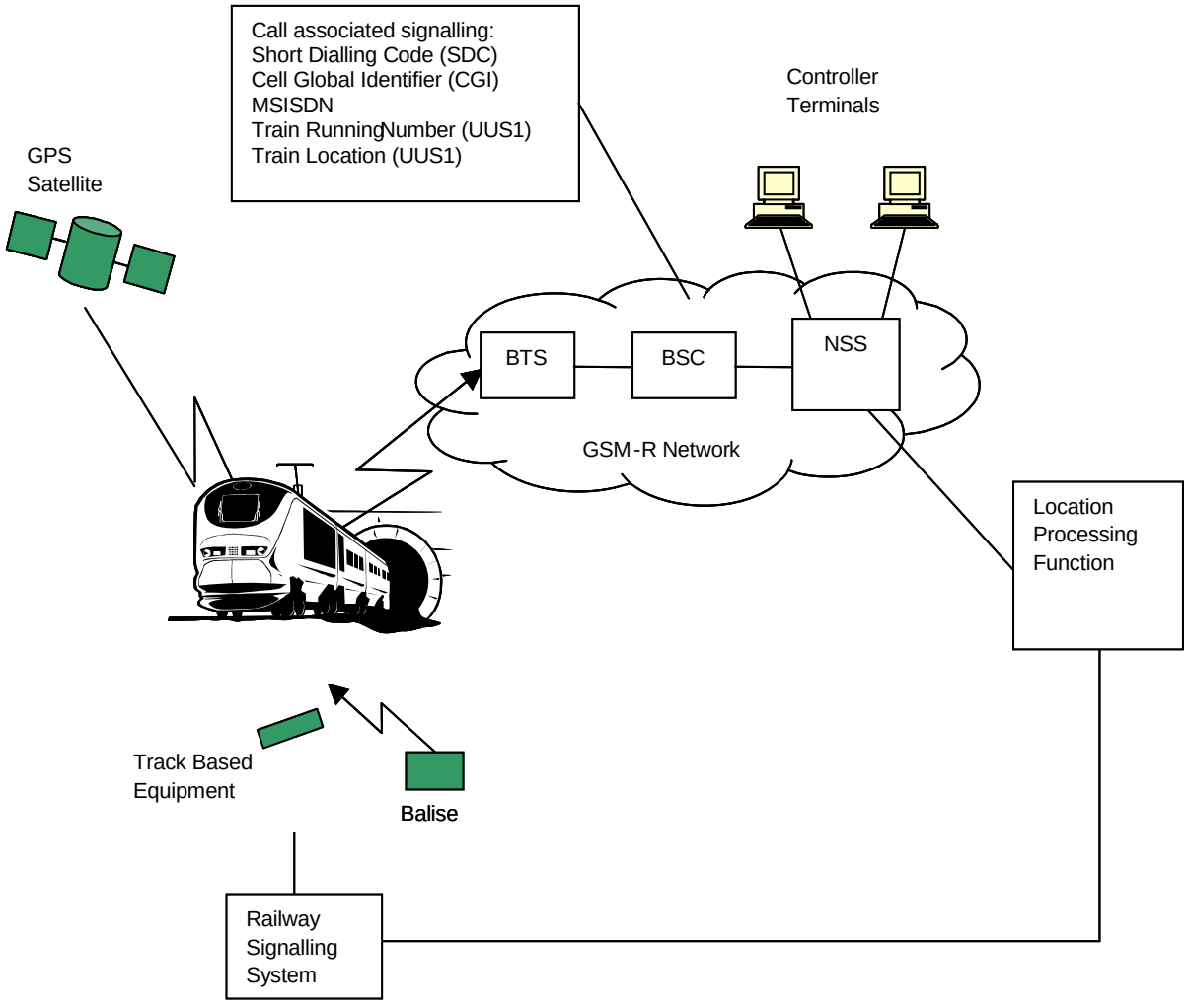

Figure 2-2: Primary and Secondary Routing Provided by NSS

2.5. Operational Aspects

2.5.1. eLDA Point Of Contact Area

a. An eLDA point of contact shall be allocated areas of track to control, known as a eLDA point of contact area. (M)

b. eLDA point of contact areas will be made up of one or more segments, of variable sizes, defined by geographical co-ordinates. Where a high level of confidence is required to discriminate between eLDA point of contact areas, a number of smaller segments may be defined. (I)

2.5.2. Track Based Equipment

a. Track based train location information may be used to provide eLDA. The location information will be supplied to the Location Processing Function using a proprietary interface. Track based train location equipment is national specific and is not required to be specified for the purpose of interoperability. (I)

2.5.3. Train Based Equipment

a. The outline of the architecture of train based equipment is shown in Figure 2-3. (I)

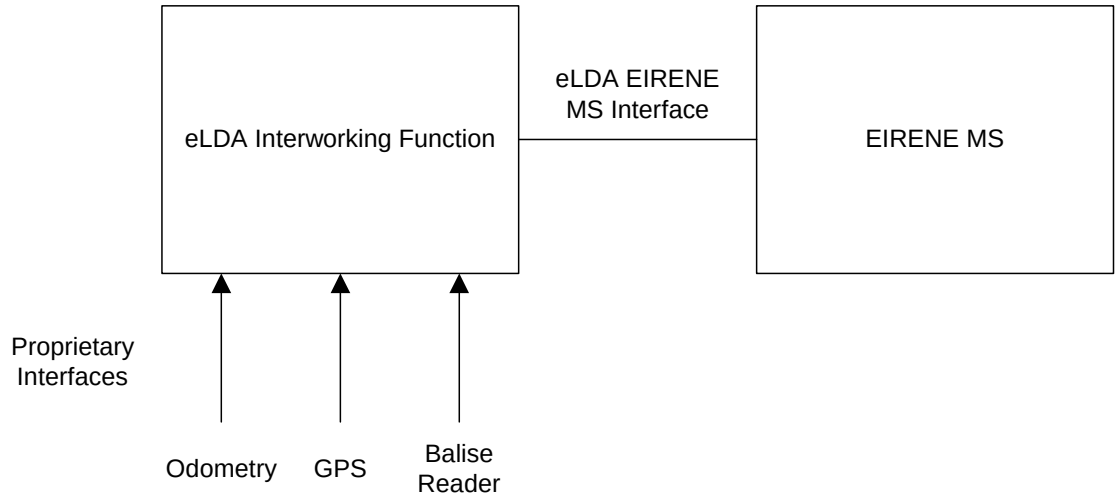

Figure 2-3 Train based architecture

b. The eLDA interworking function will provide an interworking function between the proprietary interfaces to the onboard train based location devices and the EIRENE MS. (O)

c. The interworking function may be part of the EIRENE MS or it may be a separate device. (I)

d. The interface between the eLDA interworking function and the EIRENE MS is proprietary. (I)

2.5.4. Location Information sent at Call Set-up

a. Train based location information shall be sent in the layer 3 SETUP message as UUS1 data. (M)

b. The UUS1 data field shall contain a tag indicating that location information is being conveyed in the message. (M)

c. The exception to this approach is the balise- or train-borne equipment information. The last two digits of the four-digit SDC shall be based on balise- or train-borne equipment information (if available). (M)

d. The UUS1 data includes the following GPS- or GPS- and odometry data: (M)

   1. Latitude;

   2. Longitude;

   3. Height;

   4. Speed;

   5. Heading;

   6. Elapsed time (time interval between the time the train-based equipment received valid GPS location data and the time of initiation of the call);

   7. Distance (including scale).

e. Each data element in the UUS1 message shall be encoded in the standard format of tag, length and content. This makes it easier for the recipient to decode the message in accordance with [Ref. 5]. (M)

f. Refer to section 4 for coding details. (I)

2.5.5. Network Behaviour

a. If a network does not require train-based location information (because it has a track based location system) it must not be disrupted by the receipt of location information from train-based equipment. (M)

b. Where eLDA information is unavailable or corrupted, cell based routing shall be used (failure of train-based location equipment, loss of location processing function etc.). (M)

c. Checking the integrity of eLDA train location data is a national issue. (I)

d. There is no requirement to protect eLDA data from erroneous transmission when transmitted between the train and the ground. (I)

3. SYSTEM DIMENSIONING

a. System dimensioning data is provided for information only and is intended to provide a guide to system implementers: (I)

   1. The number of trains simultaneously running in the busy hour (network wide) ranges from 500 up to 10,000. (I)

   2. The number of eLDA calls per train in the busy hour ranges from 1 up to 2.5. (I)

   3. The number of separate eLDA points of contact per cell ranges from 0 up to 30. (I)

4. MESSAGE CODING

a. Note: $X denotes X as being a Hexadecimal number. (I)

b. Train Location information is included in the Layer 3 SETUP message and is consequently part of the call set up procedure. The set up message contains two fields used for eLDA:

   1. SDC (Called party BCD number); (M)

   2. User - user information element (UUIE). (M)

4.1. SDC coding

a. The SDC number format shall conform to [Ref. 4] and [Ref. 6]. (M)

b. If balises or train-borne equipment is applied as a source of location information, the last two digits of the SDC shall be coded based on the received balise- or train-borne equipment information. (M)

c. The balise- or train-borne equipment information used for eLDA shall be unique within a cell. (M)

d. The specification of the train-borne equipment or the type of balise and the balise information required for coding of the SDC are beyond the scope of eLDA (refer to par. **Erreur ! Source du renvoi introuvable.**). (I)

e. The last two digits of the SDC shall be assigned within the range from 00 up to (and including) 30. (M)

4.2. User-User Information Element Contents

a. The maximum length of user-defined information is limited to 32 bytes (35 bytes for the overall maximum length of the User to user IE). It shall consist of the following information:

   1. The functional number of the calling party (i.e. the EIRENE mobile station); (M)

   2. Location data (consisting of e.g. GPS- or GPS- and odometry information). (M)

b. Please refer to [Ref. 5]. (I)

4.2.1. Functional Number Specification

a. The specification of the functional number shall conform to [Ref. 2]. (M)

4.2.2. Location data

a. The location data is represented by a tag. This tag shall be coded as follows: (M)

Tag Number	*Description*
06	Location data
07	Reserved for future use
08	*Reserved for future use*

Table 4-1 Location Type

4.2.3. Location data coding (Data Format 1)

a. The GPS co-ordinates shall conform to WGS84 (as specified in [Ref. 8]). (M)

b. Location data information shall be coded as follows: (M)

Parameter	Range	Encoding	Length
Latitude	89° 59’ 59.99”S 89° 59’ 59.99”N	See Table 4-3 for details	27 bits
Longitude	179° 59’ 59.99”E 179° 59’ 59.99”W	See Table 4-4 for details	28 bits
Height	- 100m + 4 500m step =1m	$0000 $11F8	13 bits
Speed	0km/h 500km/h step = 10 km/h	$00 $32	6 bits
Heading	0° 350° step = 10°	$00 $23	6 bits
Elapsed Time	Second 0..2047 Step= 1 second	$000 $7FF	11 bits
Distance	0 km 100 km Step = 10 cm, 1 m or 10 m depending on the parameter Scale	$0000 $2710	14 bits
Scale	0: 10 cm resolution 1: 1 metre resolution 2: 10 metre resolution 3: Odometry information not valid	$0 $3	2 bits
Spare	Reserved for future international use	$00 $1F	5 bits
Total			**112 bits (14 octets)**

Table 4-2 Location data message format

Sample	Area	No. of bits
89°	0 – 90	7
59’	0 – 59	6
59.99’’	0 – 5999	13
S	0	1
N	1	

Table 4-3 Lattitude Coding

Sample	Area	No. of Bits
179°	0 – 180	8
59’	0 – 59	6
59.99’’	0 – 5999	13
E	0	1
W	1	

Table 4-4 Longitude Coding

c. The parameter heading is defined as the direction of movement of the train with respect to the true North (0°). (I)

d. The parameter elapsed time is defined as the time interval between the time the train-based equipment received valid GPS location data and the time of initiation of the call. (I)

e. If the elapsed time exceeds 2046 seconds, the time is reported as 2047 seconds. (M)

f. Speed and elapsed time parameters may be used by the network to check the validity of the location information. (O)

g. Speed and elapsed time parameters may be used by the network to determine the train location when GPS information is obsolete and odometry information is not available. (O)

h. The last valid GPS location provided by the GPS train-borne equipment shall be retained by the train-borne equipment and used for inclusion in the UUS1 message. (M)

i. Odometry information is exclusively used in conjunction with GPS. (M)

j. The GPS location (as identified in the UUS1 message) is the reference point for odometry. (M)

k. The parameter Distance is defined as the distance travelled between the last valid GPS location (as identified in the UUS1 message) and the location of the train at the time of call initiation. (I)

l. The parameter Scale is defined as a qualifier to indicate the same scale used for describing all distances. (I)

m. If odometry information is not available or valid (e.g. in case the train-borne equipment only comprises a GPS receiver but no odometer), the parameter Scale shall be coded as “Odometry information not valid” (Scale = $3). (M)

4.2.4. UUIE coding

a. The UUIE message containing Functional number and Location data information (when present) shall be coded as specified in Table 4-5. (M)

b. The message incorporates as an example the binary coding of the following values: (I)

1. Lattitude: 89 59 59.99 S
2. Longitude: 179 59 59.99 East
3. Height: 1234 m
4. Speed: 210 Km/hr
5. Heading: 120º
6. Elapsed time: 2012 s
7. Distance: 95000 m
8. Scale: 10 m
9. Spare: ‘11111’

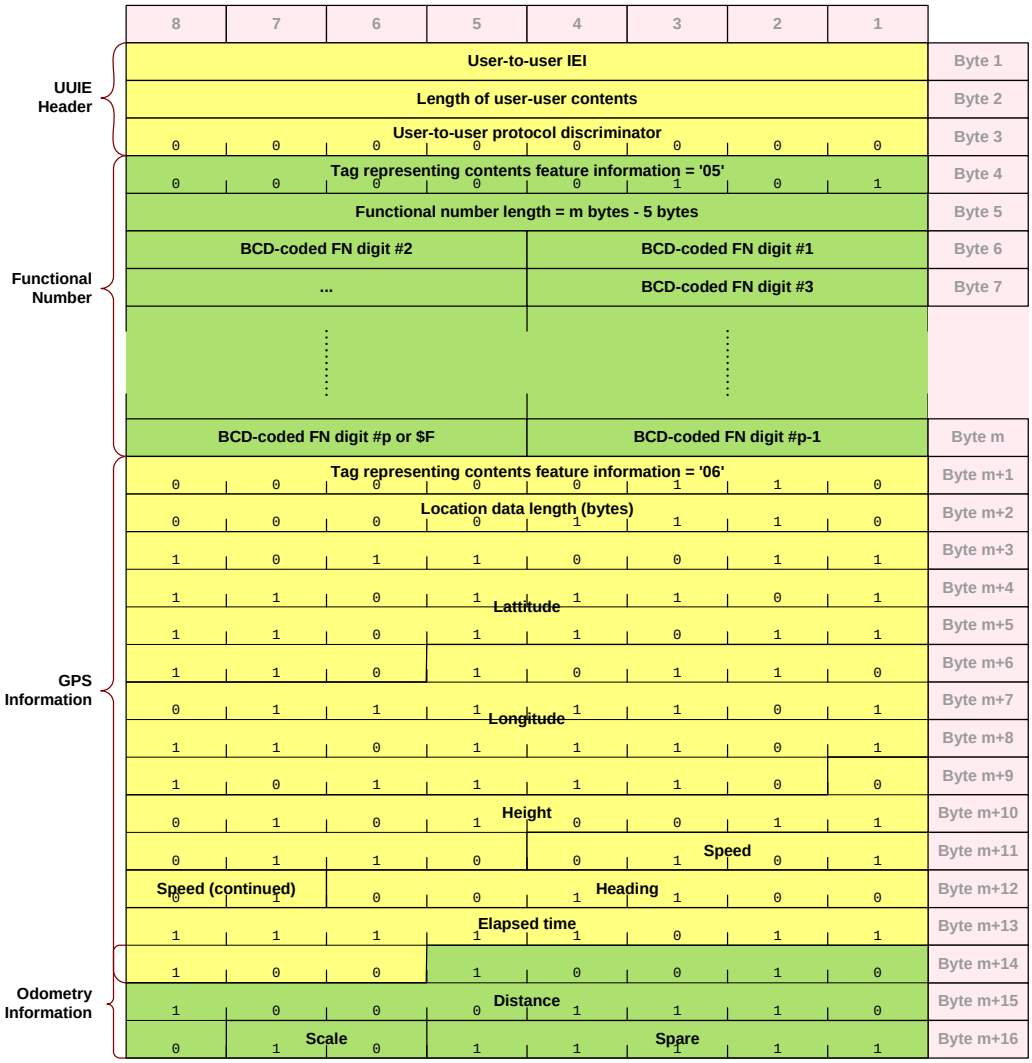

Table 4-5 UUIE coding