

TMC
Compendium

Alert-C
Coding Handbook

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INTRODUCTION

The ENV 12313-1 "*Coding Protocol for the Radio Data System Traffic Message Channel (RDS-TMC)*", is the standard that defines the Alert-C coding of traffic messages. As with all standards, it contains only the bare facts, only a few explanation and even less justification. Consequently, it gives little help in understanding the rules that are given and no help in understanding why the rules are given as they are. The Alert-C Coding Handbook aims to fill these gaps. It presents examples on how the protocol can be used, explains why several rules and limits are defined as they are, and gives hints and guidelines on how to use the parameters that are available for fine-tuning the system.

Who should be interested in the Alert-C Coding Handbook?

- Programmers who want to know the difference between duration, persistence and other details.
- Those working with an Alert-C coder who want to know what possibilities Alert-C offers for describing real world traffic situations.
- Service providers who want to know how timing parameters influence the possible data rates for Alert-C-messages.
- Broadcasters who want to know which repetition rate is appropriate for their transmitter network.

If this is the reader's first contact with Alert-C, it is advisable to first read more introductory documents. The authors assume that the reader has at least a basic knowledge of the Alert-C protocol and the TMC Service, as well as the organisational models that stand behind it. For this, it is suggested to study document 100-X804.DOC "*Projects Overview*" (Ref. 13), which, in Chapter 2, contains a good overview. It is also assumed that the reader has a knowledge of the RDS Standard EN50067 (Ref. 8). In addition, it is recommended that all the standards referenced here are at hand while reading this Alert-C Coding Handbook as many cross references are used.

The Alert-C Coding Handbook is the complement to the Location Coding Handbook. The Location Coding Handbook shows how to set up a location database, how to use it to code the exact place of an event or traffic situation. Thus it is related to the ENV 12313-3, "*Location Referencing Rules for RDS-TMC*".

The Alert-C Coding Handbook shows how to use the Events List and the elements of the Alert-C-protocol to describe what is happening at a specified location. Thus it is related to the ENV12313-1 "*Coding Protocol for RDS-TMC*" as well as the ENV12313-2 "*Event and Information Codes for RDS-TMC*".

There is, inevitably, some overlapping in the contents of the various documents to ensure a better understanding without the need for too much cross-referencing.

After a short introduction, this document concentrates on:

- Service provider tasks (like coding of messages) in Chapter 2 and 3;
- Broadcaster tasks (like transmission handling and tuning information) in Chapter 4 and 5;
- Receiver aspects in Chapter 6 and 7.

Several appendices are provided for easy access to frequently used information.

REFERENCES

1 **ENV 12313-1:** Traffic and Traveller Information (TTI) - TTI messages via Traffic Message Coding - Part 1: Coding protocol for Radio Data System - Traffic Message Channel (RDS-TMC) using Alert-C

2 **ENV 12313-2:** Traffic and Traveller Information (TTI) - TTI messages via Traffic Message Coding - Part 2: Event and information codes for Radio Data System - Traffic Message Channel (RDS-TMC)

3 **ENV 12313-3:** Traffic and Traveller Information (TTI) - TTI messages via Traffic Message Coding - Part 3: Location referencing for Alert-C

4 **ENV 12313-4:** Traffic and Traveller Information (TTI) - TTI messages via Traffic Message Coding - Part 4: Coding protocol for Radio Data System - Traffic Message Channel (RDS-TMC) using Alert-C with Alert Plus

5 **ENV 12313-5:** Traffic and Traveller Information (TTI) - TTI messages via Traffic Message Coding - Part 5: Location referencing for Alert Plus.

6 **800-C301.DOC:** TMC Compendium - Location Coding Handbook

7 **200-W803.F01:** Definition of Location Data Exchange Format

8 **EN 50067, April 1998:** Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz

9 **UECP 5.0, April 1998:** RDS Universal Encoder Communication Protocol

10 **Vienna Convention:** Agreement on common set of pictograms to be used with VMS

11 **500-D703.F01, January 1998:** European Workplan

12 **200-D823.D04, July 1998:** Implementation Guidelines for a TMC Service

13 **100-X804.F01, March 1998:** Projects Overview

14 **200-W801.D04, March 1998:** Safety and Crises Event List - SACEL

15 **The DRIVE/HARDY project, 1993:** Design of the man-machine interface, Author: Collins, J.F.; Stevens, A. (TRL), in the IEEE-IEE Proceedings of the

"Vehicle Navigation and information Systems Conference" (4th : 1993 : Ottawa, Ontario), p. 405-409 (HARDIE: Harmonisation of ATT Roadside and Driver Information in Europe)

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1 BASIC CONCEPTS

1.1 INTRODUCTION

This section introduces some basic concepts to ensure a common understanding of what is being describe.

1.2 ELEMENTS OF RDS-TMC

1.2.1 Introduction

The roots of RDS-TMC can be traced back to the experience that traffic announcements do not change very much from day to day. It is a fact that those who listen to them on a daily basis can even predict which messages will be announced at specific times of the day. Starting from this experience, the idea was born that it is unnecessary to transmit all information (names, numbers, etc.) about a traffic situation to drivers. Instead, it should be possible to compile a list of situations, attach numbers to them and store this list in a receiver. To inform drivers about a given traffic situation it is then only necessary to transmit the numbers that identify the stored information for that situation. The system within the receiver uses the number to retrieve the relevant information and presents that to the driver, giving a clear description/picture of the traffic situation.

The benefits of this idea are:

- Low bandwidth demands - transmitting numbers instead of text reduces the required bandwidth and thus makes it possible to use the RDS-system as a data carrier.
- Selectivity - by processing the traffic messages within the receiver, additional “intelligence” could be included to only select those messages that are relevant to the driver.
- Silent transmission - transmission via RDS also means that traffic information can be broadcast continuously, without disrupting the normal audio programmes.
- Language independence - as only numbers are transmitted, the list in the receiver can be in a different language from the one used on the transmitter side. This allows users to choose the language most suitable to them.
- Higher quality - the introduction of coded messages makes it possible to automate most of the processes, thus speeding up the generation and exchange of messages while improving the timeliness and quality of the traffic information service.

Implementing these ideas resulted in the creation of several lists, providing higher flexibility and making it possible to cover real-world situations.

1.2.2 Location table

Initially, a table of all, traffic-relevant, places had to be compiled. As most traffic messages contain more than one location name, provision was introduced to include information about how these places are interconnected. By receiving a single number, the system should be able to know not only the name of the location but also additional information like - which road the place belongs to, in which area it is situated, which are the next and previous places. This led to a standard which is now called the “Location Referencing Rules” (See Ref. 3).

These rules describe in detail how to set up a list of locations, how these are referenced to each other, and which attributes (like names, number etc.) are attached to each of them. Annex 3 lists all currently defined location types while Annex 4 gives the possible attributes for the various types. In Section 2.3.3 a simple example shows the content and use of a location database.

1.2.3 Event List

Next, it was necessary to compile a list of all possible traffic related situations. This not only included jams and accidents but also other events that could have an effect on the traffic, like - weather, public transport, delay times. Each of these was assigned a number, known as the event code. Behind each of the event codes is not only the textual representation but also additional attributes describing and characterising the event in more detail. Annex 3 lists these attributes with a short explanation on how they are used.

As RDS-TMC is meant to be a European system, the event list was compiled by using contributions from all member states (see Ref. 2). As a result, it now contains many more messages than any single country is likely to need. Even so, the list is not completely filled. This allows for future extensions when more experience with RDS-TMC has shown which situations are still to be covered.

At the national level, it may be necessary to reduce the number of different events available for coding to relieve the operators from the task of deciding which event descriptions to use. To assist in the selection of such national subsets, a list of safety and crisis related events was compiled which includes all those events that every subset should, as a minimum, include (see Ref. 14).

1.2.4 Modifiers and Labels

Transmitting only the numbers of the event and the location would give a rather inflexible and simplified way of presenting the traffic situation. For this reason, additional codes are transmitted that give more precise information about the situation, like -extent, direction, duration etc. The definition and use of these additional codes is the content of the Alert-C protocol, which is described in ENV 12313-1 (Ref. 1). This is the link that connects the other documents (Ref. 2 and Ref. 3) together to produce a working system.

All of the codes and the possible use of them are explained in Section 2.3.2.

1.3 BASIC ACTORS IN RDS-TMC

The coding protocol for traffic messages alone does not automatically produce a working traffic information system. In fact, a rather complicated line of actors is needed - starting at the point of incident detection through to the moment of message presentation. Following this line, it is possible to identify the different functions as they are used later in this document. The functions are listed and defined in Paras. 1.3.1 through 1.3.5, below. For more details, refer to the Implementation Guidelines for a TMC Service (Ref. 12). Note that the description does not start with the traffic information centre (TIC) because the messages are not necessarily coded in Alert-C at that stage; in fact they may be in any format - free text, DATEX-coded, etc..

1.3.1 Data Service Provider

This is an organisation that manages any traffic oriented data service by gathering data (from organisations like motor clubs or a public organisation like a TIC), processing the data and selling the data service. A Data Service Provider is responsible for the "quality" of data to its customers and must provide suitable customer support. Editorial control over the data may be part of a "data bit-rate contract" agreement. For example, a TMC service may require the Broadcaster to apply some editorial control. This ensures that both TMC messages and other broadcast services, such as spoken or teletext traffic and travel information that may be derived from more than one source, are not contradictory.

1.3.2 Programme Service Provider

An organisation that manages and originates programming and associated data for broadcasting. This will often be carried out by a Broadcaster but allows for subtle

distinctions. For instance, a separate company may be commissioned to produce a programme together with associated data (e.g. text of teachers notes for an educational series).

1.3.3 Broadcaster

A traditionally incorporated organisation responsible for a continuous strand of programmes, their quality and programme associated data; as well as being responsible for the overall co-ordination of "broadcast transmissions". Often, a Broadcaster is the licensee of a national regulator. A Broadcaster may also be a Programme Service Provider and, sometimes, a Data Service Provider.

1.3.4 Network Operator

An organisation contracted to supply both programme and data circuits that interconnect Data Service Provider, Programme Service Provider, Broadcaster and Transmission Operator. According to the connections, various protocols may be used, e.g. Alert-C, EBU Universal Encoder Communications Protocol (Ref. 9).

1.3.5 Transmission Operator

Organisation responsible for the actual transmission of the full broadcast signal, including the audio programme, programme associated data and data services. Normally, a Transmission Operator is contracted to perform the transmission task by a Broadcaster.

2 MESSAGE CODING

2.1 INTRODUCTION

This chapter explains some of the problems involved in transforming a real world situation into a coded Alert-C message. This is done by explaining the coding principles and giving some practical examples. The scope of this chapter is to answer the following questions:

- Which fields/columns of a location database are used in the coding process?
- How are the fields/columns of a location database used?
- Which tools does the Alert-C protocol offer for the coding of messages?

2.2 THEORY OF MESSAGE CODING

The coding of RDS-TMC messages can, in principle, be divided in two parts:

- Description of Where (Para. 2.3):

  Coding of the data that makes it possible for the user to identify the place the message refers to.
- Description of What (Para. 2.4):

  Coding of a total event, consisting of an event code plus duration, etc..

Both parts present more information than only the location and event codes, as is clarified in the next two paragraphs. If the language is taken into account, the situation becomes a little bit more complex, as is explained Para. 6.6.

The transmitted message will also contain information needed for message management. For instance, identify when the total information is split up into more than one group or information that is used by the receiver to identify a service and assist in fast tuning. The content of this information is dealt with in Chapters 5 and 6.

2.3 DESCRIPTION OF WHERE

2.3.1 Introduction

The description of “where” can usually be split up into three elements:

- The primary location (where is it situated).
- The extent (which other locations are affected).

- The direction bit (which indicates the direction of traffic flow affected).

The last two elements can be modified with control codes (explained in Para. 2.4.6). All three elements will be coded in different fields of a TMC-message (see Annex 5) and are used in the receiver to rebuild the original location description.

2.3.2 Extent and Direction

The extent and direction of an Alert-C message are transmitted with 4 bits: 1 direction bit and 3 extent bits. The extent and direction of linear and point locations determine the order in which specific data in the location database are presented by the RDS-TMC receiver.

The definition of the direction bit can lead to confusion. The Alert-C protocol says:

> *The direction bit (0=positive, 1=negative) shall indicate the direction of queue growth for all event types defined as directional: i.e. it is opposite to the direction of traffic flow affected. The convention specifying positive and negative directions along each road shall be fixed at the time of coding the definitive location database.*

This means that the direction of the linear locations is coded in relation to the order in which the point locations have been coded.

As a result, the extent field (3 bits) gives the number of “steps” through adjacent locations that are also affected by the events. Note:

- When the direction is 1 (negative), the steps should be taken in the negative direction of the road, using the negative (previous) offset fields in the database, starting from the *primary location*.
- When the direction is 0 (positive), the steps should be taken in the positive direction of the road, using the positive (next) offset fields in the database, starting from the *primary location*.

The last location in these steps is referred to as the **secondary location**. As the extent only has 3 bits, a maximum of 7 steps is possible for a single group message. This number may be increased in a multi-group message, using the control codes 6 (to add 8 additional steps) or 7 (to add 16 additional steps). As both control codes may only be added once to a message, a maximum of 7+8+16 = 31 steps is possible (Para. 2.4.4 provides more information on this subject).

For some events it will be necessary to use a point location with no extent (e.g.: exit closed). In these cases the direction bit will still be used to indicate the direction in which the exit is closed (i.e.: there is a difference between extent +0 and -0). If it is required that the direction bit should have no effect, it is necessary to use either a bi-directional event (like “dense fog”) or use a special control code to switch the event from directional to bi-directional. Using the example above (“exit closed”), changing to a bi-directional event would result in a message indicating that both directions are affected. Note that for areas, extent and direction are always ignored.

To make stepping based on direction possible, a location database is needed.

2.3.3 Location Database

The basic tool to code the “Where” is the location database. A location database can contain different location types. The standard ENV 12313-3 (Ref. 3) defines the following classification scheme.

Each location is described by a type code which is composed of:

- A character (A, L or P), indicating the category (Area, Line or Point).
- A number indicating the type.
- A dot.
- A number indicating a subtype.

Example:

P1.8 - roundabout (P: category = point, 1: Type = junction, 8: subtype = roundabout)

Each of the three main categories (Area, Line, Point) may represent one or more types and subtypes. Annex 3 gives a quick overview of the different, currently defined, locations types to show the large number already available (as these may be extended, only use Ref. 3 as a reference).

Each location is assigned a 16 bit code, allowing more than 60 000 locations in one database. In addition to location code, location type code and location name, additional information is given for each location. What additional references and attributes are given depends on the location type code. Annex 4 shows the possible combinations. For the following chapters, it is only the following columns that are of importance:

- First Name, Second Name and Road Number describe the location itself.

- Positive Offset, Negative Offset, Line and Area Reference describe the relationship with other locations inside the location database.

The First Name is normally the name of the location. However, in the case of roads and segments it is the name of the segment start. So, for the motorway between Rotterdam and Amsterdam, Rotterdam would be First Name, while Amsterdam would be placed into the Second Name field.

Road Number is just what is says, it is the number of the road. In several countries this is not only a number but also a letter to characterise the Road type. Typical Road Numbers are M5, A4, 128, B49n, ST1027.

The Positive and Negative Offset contain the location codes of the following and preceding location. They only make sense with point locations that are part of a segment and segments that are part of a road.

The Line Reference identifies on which segment a given Point is situated (or on which road a given segment is situated).

The Area Reference identifies which next bigger area the location belongs to. For segments and roads this is the smallest area that just contains all the points belonging to the segment or road (so for most motorways this will be the location code of the country itself).

All of this referencing is well described in the Location Coding handbook (Ref. 6).

To give a precise representation of where a given situation occurs, it is always necessary to access several of these fields in the location database.

Example:

> In case of traffic information, the location may be a point location on a road. This only identifies the so called "**primary location"**. For the coding of "where", more locations of the location database must be identified:

Next it is necessary to identify the so called "**secondary location"**. This is normally chosen in such a way that the event is now bracketed by the two locations. The second location is not transmitted directly, instead it is used to calculate how many steps this second location is away from the primary location. The number of steps is the **extent**. The calculation is performed by following the Offset References, either in a positive or negative direction, starting at the primary location and going through to the secondary location. (Note: the number of steps from secondary to primary is

not always identical to this number as there may be locations present for only one direction!)

If the Offset Negative Column is used, the **direction bit** is set to negative (1); if the Offset Positive Column is used, the **direction bit** is set to positive (0).

The total extent and its direction is identified by means of the direction bit, the extent and (possibly) the control codes that have been used to enlarge the extent. The receiver is now able to step from location to location in the direction indicated by the negative or positive direction bit to identify the secondary location.

The simplicity of the calculation is misleading; in the real world this process is quite difficult to implement because the coder has to look at the following rules during the process:

- The points/segments may not be on different roads.
- The number of steps between them (= extent) may not exceed 31.

If, for example, the primary and secondary location code are known, it is still not clear in which direction the system has to search for the secondary location (to determine the number of steps). One solution is to enter the locations in two steps:

- First, the primary location is entered.
- The system then calculates, on the fly, all possible secondary locations (up to +- 31 steps in each direction), this list is displayed to the user for entering the secondary location.

This ensures that the two rules are enforced but the system has to do a lot of calculations in the database. Pre-calculated secondary locations can solve this problem but only as long as the database is small.

The coding process finishes here. Note that the Area and Line References were not needed, they are only used in the decoding process. However, as most systems will be requested to display the message in the same format as it is presented in the receiver, most coders will also have to perform the functions of the decoder.

In the receiver, the decoder is able to rebuild the message. It gets:

- The Road Number and Segment names from the Line Reference.
- The area names from the Area Reference.
- The types from the Location Type code.

In this example, the data of these locations may form the “where” as shown in Table 2.1.

Table 2.1 Describing “where”

Message:	Explanation:
A16	Road/junction number of segment or road
Breda - Rotterdam	first name and second name of segment or road
From exit Zwijndrecht	Secondary location
to junction Ridderkerk	Primary location
[description of what]	[description about what happens]

2.3.4 Coding Examples

To illustrate the use of the location database and the way a message is coded, consider the following case:

There is a road between the towns Haarlem and Amsterdam, with four intermediate points as indicated in Figure 2-1. This road is coded in a location database and is shown as a table in Table 2.2. As can be seen in this table, the positive direction is from Haarlem to Amsterdam. The direction in the segments is chosen in accordance with the direction of the road. Finally, the offsets of the point locations on the segments is chosen in accordance with the direction of the segments.

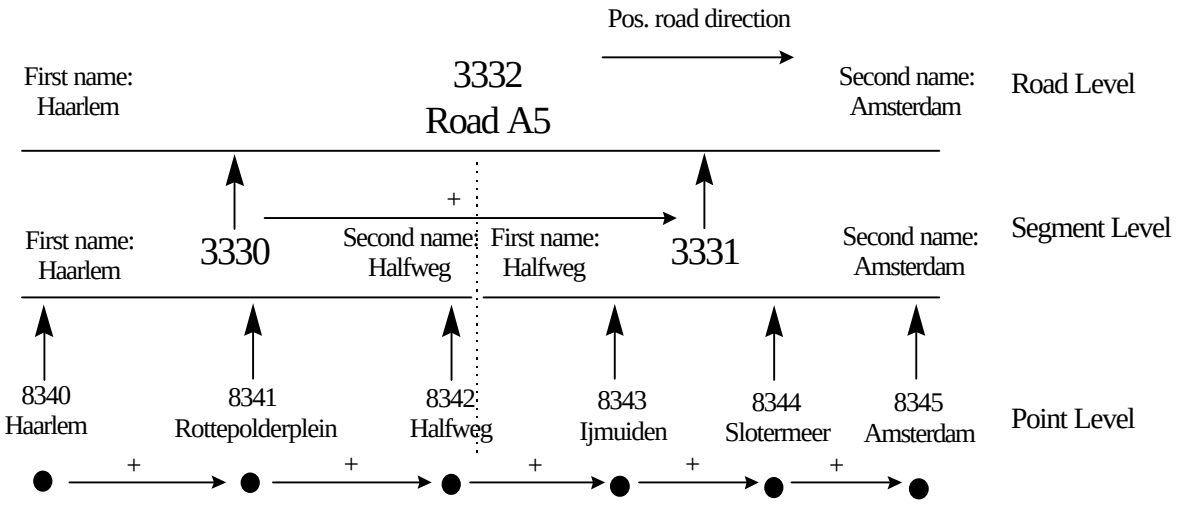


Figure 2-1: Haarlem - Amsterdam

Table 2.2: Part of a location table

Loc. Code	Loc. Type Code	Loc. Type Description	Road number	First name	Second name	Lin. Ref.	Negative offset	Positive offset
3332	L1.1	Road	A5	Haarlem	Amsterdam			
3330	L3.0	Ord 1 segm	A5	Haarlem	Halfweg	3332		3331
3331	L3.0	Ord 1 segm	A5	Halfweg	Amsterdam	3332	3330	
8340	P1.3	Motorway Junction/Exit		Haarlem		3330		8341
8341	P1.2	Motorway Triangle		Rottepolderplein	A9	3330	8340	8342
8342	P1.3	Motorway Junction/Exit		Halfweg	N5	3330	8341	8343
8343	P1.3	Motorway Junction/Exit		Ijmuiden	N202	3331	8342	8344
8344	P1.1	Motorway Junction/Exit		Slotermeer	N206	3331	8343	8345
8345	P1.1	Motorway Cross		Amsterdam	A10	3331	8344	

1. Example: Point, extent > 0

There is a problem: an accident has occurred and produced 2 km of stationary traffic - just before the exit Haarlem which extends as far as Rottepolderplein. Looking in the database identifies the exit Haarlem as code 8340. To set up the exit Rottepolderplein, it is necessary to use the Positive offset column, which is only one step. Therefore, the final message with primary location 8340, direction 0 (positive) and extent 1 is generated. In the receiver it should be presented like:

- The first name of the secondary location: Rottepolderplein.
- Then the first name of the primary location: Haarlem.

The first and second name of the linear location above (3330) are presented in the following order:

- The second name of location 3330: Halfweg.
- And then the first name of location 3330: Haarlem.

The final message would be:

“A5, Halfweg in the direction of Haarlem from Rottepolderplein to Haarlem, accident, 2 km stationary traffic”

2. Example: Point, extent = 0

If only the exit Haarlem is affected (e.g.: “exit blocked”), the extent of the message is 0. The message is then:

“A5, Halfweg in the direction of Haarlem, at Haarlem, exit blocked”

3. Example: Segment, extent > 0:

The same rules apply to a message about an order 1 segment. To give information about the motorway segment between Amsterdam and Haarlem (e.g.: “dense fog”), the message is coded with primary location 3330, direction 0 (positive) and extent 1. Note, dense fog is an event that affects both directions therefore the order of segment names is not relevant in this example. The receiver should present the message like this:

“A5, Between Amsterdam and Haarlem, dense fog”

4. Example: Segment, extent = 0:

If only the segment between Halfweg and Haarlem is affected by the fog, the extent of the message is 0, and the message is:

“A5, Between Halfweg and Haarlem, dense fog”

5. Example: Road, extent = 0:

Finally, it is also possible to generate a message about a road. There is a problem affecting most of the A5 in the direction of Haarlem. (e.g.: “slow traffic expected” due to a big sports meeting in Haarlem). Then a message with primary location 3332, direction 0 (positive) and extent 0 (always 0 for a road) is generated. To the user the message should be presented in the following way:

“A5, Amsterdam in the direction of Haarlem, slow traffic expected”

2.4 DESCRIPTION OF WHAT

2.4.1 Introduction

The “What” is normally described using the following three elements:

- Event code (description of the situation).
- Duration (how long is the situation expected to remain).

- Diversion advice (either a pre-defined diversion number or a simple advice to avoid the area can be given).

Besides these elements, which are all transmitted inside one single group, more data may be necessary to compose “what”:

- In case of a quantifier, the corresponding label with its data is used to add quantitative information to the event description.
- The message may contain labels and data to expand the description of “what”.
- Control codes may be used to change several defaults given in the event list.

All of these optional elements need additional RDS groups for transmission, thereby changing the message from a single-group message (SGM) to a multi-group message (MGM).

2.4.2 Event

The event code is a simple 11 bit code that is used as a pointer to an event description inside the event list (see Para. 1.2.3).

2.4.3 Duration

The duration is another 3 bit field and gives an indication on how long an event is expected to last. The translation of the 8 possible values into a time scale depends on the nature and the duration type of the event, see Table 2.3.

Table 2.3: Translation of duration codes into text phrases

Nature	**Information or Silent**		**Forecast**	
Duration Type	**Dynamic**	**Longer lasting**	**Dynamic**	**Longer lasting**
0	(none)	(none)	(none)	(none)
1	for at least next 15 min	for at least next few hours	within the next 15 min	within the next few hours
2	for at least next 30 min	for the rest of the day	within the next 30 min	later today
3	for at least next 1 h	until tomorrow evening	within the next 1 h	tomorrow
4	for at least next 2 h	for the rest of the week	within the next 2 h	the day after tomorrow
5	for at least next 3 h	until the end of next week	within the next 3 h	this weekend

Nature	Information or Silent		Forecast	
Duration Type	**Dynamic**	**Longer lasting**	**Dynamic**	**Longer lasting**
6	for at least next 4 h	until the end of the month	within the next 4 h	later this week
7	for the rest of the day	for a long period	within the of the day	next week

Example:

At 16:00 hours there is a report of heavy traffic on the A5 between Halfweg and Haarlem. It is known at the time of coding that the heavy traffic is caused by roadworks that will be finished at about 19:00 hours. When coding the message, the duration code 5 can be added to the message and, after decoding in the receiver, the resulting message will look like this:

"A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, dense traffic caused by roadworks. The situation is expected to last for at least the next three hours"

The duration field does not only influence the presentation, it also influences how long the message will be stored in the receiver after it was last received. This time, which is called persistence, is derived from the duration field using Table 2.4.

Table 2.4: Translation of duration codes into persistence

Nature	Information or Silent		Forecast	
Duration Type	**Dynamic**	**Longer lasting**	**Dynamic**	**Longer lasting**
0	15 min	1 h	15 min	1 h
1	15 min	2 h	15 min	2 h
2	30 min	until midnight	30 min	until midnight
3	1 h	until midnight next day	1 h	until midnight next day
4	2 h	until midnight next day	2 h	until midnight next day
5	3 h	until midnight next day	3 h	until midnight next day
6	4 h	until midnight next day	4 h	until midnight next day
7	until midnight	until midnight next day	until midnight	until midnight next day

Note that there is no difference in the persistence between information and forecast messages.

Persistence is an important tool to control the bandwidth needed for transmitting messages. If only dynamic messages with duration = 0 are used, every message has to be repeated at least every 15 minutes to prevent automatic cancellation in the receiver. In 15 minutes it is possible to transmit 15 x 60 = 900 8A-groups (assuming one 8A-group/s). If a direct repetition rate of 2 is used (three identical 8A-groups behind each other) there is room for 300 groups. If there is an average of two groups per message, this means that only 150 messages can be transmitted at the same time, compared to the upper limit of 300 messages that is allowed in the Coding Protocol for RDS-TMC (Ref.1). Also, each of the messages would show up only once in the 15 minutes, giving an average access time of 7.5 min for receivers that had just been switched on. For urgent messages this time span may not be considered good enough quality.

If it is possible to change the persistence of some of the less urgent messages to 30 minutes or longer, these messages will be transmitted less frequently. This opens additional time windows for the more urgent messages or gives room for additional messages. Naturally, this will depend on the urgency and the specific policy of each service provider. As a result, the use of duration can differ for each service.

2.4.4 Diversion advice

This element is transmitted using a single bit in a SGM, or a control code in a MGM. It can be used to advise drivers to avoid the reported traffic problem area (as described in the WHERE). If it is set to zero, no action is taken at the receiver side. Depending on the location database content on the receiver side, two different reactions are possible when a coder sets this bit to 1:

- If the location database contains pre-defined diversions, the receiver will be able to inform the driver accordingly. Example: *"A5, Halfweg in the direction of Haarlem, between Halfweg and Rottepolderplein, dense traffic. Please follow diversion route 21"*. The information will be taken from the field "diversion number" of the **secondary location**, because it is there where the driver has to leave the road to avoid the traffic jam. If the extent of the message is greater than 1, it may even be possible to connect the different diversion numbers of all affected locations.

  Example:

"A5, Halfweg in the direction of Haarlem, between Halfweg and Haarlem, dense traffic. Please follow diversion route 21 and 22"

- If no such diversion route exists for the corresponding locations, the receiver is expected to generate a simple message like:

  "Drivers are recommended to avoid the area".

The diversion bit is a good example of how differences in the quality of a location database will affect the detail and thus the quality of traffic information in TMC. The more attributes a location database contains, the more features can be implemented in the receiver.

2.4.5 Additional Information given in Multi-group Messages (MGM)

If optional information is added to a message, the use of one or more additional RDS groups is necessary. These messages are called **Multi-group Messages** (MGM). This optional addition can give greater detail or can deal with unusual situations. The maximum message length for one Multi-group Message is five RDS groups. The additional four groups have room for 28 bits each. Although these 28 bits are distributed over two blocks, they can be viewed for coding purposes as one continuous string of bits (bit container). If more than one additional group is present, the bit container is to be used as one single container - to make use of all the available bits. As a result, the bit container can have a length of 28, 56, 84 or 112 bits. The splitting of the bit container into RDS groups is only performed for transport purposes and the bit container is reconstructed in the decoder during the decoding process.

These bits are available for coding fields. Each consists of a fixed (4 bit) length label (which indicates the content) and a number of data bits (between 0 and 16 bits depending on the label, see Table 2.4).

The fields are coded in such a way that the most significant bit (MSB) is transmitted first. The end of data can be detected by finding either 7 consecutive bits equal zero or arriving at the end of the bit container, whichever comes first.

The 4-bit label specifies sixteen types of additional information. Each label is followed by a data field of defined length. The label types and data field lengths are as shown in Table 2.5.

Table 2.5: Label types overview

Label	Data field	Type of Information

Label	Data field	Type of Information
0	3 bits	Duration (value 000 is not allowed)
1	3 bits	Control code.
2	5 bits	Length of route affected.
3	5 bits	Speed limit advice.
4	5 bits	quantifier (5 bit field)
5	8 bits	quantifier (8 bit field)
6	8 bits	Supplementary information code.
7	8 bits	Explicit start time (or time when problem was reported) for driver information only.
8	8 bits	Explicit stop time for driver information and message management.
9	11 bits	Additional event.
10	16 bits	Detailed diversion instructions.
11	16 bits	Destination.
12	16 bits	Reserved for future use
13	16 bits	Cross linkage to source of problem, on another route.
14	0 bits	Content Separator.
15		Reserved for future use.

Combination of additional information

In composing multi-group messages, a broadcaster and/or service provider has to satisfy the following rules:

a) Label 0, label 7, label 8, label 13 and each control code under label 1 may be used only once per message (this implies that the maximum problem extent is 7+8+16=31 steps).

b) Label 14 may be used as a separator between different parts of a message (“information blocks”). Some types of additional data fields are allowed only once per information block (see c)) to avoid ambiguity. Separators can help in receivers to make it easier for drivers to understand messages by grouping the message content syntactically. For instance, a receiver can use label 14 to make a short pause in spoken output.

c) The following labels may be used at most only once per information block (i.e. before the first separator, between two subsequent separators, after the last separator, or per message if the message contains no label 14):
   - label 2 (length of route affected);

- label 3 (speed limit advice).

d) The remaining labels (4, 5, 6, 9, 10, 11) can be used more then once (the use of these labels is explained in more detail later in this document).

e) If a detailed diversion route is valid for one or more specific destinations only, the destination(s), i.e. a label 11 plus data field for each, must immediately precede the (first) diversion instruction (i.e. label 10 plus data field). If destination(s) are used in connection with other (e.g. supplementary) information, they must not be directly followed by label 10 (in such cases a separator before label 10 is recommended). If the diversion bit is set (with label 1, code 5), then an additional detailed diversion route can only be given for a specific destination(s). The use of a separator (label 14) between label 1 and the subsequent labels 11 and 10 is recommended.

2.4.6 Duration (label 0)

While the standard (single group) message has a fixed 3-bit field to code the duration, these bits are used for other purposes in multi-group messages. As a result, in this case, one label is needed to code the corresponding bits. Field trials have shown that the duration is seldom used, therefore this is an optional item. If duration is not present, the message defaults to the duration code 0 and only if this is insufficient is the label 0 needed. But, in such a case, the code value shall not be 0. This rule ensures that if 7 consecutive bits are all equal to zero this can be regarded as an end of data indicator.

2.4.7 Control codes (label 1)

Each control code can be applied only once to any message.

Alert-C defines eight **receiver** control codes. These can be used in a 3-bit field, following label 1, in any multi-group message. The meaning of these codes are:

Code	Meaning
0	Default urgency increased by one level.
1	Default urgency reduced by one level.
2	Default directionality of message changed.
3	Default "dynamic" or "longer-lasting" provision interchanged.
4	Default spoken or unspoken duration interchanged.
5	Equivalent of diversion bit set to "1".
6	Increase the number of steps in the problem extent by 8.
7	Increase the number of steps in the problem extent by 16.

Regarding Codes 0 and 1, urgency changes shall also “wrap around” so that increasing the most urgent level creates the least urgent of the three, and vice-versa.

The following examples indicate the difference between a standard message and one with the control code applied. All events have, as the location, the following part:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem”

This is not repeated in the coding elements.

Example for Label 1, code 0:

	Event	Diversion	Duration	Event code
1st group	Stationary traffic for 10 km	0	0	106

Received without label, this will result in the following message:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, stationary traffic for 10 km”

	A message	Event code
1st group	Stationary traffic for 10 km	106

2nd group	Label 1	0

Note that the first group no longer contains a duration or diversion bit: these fields are missing in the first group of a multi-group messages, and are added per label only when not 0. Received with label 1, data 0, the message will now be presented to the driver as an Extreme Urgent Message:

“Attention: A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, stationary traffic for 10 km”

Note: The difference between urgent and extremely urgent is not obvious in the presentation, it is mainly in the different handling of the messages during message management. An extremely urgent message will be transported faster in the infrastructure, it will be repeated more often on the transmission layer and it will be presented to the user whatever filter criteria has been set. Thus, it is advised to use this control code with care.

The label 1 with code 1 would reduce the urgency. This has no influence on the presentation, only on the transmission layer, as both messages would be broadcast with different periodic repetitions.

Example for Label 1, Code 2:

Messages are either **directional** or **bi-directional**. Use of Code 2 reverses this status.

	Event	Diversion	Duration	Event code
1st group	New road layout	0	0	811

The event “new road layout” is bi-directional. The message will be presented like this:

“A5, Amsterdam - Haarlem, between Halfweg and Haarlem, new road layout”

	A message	Event code
1st group	New road layout	811

2nd group	Label 1	2

The same event, received with label 1, data 2. It will be presented to the driver for one direction ONLY:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, new road layout”

Example: Label 1, Code 3:

Code 3 changes the time scale of events, from **dynamic** to **longer term** or vice-versa.

	Event	Diversion	Duration	Event code
1st group	Sewer overflow	0	5	974

This event would be presented as:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, sewer overflow. The situation is expected to last until the end of next week”

A message	Event code

1st group	Sewer overflow	974	2nd group	Label 1	3	Label 0	5

The same event, received with label 1, data 3, will set the time scale from “Longer lasting” to “dynamic”. As a result the message will be presented as follows:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, sewer overflow. The situation is expected to last for at least the next three hours”

At the same time, the persistence of the message will be shortened: the receiver will delete this message 3 h after the last copy was received (instead of midnight without label 1 code 3).

Example: Label 1, Code 4:

Code 4 changes the default spoken duration from **spoken** to **unspoken** or vice-versa.

	Event	Diversion	Duration	Event code
1st group	Slow traffic	0	5	115

This event will be presented as:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic. The situation is expected to last for at least the next three hours”

	A message	Event code					
1st group	Slow traffic	115	2nd group	Label 1	4	Label 0	5

The same event, received with label 1, data 4, will result in no spoken duration:

“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic”

In this case the message persistence would still be changed from 15 min (default with no duration) to 3 hours.

Example: Label 1, Code 5

The Code 5 shall be equivalent to setting the diversion bit to “1” in a single group message.

This will become necessary as soon as a single group message with duration > 0 changes into a multi-group message - consider the following message:

	Event	Diversion	Duration	Event code
1st group	Slow traffic	1	5	115

This event will be presented as:

> *“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic. The situation is expected to last for at least the next three hours. Please avoid the area”*

Information is then received that the slow traffic has a length of 16 km. It is now necessary to code a MGM because label 2 is needed to code the 16 km. As a result, it is also necessary to use label 1, code 5 to set the diversion bit, and label 0, code 5, to set the duration.

	A message	Event code
1st group	Slow traffic	115

2nd group	Label 2	13	Label 0	5	Label 1	5

Now the event, received with label 1, data 5, will result in the following presentation:

> *“A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic for 16 km, The situation is expected to last for at least the next three hours. Please avoid the area”*

Note, that the sequence of labels can make a difference in this example. If we code the labels in a different sequence, we influence the presentation:

	A message	Event code
1st group	Slow traffic	115

2nd group	Label 2	13	Label 1	5	Label 0	5

Now the message will result in the following presentation:

"A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic for 16 km, please avoid the area, the situation is expected to last for at least the next three hours."

Codes 6 and 7 deal with problems that extend further than is provided in the message problem extent field. When Code 6 is appended to a message, the number of steps indicated in the message shall be increased by 8. Code 7 provides for a further 8 steps, where necessary, increasing the number of steps by 16. Code 6 and 7 may also be used together, thus giving a total of 24 additional steps.

2.4.8 Length of route affected (label 2)

The length of route affected can be added (at most once per information block) for use with events which do not already contain this information. The meaning of the data codes is as follows:

0	Problem extends for more than 100 km
1-10	Length of problem from 1 to 10 km (1 km interval)
11-15	Length of problem from 12 to 20 km (2 km interval)
16-31	Length of problem from 25 to 100 km (5 km interval)

See Annex 1 for a more detailed list of decoded values.

An example has already been shown in connection with label 1, code 5.

2.4.9 Speed limit (label 3)

One speed limit advice per information block can be added to any message. The meaning of the data codes is as follows:

1-26	Maximum speed from 5 to 130 km/h (5 km/h interval)

See Annex 1 for a more detailed list of decoded values.

2.4.10 Additional quantifiers (label 4 and 5)

Some event descriptions have an additional quantifier, which type is specified in the event list. Label 4 must precede a 5-bit quantifier field and label 5 an 8-bit quantifier field. Which one is to be used depends on the event - see REF. 2.

See Annex 1 for a more detailed list of decoded values.

2.4.11 Supplementary information (label 6)

One or more supplementary phrases can be added to any message, using the codes defined in the “Supplementary Information” section, Part 2, Annex B of Ref. 2.

2.4.12 Start and stop times (label 7 and 8)

One start-time and/or one stop-time may be added once to any Message. Time and date codes shall use Co-ordinated Universal Time (UTC) and Modified Julian Day (MJD). The presentation will not use this information directly but conversion to local time and date will be made within the receiver. For this purpose, RDS type 4A-groups shall be transmitted and used to determine the local time. The meanings of the start and stop time codes are given in

Table **2.6**.

Table 2.6: Start and Stop Time Overview

Range	Codes	Definition
1	0-95	00.00 hrs to 23.45 hrs (15 minute interval)
2	96-200	Hour and day, starting at midnight following message receipt (1 hour interval)
3	201-231	1st of month to 31st (one day interval)
4	232-255	15 January to 31 December (half month interval)

As these numbers are very difficult to comprehend, Figure 2-2 might help in understanding what is meant:

Note that “now” is always between 0:00 and 24:00 hours, and that the three number ranges extending after 24:00 hours do have a considerable overlap!

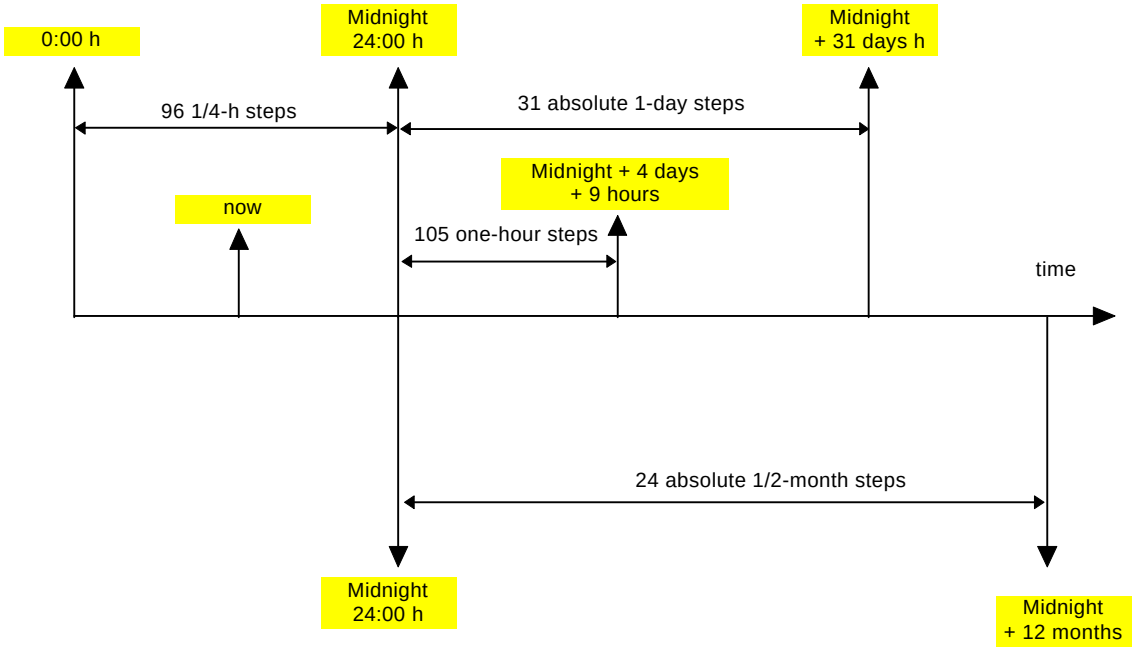


Figure 2-2: Illustrated Start & Stop Times

Examples:

Range 1:

A data code in the range 0-95 indicates a time during the current day. For example, a start time received at 09.00 hrs with a code of 42 means “problem expected from 10.30 hrs this morning” whereas the same code received at 11.00 hrs means “problem reported at 10.30 hrs this morning”.

Range 2:

A data code in the range 96-200 indicates a time within the next few days. For example, a stop time received at 09.00 hrs on Friday with a code of 153 means “until 09.00 hrs Monday”. A start time of 153 means “from 09.00 hrs Monday”. These codes shall be updated by broadcasters at midnight each day (i.e. at 00:00 hrs UTC) by decrementing the code by 24. If the result in a code is less than 96, the appropriate code in the range 0 - 95 is to be calculated. For example, a stop time with code 153 first transmitted on Friday will be decremented to 129 at 00:00 hrs on Saturday, to 105 at 00:00 hrs on Sunday and to code 36 at 00:00 hrs on Monday.

Range 3:

A data code in the range 201-231 indicates a date during the next 31 days. For example, a stop time received on the 20th of August with a code of 218 means “until 18 September”.

Range 4:

A data code in the range 232-255 indicates a date during the next 12 months. For example, a stop time received in September with a code of 236 means “until mid-March next year” while 239 means “until the end of April next year”.

Start times are for driver information only, and do not affect receiver message management. Stop times override the normal receiver message management strategy as well as providing an explicit announcement to the driver.

2.4.13 Multi-event messages (label 9)

With label 9, one or more additional event codes can be added to any message, forming a multi-event message with the event coded in the first message group. The primary location, direction and extent given in the first group apply to the whole message.

A multi-event message must not contain a silent event (i.e. an event indicated by “S” in the Event list, see Ref. 2).

If a multi-event message contains a duration code (following label 0), this code shall be interpreted according to the nature and duration type of the last event preceding the label 0 in the sequence of additional information (see Ref. 2). This last preceding event may be the first-group event.

Any quantifier (following label 4 or 5) added to a multi-event message shall be taken to apply to the last event (which may be the first-group event) preceding the quantifier in the sequence of additional information. If this last preceding event does not allow for a quantifier, or only for a quantifier with a different field length, or has already been matched to a quantifier, the given quantifier shall be ignored.

The urgency of a multi-event message is equal to that of the most urgent of the constituent events. If all constituent events are bi-directional, the multi-event message is bi-directional. Otherwise it is unidirectional.

Example: Label 9

Information is received that there is slow moving traffic on the A5 because one lane is blocked due to an earlier accident. An event like that does not exist in the Event List but the list does contain all the elements. Therefore, a MGM is coded with label 9 to code the blocked lane (event code 646) and label 6 to code the reason (supplementary information, code 171).

	A message	Event code
1st group	Slow traffic	115

2nd group	Label 9	646	Label 6	171

This message will result in the following presentation:

"A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic, one lane blocked due to an earlier accident"

2.4.14 Detailed diversion instructions (label 10)

Information about a diversion route can be given by adding one or more location(s) along that route to the message. Each location along the diversion must be identified by label 10 followed by a 16-bit location code. This code refers to the same TMC location database as that used for the same primary location in the message.

Up to three different diversion routes may be specified, preferably separated by label 14 and subject to a maximum of 5 groups per message. The second (and, if present, the third) route may only be given for specific destination(s), which means that the label(s) 10 and location(s) specifying that route must be preceded by at least one label 11 plus location code (see also Para. 2.4.4, rule "e" and section 2.4.9). The locations along one diversion route must be given directly one after the other, i.e. with no labels other then 10 in between.

The first location along the detailed diversion should be interpreted as "Diversion recommended via (location)" and subsequent locations as " ... and then via (location)". The sequence of points along the diversion shall be the same as the sequence of diversion fields in the message.

Where detailed diversions are recommended in both directions, separate messages shall be used for each direction.

2.4.15 Destinations (label 11)

In special cases, a general diversion advice (code 5 under label 1), a detailed diversion (see Para. 2.4.13) or another instruction or advice (under label 3, 6 or 9) may only be relevant for traffic heading to one or more specific destination(s). Each

specific destination can be indicated using label 11 followed by a 16-bit location code (referring to the same database as the primary location). The destination(s) is/are then followed by the information to which they apply (which are all items until the next label 11 or 14 or the end of the message). See Para. 2.4.4 for some additional rules.

A destination given at the end of an information block applies to preceding information that may be, or may include, the first group event, e.g. a trip/journey time from the primary location to that destination.

A destination shall be interpreted as “for traffic heading towards (location)” but directly following one label 11 as “... and (location)”.

2.4.16 Cross linkage to source of problem (label 13)

Any message can be cross-linked to another location that constitutes the source of the reported traffic problem. In such a case, instead of the cause of the problem being located at or before the primary location of the main message, it is located near to the cross-linked location.

Use of this option can be illustrated by means of an example. If an accident on Route 1 causes a queue onto Route 2, it can be reported on Route 2 by means of a message “accident, queuing traffic” whose primary location is on Route 2 (at the intersection with Route 1), cross-linked to the actual accident location on Route 1. Any queue length or affected length quantifier for the Route 2 message should give only the affected length on Route 2. The situation on Route 1 can be described by separate messages, which shall not utilise the cross-linkage field.

On receipt of this information the receiver should announce the traffic problems on Route 2, caused by an accident near the specified Route 1 location.

In multi-event messages, the source of a problem must be linked to the last preceding event (which may be the first group event).

2.4.17 Separator (label 14)

Label 14 may be used as a separator between different parts of a message (“information blocks”). Some types of additional data fields are only allowed once per information block (see example), to avoid ambiguity. Separators can be helpful in making messages clearer to drivers by grouping the message content syntactically. For instance, a receiver can use label 14 to make a short pause in spoken output.

Example: Label 14

Information is received that slow moving traffic is expected on the A5. It is also know that there are roadworks going on. As the two sets of information are not connected, inserting label 14 between them makes them more distinct.

	A message	Event code
1st group	Slow traffic	115

2nd group	Label 14	Label 9	701

This will result in the following presentation:

"A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic expected. Roadworks"

Without the label the receiver might have connected the two events:

"A5, Amsterdam in the direction of Haarlem, between Halfweg and Haarlem, slow traffic expected due to roadworks".

2.4.18 Other Labels (label 12 and label 15)

The remaining label codes (12, 15) are reserved for future use. For label 12 the data field length is already assigned to be 16 bit. Thus a decoder could already implement this label in the sense that the label will be skipped, its contents ignored and the decoding resume with label behind it.

On the other hand, label 15 has no predefined data field length. As a result, a current decoder has to stop decoding as soon as it detects a label 15 in the additional data. The implication is that after new functionality is assigned to label 15, it should be coded as the last label in the additional information.

New functionality to these codes has to be downward compatible to ensure that messages containing these labels can still be decoded in part by already existing decoders and that this does not result in false or misleading information.

3 MESSAGE HANDLING ON THE INFRASTRUCTURE SIDE

3.1 TRANSMISSION HANDLING IN MOUNTAINOUS AREAS

Data broadcast towards mobile receivers poses problems that are specific to this type of reception. Indeed, because of continual vehicle displacement, the reception environment is also continuously variable. This results in changing disturbances that affect the received signal. In addition, the reception antenna placed on vehicles is more or less isotropic and therefore the level of received signal is lower than with a fixed installation. Add a mountainous environment into the equation and this introduces new, significant, disturbances related to the broken relief of the surface. These disturbances include shadowing, multiple wave paths (direct, reflected and diffracted) and the power and number of transmitters needed (often significantly less coverage is possible than in an urban zone). Concerning the received field strength, it can be presumed that distortions due to the multiple-path propagation are mainly determined by the ratio of the amplitudes between the direct and reflected signals, and the delay spread between the first and last significant paths.

An experiment in a hilly environment with a transmitter located at the most elevated point of the region gives the following conclusion:

- The direct signals are relatively high in comparison with reflections on the terrain (due to the transmitter situation).
- Normal delay spreads in towns (the near hills cannot generally be seen from points of the cities).
- On the outskirts of towns, significant distant echoes are received due to the reflections on large parts of slopes of distant hills.
- The power of the signal can vary significantly within short distances due to the relief.

Obviously, even higher delay spreads can be measured in mountainous areas, introducing severe interference.

To overcome the inherent difficulties in mountainous areas, the role of the broadcaster is less important than that of receiver manufacturers. Indeed, the mobile receivers should use adaptive equalisers to take into account evolution transfer functions.

However, the TDF experience gives some propagation rules that could be used for building an RDS service in hilly regions :

- Due to the rapid evolution of the signal in space, the mobility of the vehicle helps to reduce the number and delays of wrong RDS groups.
- The frequency distortion (Doppler effect) as well as the modulation of parasite frequencies are negligible.
- A 19 dB margin is necessary between the average received field and the reception threshold for a “99% of the time” reception of the signal.
- A 70 ms absence of signal (more or less one RDS group) must be accepted by a receiver in the worst case (19 dB fading).

The last rule implies repetition of each RDS group to guarantee the service. The question remains: how often should a message be repeated? This can only be answered by each service provider based on reception tests in the given broadcasting area. However, as a rule, it can be said that the optimum in most mountainous areas seems to be a two times repetition (three identical groups in a row). Only in areas with good coverage does a single repetition seem to be sufficient. Higher repetition rates do little to improve reception while at the same time reducing channel capacity.

3.2 PROCEDURES TO HANDLE MESSAGE OVERFLOW

Traffic status is highly dependent on predictable features such as: the density of the road network, the time of the day and special events (holidays, etc.). However, for security reasons, unpredictable events represent the most important traffic information. It is then necessary to handle the message overflow of normal messages (traffic jam at 5 o’clock on the M25) so that all the information is conveyed to the user without slowing the broadcasting of abnormal situation events.

No solution is defined in the Coding Protocol for RDS-TMC (Ref. 1) and therefore it is necessary to make choices based on experiments, agreements or proprietary solutions.

A first basic implementation is to broadcast the TMC messages according to their urgency (urgency as defined in the event list, see Ref. 2). Although the latter ought to be significant only for the receiver.

A more refined solution is to add broadcasting instructions which are part of an agreement between the TIC and the service provider. For instance, a TIC could tag some messages with a high priority - meaning for immediate broadcast with a high repetition rate, implying a restricted reception delay.

Though the reception of urgent messages is now ensured, message overflow is still a problem.

A good solution is to improve the efficiency of traffic information by only broadcasting messages in the areas where they are relevant. To be able to convey a TMC message to one specific transmitter, instead of another, map matching must be set up between the broadcasting network and the road network. The message location and its extent are then necessary to define the exact broadcasting area. Special broadcasting instructions given by the TIC's can overload this automatic behaviour, however, this can result in, for instance, a national broadcast of the message.

The solution of map matching cannot cope with a highly urbanised environment, like Paris. In such an environment the broadcasting coverage of one transmitter corresponds to a region with over 5 million people and consequently a large number of local TMC messages. More sophisticated methods of message distribution, like using cells as developed by TDF, may be necessary here (see Coding Protocol for RDS-TMC, Ref. 4)

In countries with a dense motorway network and a high percentage of long distance travellers (like Germany or the Netherlands), the effect is different. Each situation has to be considered separately before deciding which transmitter(s) should convey the message. If a driver in one transmitting area is likely to be affected by an event in a second transmitting area, then the driver should get that information. As a result, the selection of transmitters is not only based on the directly affected locations (transmitted as primary location, direction and extent), it is also necessary to calculated a “radius of influence” that will be based on the estimated duration (or stop time) and the average speed on that type of road.

4 MESSAGE MANAGEMENT

4.1 INTRODUCTION

The permitted transmission frequency of TMC groups in the RDS channel is limited to between 1 and 2 groups per second. The ODA protocol involves respecting the time windowing mechanisms or of adapting them to the Alert-C and Plus protocol (regular insertion of Alert-C groups among Alert Plus groups). Time windowing may introduce severe constraints such as real-time-like software and a desire for synchronisation with the 4A-groups generated by the encoders.

Another restriction is the maximum number of TMC messages that a TMC channel can carry at any one time (limited to 300). In the case of message overflow, some solutions to deal with the problem were described in the preceding chapter.

4.2 MESSAGE REPETITION AND PERSISTENCE

Due to the reception capabilities of receivers, a minimal repetition of 2 identical TMC messages must be respected by the broadcaster. In many cases, they will be reporting traffic events without specifying the foreseen or forecasted duration. When this occurs (value “0” for the field duration), a message will persist in the receiver's memory for 15 minutes, if it is a dynamic message, and for 1 hour if it is long-lasting. After this period it will be assumed that the event is over. In the worst case, every message must be broadcast at least once within 15 minutes (repeating them or updating them) to prevent receivers cancelling still valid messages. This will not happen often because the number of messages is normally small, resulting in shorter periods between cyclic message repetition. However, it is necessary to be prepared for extreme situations with a large number of messages.

It is also necessary to pay attention to the following:

> When a problem or traffic event finishes, a cancellation message is broadcast telling the receiver about the end of the problem.

This kind of message, which is called a “silent cancellation message” (SCM) must not be confused with other updating messages or an explicit cancellation message (which is used to cancel wrong messages). The SCM is assigned no value in the field duration. Thus it will not remain in the receiver's memory after it was last received but will only be used to trigger the cancellation of the older message (based on the rules of message management).

The SCM must be broadcast during 15 minutes after its insertion (if it updates a dynamic message with duration value ‘0’) or between 1 and several hours (if it updates a longer period message with a duration value >0). After this period, the receiver will have cancelled the older message from its memory based on duration countdown and then, although it may not have received the SCM, it will stop reporting the original problem. Therefore, the transmission operator must watch over the message list to ensure that SCMs are removed from the transmission chain after 15 minutes or several hours from their insertion (depending on the duration type), without further outside input.

4.3 MESSAGE UPDATING AND CANCELLATION.

When an updating message for broadcasting arrives at the transmission control, the cycle controller must recognise, in the cycle memory, the message to be updated and substitute the new one. It is very useful to use a message version number to manage messages one by one, with no duplicate versions.

As previously stated, it is important that SCMs are automatically deleted from the chain after some time. However, if, after broadcasting an SCM, there happens to be an event from the same category in the same location, this event is managed with an entirely new message. In any event, when inserting this new message into the cycle, the old SCM has to be removed. From this it can be concluded that the cycle controller has to have a certain amount of intelligence to detect such situations and to act accordingly.

With regard to the explicit cancelling messages (ECM), in principle it is recommended to only use them to cancel wrong messages that give false information. In other words, not use them to do the function of SCMs. If an ECM must be used, it is recommended to broadcast it like an SCM - with X priority at broadcasting; that is - fast reception and broadcasting it for only 15 minutes or 1 hour (depending on type).

The Alert-C protocol (see Ref. 1, section 3.4.4) defines special cancellation procedures using the event code 2047 (null message) and the location code FFFF. With these, it is possible to either (see also Table 4.1):

- Cancel all the messages referencing the same location.
- Cancel all the messages coming from the same TMC service.
- Cancel all the messages belonging to the same updating category.

Table 4.1: Special cancellation codes

Event	Location	Effect
Code = x	Code = FFFF	Cancels all messages belonging to same update class as the event with code x
Code = 2047	Code = x	Cancels all messages having the primary location code x
Code = 2047	Code = FFFF	Cancels all messages coming from the same TMC service

In the future, when experience has been gained, service provider's will probably state some new rules because of receiver capacity or due to presentation requirements. However, the wide variety of receivers (from the speech output to the graphical devices) probably means that receivers will be adapted to the broadcasting flow rather than vice versa.

4.4 USE OF CONTINUITY INDEX

All multi-group messages contain a three-bit continuity index field (X2-X0) the purpose of which is to help distinguish between different multi-group messages. All groups within any particular multi-group message contain the same value of the continuity index. This value is maintained throughout each of the message's immediate transmission repetitions although it may change in the periodic message repetition. The continuity index shall be incremented in the subsequent multi-group message even if it is the periodic repetition of itself (see Ref. 1).

Six values are defined for the continuity index, from 001 to 110 inclusive. The values 000 and 111 are reserved for other functions. When the index has reached 110, its next value shall be 001.

TMC channel capacity should be set and/or TMC message insertion should be arranged in such way that:

- Each multi-group message is fully transmitted, including immediate repetitions, within 15 seconds (minimum 1 type 8A-group/sec x 3 repetitions x maximum 5 groups = 15 sec.).
- Any given value of the continuity index must not re-occur in a different message within a period of 15 seconds (at higher transmission rates with shorter multi-group messages this period must also be respected).

5 SYSTEM MESSAGES

5.1 INTRODUCTION

There are two different types of system messages:

- System information that is conveyed in type 3A groups;
- Tuning information, conveyed in type 8A groups (this is detailed in Para. 5.6).

Additionally, time and date information is needed. This is conveyed in type 4A groups as part of the RDS data stream (this is detailed in Para 5.7).

5.2 SYSTEM INFORMATION

System information is conveyed in type 3A groups with the Application Identification (AID) for Alert-C (= CD46). There are up to four different 3A variants possible of which only two have so far been defined. The coding and content of the two already defined variants is shown in Figure 5-1.

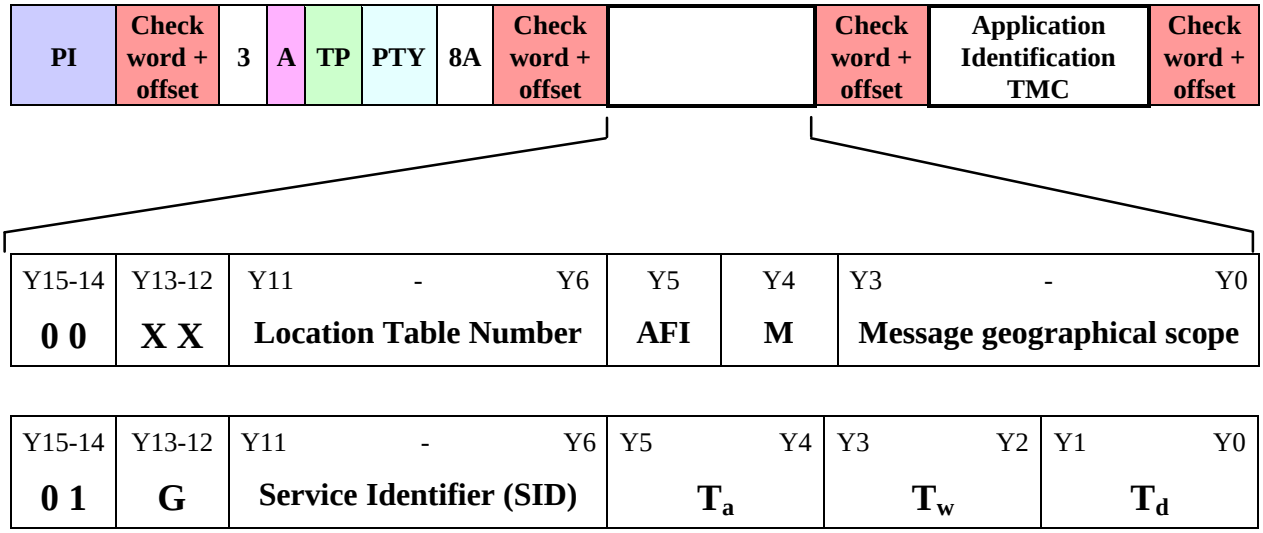


Figure 5-1: System messages in 3A group

The most important information, the Location Table Number (LTN), is grouped into the mandatory variant 0. In the basic mode, the other variants are optional. As for the remaining field, default values may be assumed.

Variant 0 contains, besides the LTN, the Alternative Frequency Indicator (AFI) bit, the mode bit and the Message Geographical Scope (MSG) bit field, all of which can be used to enhance the performance of a TMC-receiver but may also be ignored.

The LTN is essential for the TMC-decoder as the transmitted location codes (LC) can only be interpreted in combination with the LTN and the Country Code (CC -

which is part of every Program Identifier (PI)). As even the combination LC+CC+LTN is not unique all over Europe, because some countries share the same CC, the Extended CC (ECC) was intended to make the final distinction possible. However, because the ECC is transmitted as part of a 1A group-variant only, this could not be ensured in all countries. As a 'work-around', the 64 possible LTN have been split into groups which will be assigned to each country in such a way that for all countries the combination LC+CC+LTN becomes unique. The assignment of the LTN for each country can be found in Ref. 3.

The remaining parts of the system information are described in the following sections, however, reference should also be made to the Alert Coding Protocol itself, Ref. 1.

5.3 THE SERVICE-ID (SID)

5.3.1 What is SID intended for?

The service providers (SP) are not necessarily identical with the broadcasters in an RDS-TMC service area and competition can arise between the service providers in the same RDS-TMC service area. To avoid potential conflicts or delay in presenting messages on the receiver, the introduction of a "service identifier (SID)" has been decided upon.

The purposes of the SID are:

- The TMC service ID indicates that TMC messages received from this transmitter can be used to update messages from all other transmitters having the same country code, location database number and TMC service ID (see Ref. 1 Para. 3.1.1).
- To avoid extensive tuning between several SPs offering RDS/TMC services - when a receiver is first switched-on or a specific service is momentarily lost.
- To guarantee to consumers that a receiver will tune as soon as possible to those specific or marked services they have chosen by selecting a special location database distributed by this service.

Therefore, the SID identifies the data service provider in its country. At a European level, coupling the SID number, country code and the Location Table Number provides a unique identification of the service.

One or more service IDs will be stored together with any TMC-location database. The receiver will start with the first service ID on the card and will try to find this specific service. If this service is not found then it will try the next ID and so on.

The way to order SIDs is very important and depends on which service provider will commercialise or distribute the cards.

To illustrate the use of SIDs, the following example (Figure 5-2) shows the situation where a service area is covered by 2 services operators (linked to 2 road operators) with an important overlap.

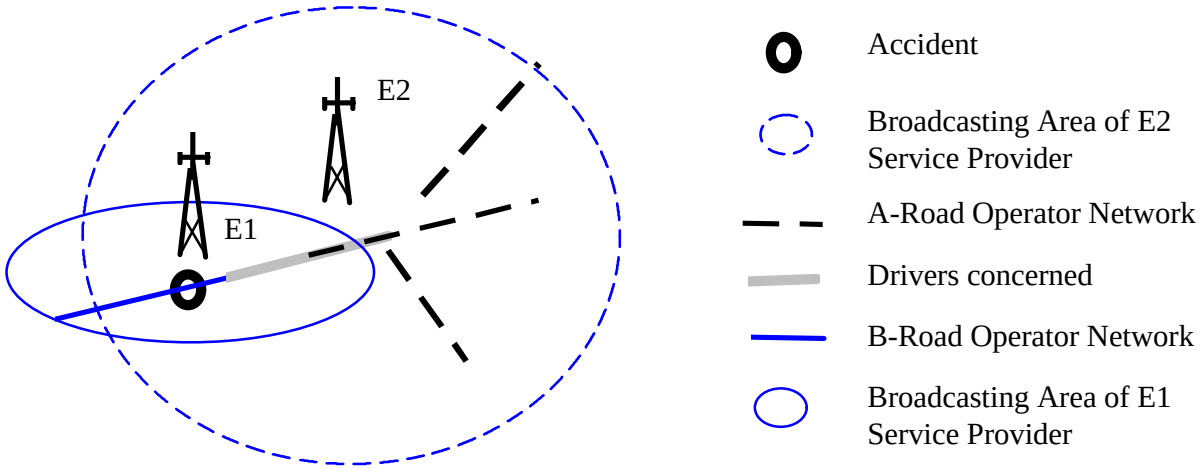


Figure 5-2: Overlapping Areas of Responsibility

There is an overlap between two broadcasting areas on the B road network. The transmitter of E1 service provider gives more detailed TMC information on the B road network. The transmitter of E2 service provider provides more detailed TMC information on the A road network. When leaving the E1 area, the TMC receiver tunes to the E2 transmitter, even if there is no tuning agreement between the E1 and E2 service providers. This is because, at a minimum, the receiver will scan the FM frequencies until it finds a TMC Service.

However, when entering the B road network, no guarantees are given that a receiver only scans the E1 transmitter as the receiver is able to receive both E1 and E2 correctly. It is then necessary to use the SID for more system information than just the tuning parameters (mapped frequency, AF or PI). SID provides the ability to search for, and tune to, the specific or marked E1 service (see section 5.6), as only this service gives the detailed information about the A road network.

If the receiver holds a TMC-database with the E1 SID then it will tune automatically to the marked E1 service. Therefore, it is necessary that each TMC Service provider has its own SID number to clearly mark its service, to engage its editing responsibility and to provide identification if it is needed.

The SID can also be correlated with the locations of a predefined service area for automatic selection in navigation systems.

5.3.2 How to obtain a SID?

SIDs are uniquely assigned at national level by the same organisation that also assigns the location database numbers (normally the Ministry of Transport or equivalent - see the European Workplan, Ref. 11). Sixty-three different SIDs can be assigned per country.

5.3.3 How is SID implemented?

5.3.3.1 On the air

The SID is transmitted in the 3A-group as shown in Figure 5-1.

5.3.3.2 In the receiver

The TMC receiver's bearer(s) are the exchange medium used to distribute and load TMC databases or service provider parameters into receivers. Therefore, the SID must be implemented into those bearers.

A distinction has been made between two types of bearers:

- The TMC chipcard.
- Other TMC database(s) bearer.

The chip card is highly recommended for use as the TMC database and SID bearer. This is because it has already been standardised and its physical and electrical standard, ISO 7816, corresponds to cards that are widely used today.

Figure 5-3 shows how a receiver system, using a chip card as the TMC database bearer, can be realised. Systems using other bearers, e.g. CD-ROMs, will have similar functionality.

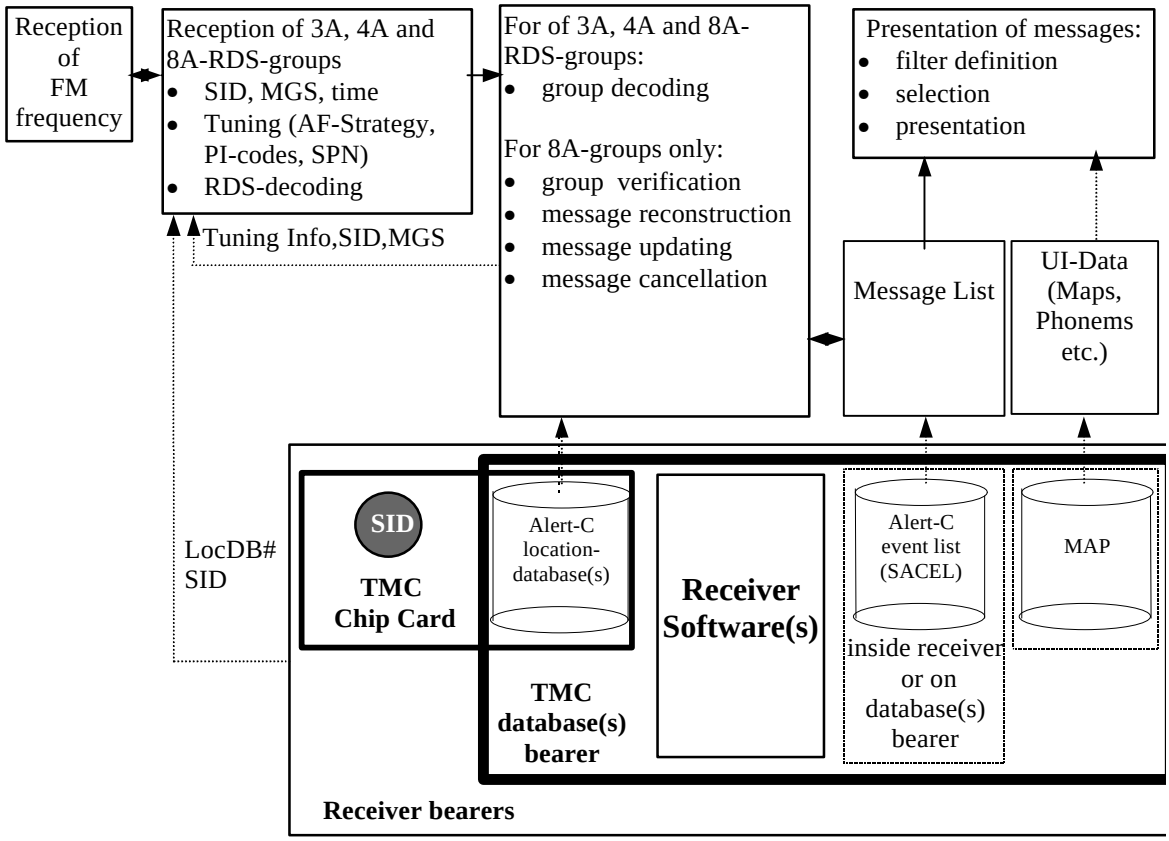


Figure 5-3: Chip Card TMC Database

5.4 TMC RECEIVER BEARER(S)

Receiver bearers are a general term to identify an exchange medium used to distribute and load TMC databases or service provider parameters into receivers. These TMC databases or service provider parameters may require periodic updating because the set of location codes is no longer up-to-date or because consumers prefer the TMC Service transmitted by another service provider.

In principle, it is possible to differentiate between two elements:

- The TMC service identifier bearer.
- The TMC database(s) bearer.

The TMC database(s) bearer can have several physical formats (Chip Card, PCMCIA, CD ROM, etc.). It can be used to store the TMC location database, the event list, and, depending on its capacity, the digital map to support a navigation system or the decoding software needed for the receiver.

Some receivers use a TMC chip card to store some of the information. The TMC chipcard looks like a credit card or a GSM mobile phone SIM card. For this card it is advisable to apply the electrical standard ISO 7816 and conform to the work done

in the *CEN/TC 224 «Machine readable cards, related device interfaces and operations», Working Group 11 «Surface transport applications» pr ENV 1545*. The card can be used to store the SIDs code or key control access for added value services. Some receivers will also use it to store the TMC location database.

Other receivers may have the TMC location codes integrated into a digital map, thus allowing TMC decoding and dynamic navigation based on real traffic situation.

5.5 TRANSMISSION MODES

5.5.1 Introduction

The rather complex feature of TMC windowing was introduced in the last stages of the RDS-TMC standardisation. It deals with the fundamental requirement for a receiver to be able to leave a given channel for a predictable period of time without missing any TMC information. This section is intended to give some insight into the reasoning behind this effort.

5.5.2 Why do we need TMC transmission windows?

When industry and broadcasters defined the requirements for a TMC receiver, they agreed that the ideal receiver should contain two tuners. The reasoning was based on the following:

1. For the user, TMC should not be a step backwards compared to RDS/EON; the user should be free to choose an audio programme and still receive TMC.
2. A search for TMC will always be much longer than a PI-search - if done by a single tuner this would result in unacceptable disruptions (muting) of the audio program.

While a 2-tuner concept could fulfil these requirements, it has one major problem - it is expensive. The additional costs are not only caused by the integration of the 2nd tuner, but also by the more complex software needed to make such a system work.

Marketing studies have shown that potential buyers are not willing to spend more than 100-200 DM for the additional TMC-functionality. If the receivers are too expensive this could endanger the success of TMC or at least slow down the market penetration. The solution was to look at how to make the 2-tuner concept more attractive. This could be achieved by not only using the second tuner for TMC but also for supporting the 1st receiver by:

- Searching for alternative frequencies;

- Monitoring of field strength;
- Updating AF-lists;
- Other RDS data gathering.

This support would result in less disruption of the audio program, especially under difficult receiving conditions, and would thus give the 2-tuner concept an additional marketing advantage.

5.5.3 Introduction of TMC-windows

5.5.3.1 Synchronisation of TMC Transmissions

While the tuning information solved some problems, it introduced a new one. When the receiver tuner performs tasks supporting continuity of reception of the TMC service and/or the audio program, it has to leave the TMC channel and switch to other frequencies. As a result it cannot receive TMC messages. Because the time needed for these tasks was estimated to be in the order of 50% of the total, this would result in the loss of about 50% of all 8A-groups. This is not acceptable, as the reception of multi-group messages would become impossible. There had to be a way to synchronise the TMC transmission with the measuring tasks, which Figure 5-3 attempts to illustrate. The upper half of this illustration shows a typical FM-band with several occupied frequencies. The scan of this band can take a long time (several minutes in a worst case situation) during which TMC messages would be lost. With time windowing, the receiver is able to do the scan in several steps, each measuring step followed by a TMC gathering step. As long as the TMC gathering is synchronised to the TMC broadcast, as indicated in the lower half of the illustration, no TMC messages are lost due to scanning the FM band.

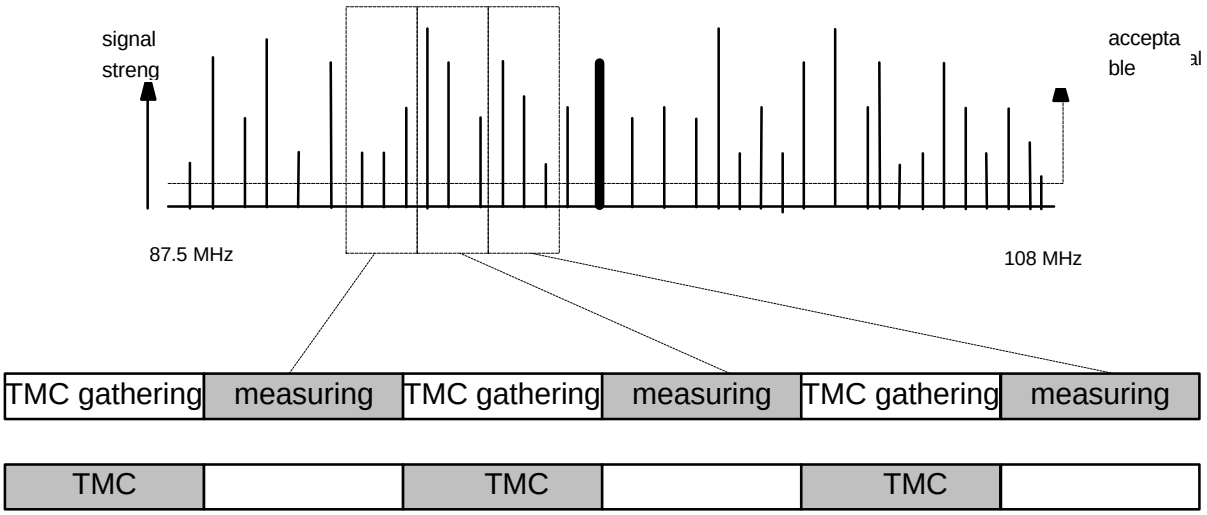


Figure 5-4: TMC Transmission Synchronisation

For this process the receiver has to constantly switch between two tasks - TMC gathering and measuring the field strength. The synchronisation between these tasks should take into account the following requirements:

- Measuring slots are needed for quick tasks like field strength measuring.
- Longer lasting windows are needed that enable the receiver to perform longer lasting tasks like collecting Program Service names.
- Any solution has to also take into account that the reaction time for these tasks are different:
  - quick tasks have to be possible in less than a second (whenever the 1st receiver needs support);
  - longer tasks are less critical.
- The synchronisation between receiver and transmitter should be done without additional groups, as the channel capacity is already limited.
- Finally, the synchronisation should still work in bad reception areas.

The next step was to find solutions that matched these requirements.

5.5.3.2 Solution: Quick Tasks

Initially a solution was found for quick tasks. The encoder had to ensure that after transmitting an 8A-group, a minimum number of other RDS-groups would be transmitted before the next 8A-group; Figure 5-5 illustrates this solution.

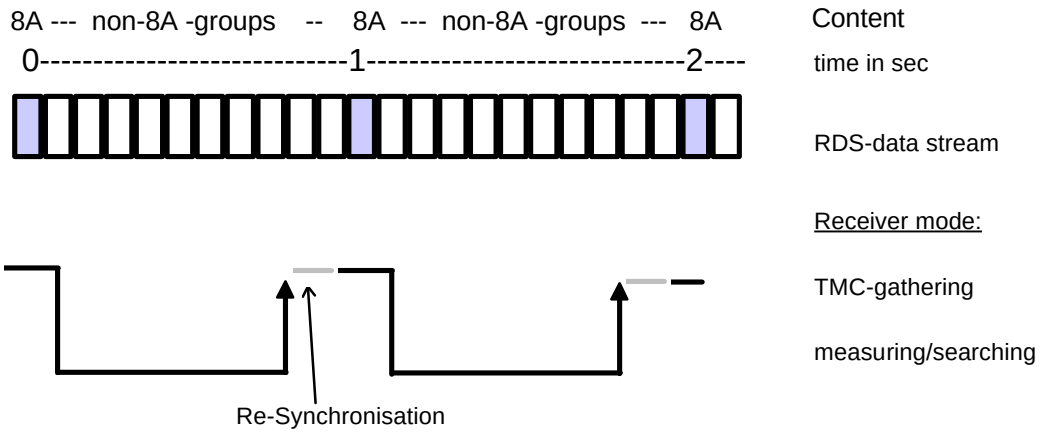


Figure 5-5: Quick Tasks Solution

This solution uses the 8A-groups themselves for synchronisation. No additional bits are necessary. It will also work in bad reception areas, as the receiver is able to re-synchronise with any received 8A-group.

The size of the window (gap) is determined by the number of non-8A-groups inserted between any two 8A-groups. If this number is known it is possible to calculate how long the receiver can measure and search other frequencies before it has to switch back to the TMC frequency. This procedure provides time for re-synchronisation on the data stream as well. Small deviations, as caused by the insertion of 4A-, 14B- or 15B-groups, can be tolerated.

The minimum number of non-8A-groups between any two 8A-groups should be assumed to be either a default value or to be coded into the system information. However, there also has to be a maximum number of non-8A-groups defined. If not, the TMC-receiver is bound to stay tuned to the TMC-frequency longer than necessary once it has missed one or more TMC-groups or if the channel stops transmitting 8A-groups.

5.5.3.3 Solution: Longer Tasks

A solution for longer tasks was more difficult to find. Several ideas were discussed but none of them were sufficient to fulfil the above requirements. Finally, the BBC proposed a solution they called “spinning wheel”. It is based on the following ideas:

- Divide the minute into an integer number of time slots.
- Split each of these time slots into a first part (activity time, T_a), during which 8A-groups may be inserted into the data stream, and a second part (window time, T_w), during which no 8A-groups shall be inserted into the data stream.
- Between the start of the minute (as indicated in the RDS-data stream by the presence of the 4A-group) and the start of the first time slot, a delay is possible (delay time, T_d)

The meaning of the parameters T_a, T_d and T_w is illustrated in Figure 5-6.

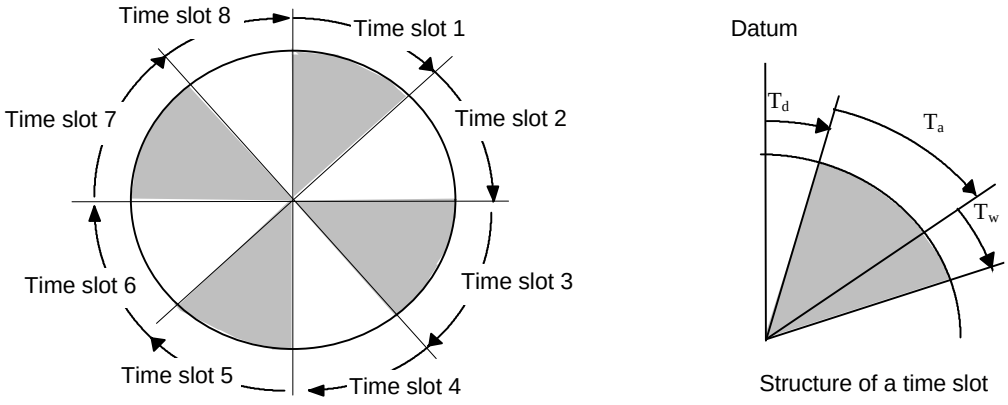


Figure 5-6: Longer Tasks Solution (Spinning Wheel)

The insertion of 8A-groups is governed by the following rules:

- No 8A-groups should start outside the activity window.
- An 8A-group may be completed outside the activity time.
- T_a , T_w , T_d have to be multiples of a second, with 60 s/(T_a + T_w)= n (n : integer>0).

The actual values of these parameters should be assumed to be either default values or be coded into the system information.

In this solution the 4A-groups are used for synchronisation, therefore, as these are needed for TMC anyway, this introduces no additional overhead (see ENV 12313-1, chap 2.2.4: REF. 1). This solution will also work in bad reception areas because the receiver is able to calculate the future time slots as soon as it has received the timing parameters once.

5.5.4 Coding of the Transmission Mode Parameters

To implement both solutions it was necessary to code a total of 4 parameters. Two solutions were possible:

- Code the values themselves;
- Assign mode-numbers that represent a given combination of these parameters.

The first approach was chosen for the following reason - out of the number of different combinations it is difficult to decide which one is correct. There was also no experimental data available that could be used for guidance. If the wrong combination had been chosen, the first generation of receivers would not have been able to benefit from any changes introduced at a later stage. By coding the parameters directly it is possible to fine tune the TMC-system even when a large number of receivers are already on the market.

Because all the parameters were assumed to be static information, it was decided to code them into the 3A-group, variant 1. As this variant is not available in the 1A/8A-solution (and it may also be possible that broadcasters/service providers do not want to use two variants of the 3A-group) a default mode was defined that is called **“Basic Mode”**. All other modes that need variant 1 of the 3A-group are called **“Enhanced Modes”**. One bit of the 3A-variant 0 (the former C/P-bit of the 1A, which is not needed in the 3A/8A-solution) is used to indicate that the service is using an enhanced mode and that the relevant bits in variant 1 are to be interpreted as timing parameters.

The transmission mode parameter G, T_a, T_d and T_w are transmitted using lookup-tables, which are defined in EN12313-1 (Ref.).

5.5.5 Choosing the right TMC transmission mode parameters

Keeping in mind the capacity demands of other RDS-groups, as well as limiting the processor capacity needed for the receiver, not all combinations of G, T_a and T_w give a useful combination. Table 5.1 gives some useful examples, that are compatible with the restrictions given in the EN12313-1, and the resulting data rates.

Table 5.1: Examples of the Permitted Transmission Modes

Mode	**G**	**T_a**	**T_w**	**max. 8A/s**	**max. average 8A/s**
default	8-14	1	0	2 groups/s	1.26 groups/s
A	5	1	1	2 groups/s	0.92 groups/s
B	3	1	1	3 groups/s	1.37 groups/s
C	5	2	1	2 groups/s	1.22 groups/s
D	3	2	1	3 groups/s	1.83 groups/s
E	3	3	1	3 groups/s	2.12 groups/s
F	3	2	2	3 groups/s	1.37 groups/s

The first step in calculating the maximum average repetition rate $R_{av,max}$ is to find out how many 8A-groups fit into the time slot provided by the activity time:

$$N_{max} = \frac{INT(11.4 * T_a)}{G+1}$$

Example:

For $T_a = 2$ and $G = 3$ this results in 5.5 groups. The maximum average repetition rate per second can now be derived from this value by dividing it through the sum of activity time and window time:

$$R_{av,max} = \frac{N_{max}}{(T_a + T_w)}$$

In our example (T_a=2, G=3, T_w=1) this leads to 5.5/3 = 1.83 groups.

5.5.6 Change of TMC Transmission Mode

Change of TMC transmission mode should only be done in the order of hours, to make this information slow labelling information. A service should choose the operating mode according to the number of messages to be transmitted. This number will vary between high numbers during the rush hours and low numbers during the night time.

A change is only possible when operating in the 3A/8A mode, as the 1A/8A has only one mode of operation. The switch from 1A/8A mode to 3A/8A is indicated by the appearance of the 3A-groups, which should cause a readjustment of all relevant parameters in the receiver.

If a transmission site wants to change its transmission mode, this is only possible at the minute's edge. It should signal this in advance in the outgoing activity window by placing, in the very last time slot before switching modes, amended 3A-groups in the position where 8A-groups could have been expected (this is because it is the only time that a receiver can be expected to be listening to the main service). Transmission of 8A-groups can then be resumed in the next (new) activity time.

Once the new mode has been established, the expected activity windows of the old mode should each carry one 3A-group for a minute afterwards. This will make certain that all receivers can notice the change.

5.5.7 Summary

With the introduction of the TMC transmission mode parameters it is now possible to efficiently implement TMC functionality in 2-tuner systems. Note that, in addition, dedicated TMC-receivers will benefit from this solution as they will be able to improve their RDS-functionality by using the TMC-windows for measurement tasks.

The coding gives broadcasters and service providers the freedom to choose between basic and enhanced modes, thus allowing a stepwise introduction of features based upon the availability of appropriate RDS-Encoders.

The receiver manufacturers can start implementing this feature without delay, as fine tuning of these functions can be achieved at any time by changing the values of the transmitted parameters.

5.6 TUNING INFORMATION

5.6.1 Introduction

In-car RDS-TMC equipment needs to change from one transmitter to another if the signal becomes weak.

The simplest way of scanning the FM band for 3A-groups with a TMC-application ID and the right service characteristics could, in the worst case, take several minutes. As this is unacceptable from the user's point of view and for traffic safety reasons (for instance missing of an x-urgent message), the receiver should only switch to pre-defined frequencies. TMC-service networks are independent from program networks and may consist of more than one programme network. Therefore, it is necessary to provide, so-called, “tuning information” about the stations and the respective frequencies that form a TMC-service network.

As these networks will not exist initially, but grow and change, the linked tuning information will also change. This leads to the conclusion that, to ensure up-to-date information is always available, tuning information should be broadcast together with user messages. Only in the case where the TMC-network and the programme-network are coincident, is there no need to broadcast tuning information. This is because the alternative frequencies (AFs) transmitted for the normal RDS service provide the necessary functionality, thus avoiding the need to use channel capacity for intra-network tuning information. The concept of an alternative frequency indicator (AFI) bit was introduced to identify such a situation. If all frequencies of a programme network (same PI code) fulfil the “Conditions for using Tuning Information” the AFI bit shall be set to 1. This indicates that all alternative frequencies broadcast in the 0A-group for the audio program can be used to switch to the next station. In all other cases the AFI bit is set to 0.

Provision of additional intra-network information is necessary. Network information is defined for two situations:

- Intra-network tuning information;
- Inter-network tuning information.

Network here means from the view of program networks. Intra-network means tuning information about stations with the same PI code. Inter-network means tuning information about stations with different PI codes.

Mechanisms to ensure continuity of services that are already proven by RDS, such as the coding of alternative frequencies in 0A, will also be used. Inter-network

tuning information is always additional because it is not provided for radio programs in RDS. Different situations like “connecting program networks”, “gap filling” and “conditional gap filling” can occur and can be described with the defined variants.

For further information, some examples are described in the next paragraphs. The choice of the adequate “tuning information variant” depends on matching the TMC-network and program network indicated by the AFI bit. Another important function obtained with the tuning information enables the indication of Other Networks (ON) carrying the same or another RDS-TMC service.

5.6.2 Example 1: Connecting audio networks (fictive example)

In a situation such as shown in Figure 5-7, where each region has its own PI code, the easiest and best way to reference between the audio programs is to use 8A-group variant 8 (1000).

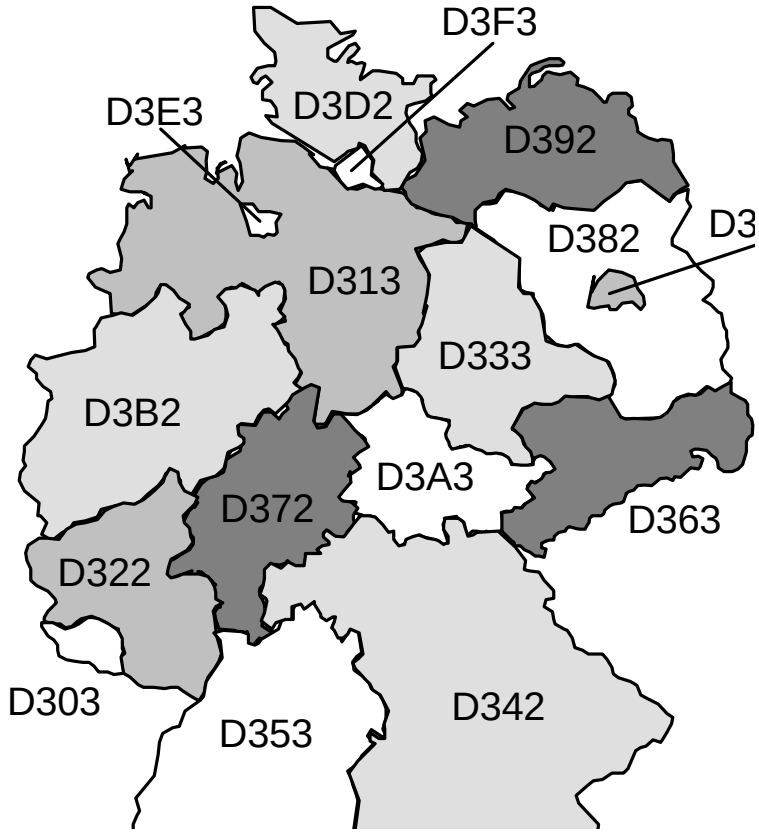


Figure 5-7: Connecting Audio networks

However, a prerequisite is that for 3A-group of all networks:

- AFI = 1, (no extra tuning information for intra-network referencing necessary);
- BSC: I = 1, N = 1, R = 1/0, L = 0;

- LTN = in range of the whole country.

The tuning information can then be coded as:

In ODC (8A): tuning information (list with PI codes in 8A variant 1000):

1000	D303	D313	1000	D382	D392
1000	D322	D333	1000	D3A3	D3B2
1000	D342	D353	1000	D3C2	D3D2
1000	D363	D372	1000	D3E3	D3F3

5.6.3 Example 2: Gap filling (fictive example)

In this case, where a whole region has a single PI except a small area (see Figure 5-8), it would be more convenient to broadcast the 8A variant 6; then, the information contained in 3A and 8A for each area would be:

	3A	8A		
8201	AFI = 1	variant = 0110	“92.6” “fc”	8203
8203	AFI = 0	variant = 1000	8201	8201

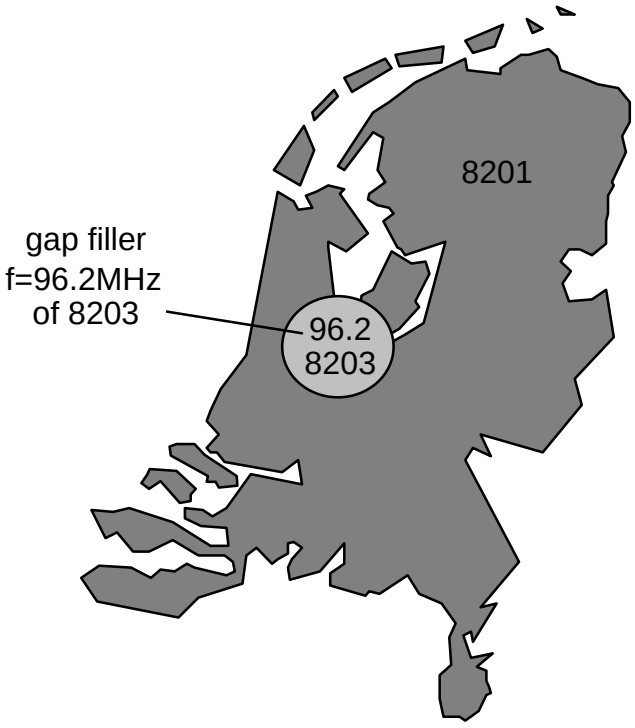


Figure 5-8: Gap Filling

5.7 USE OF THE 4A-GROUPS

In the basic TMC transmission mode, the only constraint that must be achieved is to insert enough non-8A RDS groups between 2 consecutive 8A-groups in order to allow the receiver to test alternative frequencies. In this mode there is no constraint on 4A-groups (except that they are transmitted because they are needed for message management and, if the message contains start and/or stop times, they are also needed for message presentation).

An enhanced mode is implemented in order to preserve larger and regular periods of time without any TMC information. During this time the receiver can perform search activities.

This mode is based on the division of a minute into a succession of activity and window times. No TMC groups may begin within the window time; this means that during the window time the receiver is “sleeping”, as far as the TMC service is concerned. Therefore, during this time, the receiver concentrates on testing alternative frequencies to provide a better reception of the same service, or, if the tuned service can no longer be received, to find another service. Shorter periods without any TMC groups exist in the same way as in the basic mode and may be used to test field strength or PI code.

In order not to lose any TMC group, the sequence of activity and window times must be very regular. For this reason, activity and window times contain an integer number of seconds. To achieve this, the timing of the RDS frame is based on its division into minutes, each minute containing an integer number of window and activity times.

The beginning of the minute is flagged by a 4A-group. It is of great importance to achieve very precise minute intervals to allow the receiver to control its sleeping periods. This precision is achieved by using a timer synchronised to the occurrence of 4A-groups. Therefore, the interval between two consecutive 4A-groups should be 685 or 686 RDS groups. This timing may be achieved by synchronising between 4A-groups and UTC time, the 4A-group being broadcast at the beginning of the UTC minute. However, although a delay may occur between the beginning of the UTC minute and the 4A-group, this delay must be fixed and the duration of 685-686 groups for a minute always provided.

As in the paging mode, the timing for activity and window periods can be more easily achieved if 1A and 3A-groups are broadcast at the beginning of each second. However this is not mandatory.

When receivers switch from one frequency to another, synchronisation is no longer retained. The receiver has to acquire a new 4A-group in order to know the minute edge and new system information in order to have the new duration for activity and window times. In order to ease this process, the receiver is kept awake for several minutes - receiving all 1A, 3A, and 8A-groups.

6 THE RECEIVING PROCESS

6.1 INTRODUCTION

This chapter considers, in more detail, which receiver processes are needed to collect, verify and decode the 8A-groups, link them in the case of MGM, and finally reconstruct the messages which are coded within.

6.2 GROUP VERIFICATION

Using the transmitted system and tuning information, the receiver selects a TMC-service and starts collecting 8A-groups. Each 8A-group will be accepted only after two identical copies have been received (either on the transport level - immediate repetition - or on the session level - periodic repetition). Different repetition rates, different numbers of messages being broadcast at the same time and changes in the reception probability transform this seemingly simple endeavour into an area where different verification schemes may be invented, leading to vastly different results. This topic is not covered in great detail because it can be handled differently by different receiver manufacturers without introducing incompatibilities.

6.3 LINKAGE OF MULTI-GROUP MESSAGES (MGM)

As long as only single group messages are received, decoding can start right after the verification stage. However, if multi-group messages are received, it is first necessary to collect the groups that make up one multi-group message. The process of adding the single and subsequent groups shall be **linked** to a first group if:

- The first group, second group and (where relevant) any subsequent groups are each correctly received at least **once** within any 15-second period.
- The continuity index has the same value in all the groups being linked;
- The group sequence identifier shows there are no missing **intermediate** groups in the message. Missing groups at the end of a message shall not prevent linking of two or more initial groups.

Before being presented to the driver, any group must also have been **validated** (received identically, at least twice). Linking is required for at least **one** of the copies. Validation of each group (for which error correction is allowed) may occur before, during or after reception of the linked sequence.

When the first two or more groups of a multi-group message have been received, linked and validated, without having linked and/or validated one or more subsequent groups, any additional information (labels plus data fields) which is complete shall be

presented to the driver. If, however, the last correctly received group ends with one or more detailed diversion instructions, no part of the diversion shall be presented until the whole diversion has been correctly received.

6.4 THE DECODING PROCESS

Depending on the different types, extent and direction, different message structures have to be foreseen in the receiver. This ensures that, during the decoding process, only the relevant slots in a fixed structure are filled in.

As an offset may combine two locations, each of which represents a different subtype, it seems that the examples given in Para. 3.2 can only represent a small fraction of all possible message structures. However, a closer look at all types and subtypes reveals that there are some constraints:

- No linkage between different categories is possible .
- No linkage between areas is possible (extent always=0).
- No linkage between roads is possible (extent always=0).
- Linkage between segments is only possible within the same line/road.
- Linkage between points is only possible when they are situated on the same line/road.

Thus the tools (location code, extent and direction), can only describe a limited set of situations. In fact, there are only 6 different cases possible:

1: Area message.

2: Road message.

3: Segment message with extent = 0 (one segment).

4: Segment message with extent > 0 (two segments).

5: Point message with extent = 0 (one point).

6: Point message with extent > 0 (two points).

It becomes somewhat more complicated when urban point locations are considered. The messages involving urban point locations have a different syntax from those containing only non-urban locations. This is due to the fact that inside cities not all roads have road numbers, therefore road names have to be used for those locations. Also, road names are not necessarily unique, even inside the same city, so use also has to be made of area names to get a precise (unique) description. This raises the number of different cases to 11.

It is also possible that for special combinations of locations and events, additional logic has to be introduced to get a good description. However, for the moment the cases given here should suffice.

Figure 6-1 shows examples of different location types.

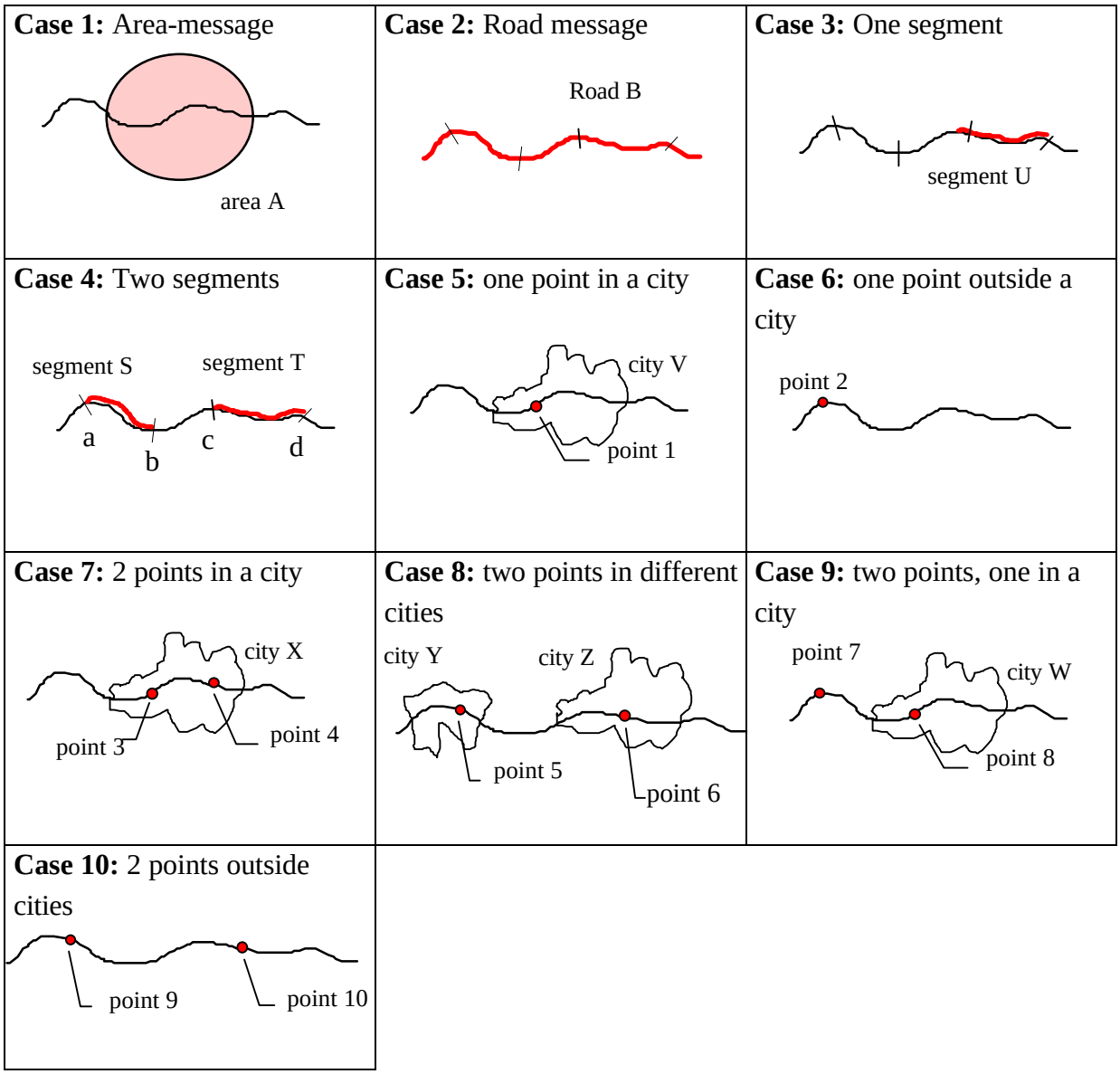


Figure 6-1: Possible Location Types

6.5 MESSAGE RECONSTRUCTION

To illustrate the process of decoding a message in the receiver, some examples are given in which the reconstruction is explained step by step.

1st example: Case 1, Location type code equal to A1.0, A2.0, A3.0 or A4.1

British example: *"In the area of Wales: fog"*

German example: *"Im Bereich Niedersachsen: Nebel"*

1st Comment:

A single phrase like *"in the area"* is possible as the name of the area is, in these cases, sufficient to identify that area. (i.e.: It is not necessary to add a specific location type string like *"Bundesland Niedersachsen"*).

2nd Comment:

In all examples it is assumed that the system information has already been received (3A and 4A groups) so that:

- the receiver can verify that its location table is identical to the one used for the coding of the received messages;
- the receiver's clock is synchronised with the clock at the transmitter site;
- the 8A groups to be decoded have been verified by receiving at least two identical copies.

In other words, the receiver has "locked on" to the service.

Decoding process in steps:

1. Use location code to look up location subtype. Result: A1.0 (or A2.0 or A3.0).
2. Use location subtype to look up predefined phrase. Result: string (*"In the area of"*)
3. Use location code to look up and add First name. Result: string *("In the area of Wales"*)
4. Location string ready, insert delimiter (e.g. ","). Result: string (*"In the area of Wales,"*)
5. Use event code to look up and add the event text. Result: string (*"In the area of Wales, fog"*)
6. Output final result

Step 1 and 3:	use the location list
Step 5:	uses the event list
Step 2, 4 and 6:	may be receiver/implementation dependent

2nd Example: Case 1, Location code type code equal to A4.2, A5.0, A7.0, A8.0 or A9.0

British example:	*"Midlands, County Warwickshire, heavy traffic"*
German example:	*"Niedersachsen, Landkreis Hannover, hohes Verkehrsaufkommen"*

Comment:

This time a single phrase for the different location types is not possible, as the name alone is insufficient to identify the area. For example: in Germany there is a "Landkreis Hannover" (county) and a "Stadt Hannover" (city). It is also possible that even this is insufficient as there may be different cities with the same name in different parts of the country. So, the next higher area is also needed to distinguish the city of Hannover uniquely.

Decoding process in steps:

1. Use location code to look up location type. Result: A4.2 (or A5 or A7 or A8 or A9)
2. Use location code to look up Area Reference. Result: 2nd Location code
3. Use 2nd location code to look up and add First name of Area. Result: string ("Midlands")
4. 1st part of Location string ready, insert delimiter (e.g. ","). Result: string ("Midlands,")
5. Use location code to look up location type string of 1st location. Result: string ("Midlands, County")
6. Use location code to look up First name of 1st location. Result: string ("Midlands, County Warwickshire")
7. Location string ready, insert delimiter (e.g. ":"). Result: string (Midlands, County Warwickshire:")
8. Use event code to look up and add the event text. Result: string ("Midlands, County Warwickshire: heavy traffic)
9. Output final result

Step 1, 2, 3, 5 and 6: use the location list

Step 8: uses the event list

Step 4 and 7: may be receiver dependent

6.6 MORE DECODING EXAMPLES

In the following examples the start point is a hexadecimal notation, giving a whole RDS-TMC group. To follow the examples, transfer the hexadecimal values into binary values, and than use the tables in Annex 5 to isolate the message elements:

Example 1:

1st group: D392 8401 8865 2094

2nd group: D392 8401 4258 0000

In this message the following information can be found:

1st group:

1st block (D392): CC = D: PI-code from Germany (or Libya or Togo or …, needs extended country code (ECC) to be sure), coverage area = 3: supra-regional; program reference number = 92 (refer to Ref. 8 for detailed description of the PI-code).

2nd block (8401): group 8A, with TP = 1, normal Alert-C-message (X4 = 0), not a system message (X3 = 0), continuity index = 1.

3rd block (8865): first-group marker = 1, direction = 0, extent = 1, event = 101 (0 x 65).

4th block (2094): location code = 8340 (in decimal notation).

2nd group:

1st block (D392); PI-code.

2nd block (8401): group 8A, with TP = 1, normal Alert-C-message (X4 = 0), not a system message (X3 = 0), continuity index = 1.

So far the information is identical in both groups. As the continuity index is the same and it is assumed that the groups are received and validated in sequence, linking the two groups is allowed. The difference starts with the third block.

3rd block (4258): first-group indicator = 0; second-group indicator = 1; group-sequence indicator = 0 (= last group), label 2, data = 11; (length of route affected = 12 km).

The remaining three bits and the whole of the 4th block (0000) contain all 0s: no further information.

Now using the location data given Table 2.2, the following message can be arrived at:

"A5, from Halfweg in the direction of Haarlem

between Rottepolderplein and Haarlem,

stationary traffic for 12 km."

In the following examples the first group is kept constant (only CI is changed) and emphasis is put on the contents of the remaining groups.

Example 2

1st group: D392 8402 8865 2094

2nd group: D392 8402 42D0 D000

In this message the following information can be found:

1st group:

Except for CI, identical to example 1

2nd group:

3rd block (42D0): first-group indicator = 0; second-group indicator = 1, group-sequence indicator = 0 (= last group), label 2, data = 26; (length of route affected = 75 km).

The remaining three bits contain all 0s but the 4th block (D000) contains not all 0s in the first 4 bits: decoding has to continue without stopping at the block border.

Label 1, data = 5 (control code 5: equivalent of diversion bit set to 1).

Now using the location data given Table 2.2, the following message can be arrived at:

"A5, from Halfweg in the direction of Haarlem

between Rottepolderplein and Haarlem,

stationary traffic for 75 km, please avoid the area if possible."

Or, if a predefined diversion exists (depends on location list content):

"stationary traffic for 75 km, follow the diversion signs number 7."

Example 3

The first two examples were straight forward. The following examples are more complicated, based on the German location list. Using the German location list it is possible to verify the correct representation of the location names, however, without the list it is still possible to follow the decoding process.

1st group: D392 8403 C2C2 1BBE

2nd group: D392 8403 7E90 E6CE

3rd group: D392 8403 2560 8C34

4th group: D392 8403 15DE F45B

5th group: D392 8403 0214 5888

1st group:

3rd block (C2C2): first-group indicator = 1; direction = 1, extent = 0, event = 706 (0 x C2C) [road marking work]

4th block (1BBE): location code = 7102 (in decimal notation) = A40, segment "Duisburg - Venlo"

2nd group:

3rd block (7E90): first-group indicator = 0; second-group indicator = 1, group-sequence indicator = 3 (= three more follow = 5 group message), label 14 (this label is not really needed here but does no harm); label 9, 4 bits of data, data block continues in block 4

4th block E6CE: 7 more bits of data -> data = 115 (= slow traffic); label 6, 5 bits of data, field continues in 3rd group

3rd group:

3rd block (2560): first-group indicator = 0; second-group indicator = 0, group-sequence indicator = 2 (= two more follow), 3 more bits of data -> data = 114 (= “do not allow unnecessary gaps”); label 11, 5 bits of 16, data continues in block 4

4th block (8C34): 11 more bits of data -> data = 1121 (= city “Duisburg”); label 10, 1 bit of data, field continues in 4th group

4th group:

3rd block (15DE): first-group indicator = 0; second-group indicator = 0, group-sequence indicator = 1 (= one more follows), 12 more bits of data -> data continues in block 4

4th block (F45B): 3 more bits of data -> data = 12023 (“A61, AK Mönchengladbach”); label 10, 9 bits of data, field continues in 5th group

5th group:

3rd block (0214): first-group indicator = 0; second-group indicator = 0, group-sequence indicator = 0 (= last group), 7 more bits of data -> data = 11664 (”A52, AK Neersen”); label 10, 1 bit of 16, data continues in block 4

4th block (5888): 15 more bits of data -> data = 11332 (“A44, AK Strümp”); last single bit (= 0) is of no use

Using the German location database, the decoding arrives at the following message:

“A40; from Venlo in the direction of Duisburg,

road marking work. Slow traffic, do not allow unnecessary gaps.

Recommended diversion to Duisburg:

via A61 Mönchengladbach, A52 AK Neersen and A44 AK Strümp”

Example 3

1st group: D392 8404 F06C 272E

2nd group: D392 8404 61E4 715D

3rd group: D392 8404 1345 5086

4th group: D392 8404 0C61 30E0

1st group:

3rd block (F06C): first group indicator = 1; direction = 1, extent = 6, event = 108 (0 x 6C) [queuing traffic]

4th block (272E): location code = 7102 (in decimal notation) = “A1, exit Manderscheidt”

2nd group:

3rd block (61E4): first-group indicator = 0; second-group indicator = 1, group-sequence indicator = 2 (= two more follow = 4 group message), label 1, 3 bits of data, data = 7 (increase the number of steps in the extent by 16); label 2, one bit of 5: data continues in block 4

4th b lock (715D): 4 more bits of data -> data = 7 (= length of route affected = 7 km); label 1, data 2 (= default directionality changed), label 14; one bit of next label, field continues in 3rd group

3rd group:

3rd block (1345): first-group indicator = 0; second-group indicator = 0, group-sequence indicator = 1 (= one more follows), 3 more bits of label field -> label 9, 9 of 11 data bits, data continues in block 4

4th block (5086): 2 more bits of data -> data = 1301 (= “dense fog”); label 4, data = 4 (quantifier for event 1301: “visibility less than 40 m”); label 3, one bit of 5, data field continues in 4th group

4th group:

3rd block (0C61): first-group indicator = 0; second-group indicator = 0, group-sequence indicator = 0 (= last group), 4 more bits of data, data = 12 (“speed limit 60 km), label 6, 4 of 8 data bits -> data continues in block 4

4th block (30E0): 3 more bits of data -> = 19 (advice: “use fog lights”); label 0, data = 7 (duration: “The situation is expected to continue for the rest of the day”)

For the message presentation, it is necessary to add the two extents (6 + 16 = 22) to find the second location (A1, exit Illingen). Event code 130 is directional. This would cause the whole message to be directional although the fog affects both directions. The control code 2 changes this so the message becomes bi-directional.

With label 4 this first part is separated from the second to indicate that the rest of the message is to be taken as separate information for that location. Thus the duration that is expected to continue for the rest of the day is the fog, not the queuing traffic.

When presented in the car, this would look/sound like:

A1, Saarbrücken - Euskirchen

between junction Illingen and junction Manderscheidt;

in both directions queuing traffic for 7 km.

Dense fog, visibility reduced to 40 m,

speed limit 60 km

use fog lights,

the situation is expected to continue for the rest of the day.

6.7 COMPARISON OF MESSAGE STRUCTURES IN DIFFERENT LANGUAGES

As long as the MMI (man-machine-interface) is display oriented, the use of icons and colours ensures a language independent representation of the messages. However, as soon as text or speech is used, there are differences in how to present the messages. The difference is not only in the different languages used but also the structure of the message, i.e. the sequence in which the single message elements will be presented.

To illustrate this a standard traffic situation from the Netherlands is represented in several European languages. The structure used in the examples is chosen to simulate the current practise for giving spoken traffic information in the different languages

Table 6.1 gives the values for the elements of the location and events list used in this example. The first column gives the special notation to indicate the process used to arrive at the value (e.g.: “LocCode: RefLine: RoadNr”). This means “First use the location code to access the RefLine-field of the location database”. There a reference to another location code is found. This Location Code is used to look up the road number in the column “RoadNr”, which has the value shown in the second column. For simplicity, the characters A to F are used to represent the different message elements. This gives a better overview when comparing the message structure (syntax) in the different languages, which is shown in the Table 6.2.

Table 6.1: Values of Accessed Elements

Accessed elements location and event list	Value	Indicated by
LocCode: RefLine: RoadNr	A1	A
LocCode:RefLine:Name2	Rotterdam	B
LocCode:RefLine:Name1	Amsterdam	C
LocCode:Name1	The Hague	D
LocCode:Extent:OffsNeg:Name1	Schiphol	E
EventCode: EventText	Accident. Stationary traffic for 4 km.	F

In Table 6-2, the results for the different European languages are given. From this it can be seen that the same situation is described quite differently. Even within a single language there are different structure possibilities.

The third column uses the assigned characters to indicate the position of each message element. As an example, analysing the “access order of the elements” for the Spanish and German languages shows that “F” is accessed as the 4th element in Spanish and as the 6th element in German. Additionally, the “glue” words, used to combine segment elements, can also be different. In Spanish the words “from ... to” are used whereas in German the phrase is “in the direction”. On the other hand, the joining words for the name message elements “D” and “E” are the same “between ... and”.

It is therefore possible to conclude that the message presentation in different languages will differ in respect of:

- The sequence in which the message elements are presented.
- The frequency of use for single message elements (see Italian example).

- The glue words used to combine the message elements into a natural, spoken, sentence.

When programming a TMC-decoder these circumstances have to be kept in mind if easy switching between languages is to be possible.

Table 6.2: Comparison of Message Structure in Different Languages

Language	Spoken traffic information	Access order of the elements
Danish	Rute A1, fra Rotterdam til Amsterdam, mellem The Hague og Schiphol, stillstående trafik over 4 km på grund af uheld	Rute A, fra B til C, mellem D og E, F
Dutch	A1, Rotterdam Amsterdam, tussen Den Haag en Schiphol, 4 km Stilstaand verkeer als gevolg van een ongeval.	A, B C, tussen D en E, F
English	A1, Rotterdam Amsterdam, accident, stationary traffic for 4 km, between The Hague and Schiphol.	A, B C, F, between D and E
Finnish	A1, Rotterdam Amsterdam, välillä The Hague ja Schiphol, Onnettomuus, liikenne seisoo 4 km matkalla. *Alternative:* *Inflected, natural spoken traffic information:* A1, Rotterdamista Amsterdamiin, The Haguen ja Schipholin välillä, Onnettomuus, liikenne seisoo 4 km matkalla.	A, B C, välillä D ja E, F A, B’ C’, D ja E välillä, F
French	A1, Rotterdam Amsterdam, accident, circulation bloquée sur 4 km entre La Haye et Schiphol *Alternative:* *Inflected, natural spoken traffic information:* circulation bloquée sur 4km entre La Haye et Schiphol sur l’A1, Rotterdam Amsterdam, du fait d’un accident	A, B C, F, entre D et E
German	A1, Rotterdam in Richtung Amsterdam, zwischen den Haag und Schiphol, Unfall, 4 km Stau.	A, B in Richtung C, zwischen D und E, F
Italian	A1, Rotterdam Amsterdam, direzione Amsterdam, traffico bloccato per 4 km causa incidente tra The Hague e Schiphol	A, B C, direzione C, F tra D e E
Norwegian	Rute A1, fra Rotterdam til Amsterdam, mellan Haag og Schiphol, 4 km stillestående kø pågninn av trafikkuell	Rute A, fra B til C, mellan D og E, F

Language	Spoken traffic information	Access order of the elements
Spanish	A1, sentido Rotterdam Amsterdam, accidente, tráfico rojo en 4 km, entre la Haya y Schiphol.	A, sentido B C, F, entre D y E
Swedish	inflicted, natural spoken traffic information: A1, Rotterdam Amsterdam, mellan de Hague och Schiphol, 4 km stillastaende trafik, pa grund av en olycka	A, B C, mellan D och E, F

7 HOW TO PRESENT THE MESSAGES: MAN-MACHINE-INTERFACE-ASPECTS

7.1 GENERAL

There are two main aspects to a man-machine-interface (MMI):

1. Easy to understand operation of the device (manual input). For instance, access to the Traffic Information presentation shall be located in a top level menu (e.g.: direct access via a “TMC” or “Traffic Info” button).
2. Easy to evaluate traffic data presentation (visual / audio output). In order not to decrease safety by distracting the driver, the information shall be presented in a way that requires the driver to use the minimum amount of time to read/listen to the maximum amount of relevant information.

7.2 WHICH TYPES OF TMC DEVICES WILL BE AVAILABLE ?

7.2.1 Introduction

In principle there are at least two possible classification schemes for RDS/TMC receiver concepts:

- The first is based on the components used:
  1. Stand alone, single tuner RDS/TMC receiver;
  2. Stand alone, double- or multi-tuner RDS/TMC receiver;
  3. Combination of RDS/TMC receiver and navigation system;
  4. Navigation system with integrated RDS/TMC receiver;
  5. Home receiver and PC-based systems.
- The second is based on how the user interface is implemented:
  A. Text only message presentation;
  B. Speech only message presentation;
  C. Graphical message presentation (map display, by icon or colour);
  D. Other (or none) message presentation.

Each of the different components can be combined with one or more of the different user interfaces (although not all combinations will make sense). As a result, the matrix shown in Table 7.1 gives all possible, some useless, receiver concepts:

Table 7.1: Receiver Concept Matrix

		A Text	**B Speech**	**C Map**	**AB Text & Speech**	**AC Text & Map**	**BC Speech & Map**	**ABC Text Speech & Map**	**D Other**
1.	Single Tuner	(✓)		(✓)	✓				
2.	Double Tuner								
3.	Combi-System					✓			
4.	Integrated Solution			(✓)		✓			
5.	Home Receiver					✓			

The ✓ indicates devices that have been introduced into the market, (✓) means that the device has been announced or is available as a prototype.

The following sections concentrate on the in-car devices. For other concepts see the Location Coding Handbook (Ref. 6).

7.2.2 Stand-alone TMC Radios

The most affordable implementation of TMC comes as a stand-alone TMC Radio dedicated to the default language of one country with a TMC database chip card. This unit would provide the following features:

1) The received traffic messages can be played back as digitised voice messages in the chosen default language, or as a text list on a display.
2) In order to filter the relevant traffic messages the user has to program the required geographic area, selected from a predefined set, or program a set of required road numbers. The messages are then filtered for these selections only.

Ergonomic study reports are available indicating that the optimal basis for a text-only display of traffic messages is: 4 lines of at least 20 characters (Ref. 15). It also shows that the different types of information should always be presented in the same position, helping the user to quickly retrieve specific items (refer also to Para. 7.4.1).

```
12345678901234567890
12345678901234567890
12345678901234567890
12345678901234567890
```

7.2.3 Navigation system with connected TMC Radio

Where a navigation system with a colour screen is available, the information can be processed and presented to the user more efficiently:

1. As soon as a planned route is available, the system can automatically filter the relevant information.
2. The received traffic messages can be viewed as part of a map display. This can show the area around a car's position in a way that is easily understood by drivers who are used to reading paper maps. Features can include adjustment for scale. Additionally, the messages can be presented by synthesised speech or as a textual list on the display.
3. Geographic location filtering is no longer necessary. Additionally, an event class filter can be set to reduce the amount of information on the screen.

7.2.4 Navigation system with integrated TMC Radio / dedicated TMC Tuner

Imminent solutions will most likely provide complete integration of the TMC data reception and TMC station selection tasks. This will mean that the user no longer needs to operate TMC as a sub-functionality of an RDS Radio.

Therefore, the TMC MMI will be completely integrated into the navigation MMI.

7.3 MANUAL INPUT

7.3.1 Introduction

The main target for development of the current and future integrated systems, in the eyes of the users/drivers, shall be the reduction of manual interaction to a minimum.

7.3.2 TMC mode

As TMC is the digital alternative to the already well known TP/TA indication of spoken traffic information, and the fact that TMC is not yet available everywhere, the user will have to define the radio's behaviour. This will mean choosing between the priority of TA over TMC or the priority of TMC over TA. It is proposed to name the latter selection "TMC mode".

It may be discussed if it makes sense to mix both sets of information (spoken TA & TMC).

In order to keep the user informed about which operating mode is selected, a mode indicator has to be provided, e.g.

TMC

7.3.3 Finding a TMC station

If TMC mode is selected, the radio shall behave according to that preference. The user shall rely on the fact that the radio - after a search for a TMC station has been initiated - will find a TMC station, or return to the last tuned station and give an indication if no TMC station could be found.

An option is that the radio automatically starts searching for a TMC station if the last tuned station could not be identified as a TMC station when TMC mode was enabled.

7.4 VISUAL / AUDIO OUTPUT

7.4.1 Display of a stand-alone TMC Radio

The text display may contain per message:

- The road name;
- The direction;
- The names of the exits/junctions which define the affected part of the road;
- The type of the traffic event, with implicit or explicit quantified severity/length indication.

A45: Wetzlar Olpe
between Siegen-Süd
and Freudenberg
3km slow traffic

The recommended playback mode should be the audio output. The user should have the option to configure the rules for audio output; for example, select between automatic/manual playback:

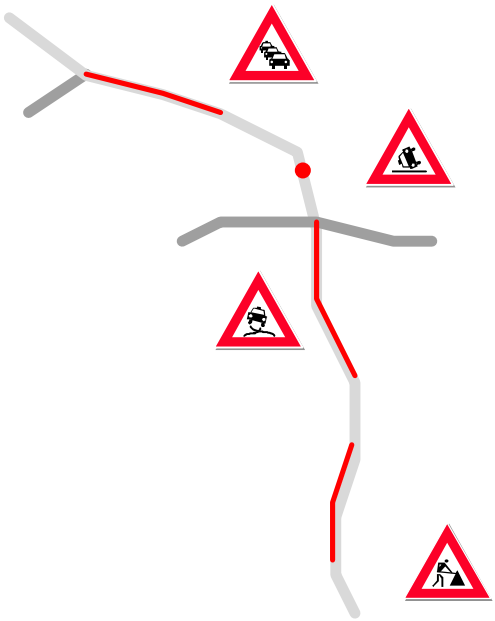
- Playback of all stored messages (only for manual playback);
- Playback of all new/updated messages;
- Playback of new/updated urgent messages only.

This event type filter can, of course, be coupled with the programmed location filter (see Para. 7.2.2)

The playback function shall be directly accessible via a special key or a top level menu entry.

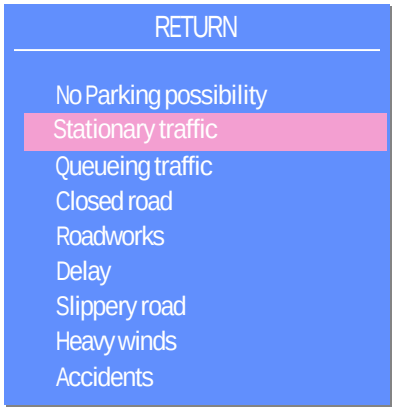
7.4.2 Display of a Navigation System

Text lists can also be implemented in navigation systems. This allows more comfortable browsing because of the, normally, larger screen size.



However, the big advantage is the map display, especially if it comes close to representing the standard paper maps most people are familiar with.

Also, users will have little difficulty understanding the situation if standard traffic signs are superimposed onto that digital map. The icons should conform to those used for VMS signs /Vienna Convention.



Additionally, the user shall be offered a preference selection in order to filtering the event type.

In a navigation system that offers a map display, the TMC information shall be available all the time (making it comparable to the direct-access in a radio). The driver should not, for example, be forced to select a special “TMC map”.

GLOSSARY

ACCEPT:

Alert Concerted Co-operation in European Pilots for RDS-TMC EU R&D project on RDS-TMC, DRIVE II.

ALERT:

Agreed Layer for the European RDS-TMC service
The common European denominator to the RDS-TMC service providing the pan – European service

Alert-C:

Message coding protocol and traffic event list

TMC Compendium:

Book of requirements describing the service and the way to perform it.

Alert Plus:

Message coding protocol for status orientated message, a parallel protocol to Alert-C, which includes Alert-C.

ATT-ALERT:

Advanced Transport Telematics - Advice and problem Location for European Road Traffic
EU R&D project on RDS-TMC, DRIVE II.

CEN Comité Européen de Normalisation

European standardisation body, with relevant Technical Committees and Working Groups. The relevant ones for the RDS-TMC topic are :

TC 224 : Machine Readable Cards, Related Device Interfaces and Options;
TC 226 on Road Equipment;
TC 278 on Road Transport and Traffic Telematics,
- WG4 on Traffic and Traveller Information
- WG7 on Geographic Road Database,
- WG10 on Man-Machine Interfaces,
- WG13 on Architecture and Terminology.

CENELEC:

Comité Européen de Normalisation ELECtrotechnique
European standardisation body

DATEX:

Protocol to exchange traffic information data between Traffic Information Centres

DEFI:

DEfinition of First step Implementation
ERTICO initiative for RDS-TMC implementation supported by EC DGVII.

DRIVE:

Dedicated Road Infrastructure for Vehicle safety in Europe
European Union R&D programme.

EBU:

European Broadcasting Union
Union of public broadcasters

ECM:

Explicit Cancellation Message
A TMC message containing an event that indicates that a formerly announced problem no longer exists. This message is for driver information, as opposed to the SCM which is used for message management.

EUROAD:

Concept developed in ACCEPT project.
Used to provide the traffic information in distant and foreign RDS-TMC service areas

FM:

Frequency Modulation

FORCE:

An enhanced Field trial for the large scale intrOduction of RDS/TMC infrastructure in Europe
EU R&D project on RDS-TMC, 4th Framework Programme.

MGM:

Multi-group Message
A TMC message consisting out of between 2 and 5 RDS groups

MoU:

Memorandum of Understanding
Agreement between the actors of the TMC Service to promote it and to comply with the TMC Compendium

RDS:

Radio Data System
System for the transmission of digital information for radio FM waves

RDS-ALERT:

Advice and problem Location for European Road Traffic
EU R&D project on RDS-TMC, DRIVE II.

SCM:

Silent Cancellation Message
A TMC message containing an event that indicates that a formerly announced problem no longer exists. This message is for message management only, as opposed to the ECM which is used for driver information.

SGI:

Second Group Indicator
Bit to mark the second group of a multi-group message

SGM:

Single Group Message
A TMC message consisting out of only one RDS group

SID:

Service ID

TERN:

Trans-European Road Network

TIC:

Traffic Information Centre

TMC:

Traffic Message Channel

UTC:

Universal Time Co-ordinated

ANNEX 1: EVENT LIST ATTRIBUTES

The Event list is a compilation of all traffic relevant situations, assigning an event code to each of them. Besides code and text representation, each event is also characterised by the following additional fields:

1. Update class

The event list is divided into update classes. An update class contains all those messages that would give contradicting information if given at the same time for the same location.

Example: “2 km traffic jam” and “6 km traffic jam” belong to the same update class, while “accident” and “roadwork” do not.

For several special messages, the strict application of this rule would lead to a lot of one-message update classes. Some messages are grouped into update classes based on the assumption that, while not direct contradictions, they will seldom be applicable at the same time.

The update classes are used for receiver message management. This means that only messages from the same update class will update (overwrite) each other (see Ref. 1 for details)

2. Nature

The nature of a message defines whether it is a normal message about an existing event, a forecast about something that will happen in the future or a special message used for message management. The general meanings of the nature codes are as follows:

(blank)	-	information;
F	-	forecast;
S	-	silent: no message shall be presented to the user.

3. Quantifiers

Several event descriptions may be more precise if they contain an additional value. Examples would be weight limits, temperatures, speeds. The quantifier attribute tells the system which sort of value can be added to the text description. A list of all currently defined quantifiers can be found in Annex 2. The column “Q” of the event list contains the optional quantifier field, this holds the reference numbers of

quantifiers listed in the event list. The position of the optional quantifier in the event text, plus, in some cases, other accompanying words, is shown by (...Q...) within the text.

Note:

In languages other than English this simple way of indicating the position is not useable. This is because the use of quantifiers results in adding and removing parts of other words, thus making the above mentioned bracket system useless. As a result, it is recommended that each transformation of the event list (including the English version) contains at least three text columns:

- One without quantifier;
- One with the quantifier as singular (“one accident”);
- One with the quantifier as plural (“Q accidents”).

It was also discussed whether to split up the column without a quantifier into two further columns, one with implied singular (“accident”) and one with implied plural (“accidents”). This proved not to be useful for the receiver as it has no way of deciding which formulation to use. A better solution is to choose the formulation in such a way that the most probable one will always be used.

4. Duration

The field “T” is the duration type. “D” indicates “dynamic” events of short duration and “L” indicates longer-lasting events. If this code is bracketed ( ), or if the time-of-day quantifier (no.7) is actually used in the message, no duration shall be presented to the user. In these cases, the duration indicates a persistence, used for message management only.

5. Direction

The field “D” is the default direction of the event. A “1” indicates that one direction and a “2” that both directions of traffic are normally affected by the event. TMC decoders can use this field to help determine which events to present to the driver and how.

6. Urgency

The field “U” is the default receiver urgency, with values “X” for extremely urgent, “U” for urgent, and blank for normal events (see Section 2.4).

7. Update class

The field “C” gives a numerical representation, indicating to which update class the event belongs. Only update classes 1 - 31 can be found in Part 2.1 of Ref. 2. Some update classes (classes 32-39 in the present list), which are exclusively for events with nature “F” and duration type “L” or (L), can be found in Part 2.3 of Ref. 2. They contain no events of another type (except S).

8. Phrase code

The field “R” gives phrase codes (references) for use by TMC operators. An event may be a single phrase event, or a combination of two or more phrases. Each phrase is allocated a phrase code consisting of at least a single code letter (A - Z) and a code number (1 - 999). Single phrase events are indicated by a single code letter and a code number of one or two digits (e.g. A1 - A99). Expected events are indicated by the normal phrase code followed by “E” (e.g. A1E). Dangerous events are indicated by the phrase code followed by “D” (e.g. G6D). Events with quantifiers can have three digits (e.g. A101). Longer lasting forecasts are indicated by the letter F.

The Event List also contains several predefined combinations of single phrase events to make better use of the available channel capacity. These combined events are indicated by the combined codes of the constituent phrases (e.g. B11.C1). Note: the phrases used in combined events are not always word for word identical to the corresponding phrases used in the single events. Binding words or small changes to the wording are necessary.

The code letters are not related to the update classes, but have the following meaning:

- Level of Service
- Incidents/Accidents
- Closures
- Lane Restrictions
- Roadworks
- Obstruction Hazards
- Road Conditions
- Weather

- Winds
- Environment
- Temperature
- Activities
- Delays/Cancellations
- Dangerous Vehicles
- Exceptional Loads
- Traffic Equipment Status
- Traffic Regulations
- Parking
- Information

The code letter Z is used to indicate phrases from the List of Supplementary Information (see Part 2.2 of Ref. 2).

The phrase codes are not normative, but are only given as additional information about the contents of a given event and should be helpful when implementing software.

ANNEX 2: QUANTIFIERS

In Ref. 2 the following quantifiers are defined:

No	Meaning	Range	Examples
0	n (small number)	(n = 1, 2,... ,28; 30, 32, ...36);	1 00001, 2 00010
1	N (number)	(N = 1, 2, 3, 4;	1 00001, 2 00010
		10, 20 ,... 100;	10 00101, 20 00110
		150, 200,... 1000)	150 01111, 200 10000
2	less than V metres	(V = 10, 20,... 300)	10 00001, 20 00010
3	P percent	(P = 0, 5,... 100)	0 00001, 5 00010
4	of up to S km/h	(S = 5, 10,... 160)	5 00001, 10 00010
5	of up to M minutes	(M = 5, 10,... 50;	5 00001, 10 00010
	(H hours)	H = 1, 2,... 12;	1 01011, 2 01100
		18, 24,... 72)	18 10111, 24 11000
6	T degrees Celsius	(T = -50, -49,... +50)	-50 0000 0001, -49 0000 0010
7	H time	(H = 00.00, 00.10,... 23.50)	00.00 0000 0001, 00.10 0000 0010
8	W tonnes	(W = 0.1, 0.2,... 10.0;	0.1 0000 0001, 0.2 0000 0010
		10.5, 11.0,... 60.0)	10.5 0110 0101, 11.0 0110 0110
9	L metres	(L = 0.1, 0.2,... 10.0;	0.1 0000 0001, 0.2 0000 0010
		10.5, 11.0,... 80.0)	10.5 0110 0101, 11.0 0110 0110
10	of up to D millimetres	(D = 1, 2,... 255)	1 0000 0001, 2 0000 0010
11	M MHz	(as defined in EN 50067 and the RDBS-Standard)	87.6 0000 0001, 87.7 0000 0010
12	k kHz	(as defined in EN 50067 and the RDBS-Standard)	ITU Regions 1,3 (Region 2) 0000 0001 153 (reserved) 0000 0010 162 (reserved) 0001 0000 531 (531) 0001 0001 540 (541)

Note 1:

The number of different quantifiers is limited only by the number of available events. This is because they are not directly transmitted but are part of the event

list (which is stored in the receiver). As a result, new events may also lead to the introduction of new quantifiers.

Note 2:

The label 2 (length of route affected) and 3 (speed limit) may be seen as special quantifiers because they can be attached to any situation, independent of the event. This can sometimes result in senseless combinations (e.g.: temperature and length of route effected). On the coding side, care has to be taken to avoid these combinations.

The following table gives a translation of the 5 bit codes following label 2, 3 or 4. Label 5 is used to transfer 8 bit quantifiers, which could not be included in this small table.

Binary Value	**Label 2**	**Label 3**	**Label 4 Quantifier 0**	**Label 4 Quantifier 1**	**Label 4 Quantifier 2**	**Label 4 Quantifier 3**	**Label 4 Quantifier 4**	**Label 4 Quantifier 5**
	Affected length	Speed limit	Small number	Numbers	Visibility	Probability	Speed	Time period
1	1 km	5 km	1	1	10 m	5 %	5 km	5 min
2	2 km	10 km	2	2	20 m	10 %	10 km	10 min
3	3 km	15 km	3	3	30 m	15 %	15 km	15 min
4	4 km	20 km	4	4	40 m	20 %	20 km	20 min
5	5 km	25 km	5	10	50 m	25 %	25 km	25 min
6	6 km	30 km	6	20	60 m	30 %	30 km	30 min
7	7 km	35 km	7	30	70 m	35 %	35 km	35 min
8	8 km	40 km	8	40	80 m	40 %	40 km	40 min
9	9 km	45 km	9	50	90 m	45 %	45 km	45 min
10	10 km	50 km	10	60	100 m	50 %	50 km	50 min
11	12 km	55 km	11	70	110 m	55 %	55 km	1 hours
12	14 km	60 km	12	80	120 m	60 %	60 km	2 hours
13	16 km	65 km	13	90	130 m	65 %	65 km	3 hours
14	18 km	70 km	14	100	140 m	70 %	70 km	4 hours
15	20 km	75 km	15	150	150 m	75 %	75 km	5 hours
16	25 km	80 km	16	200	160 m	80 %	80 km	6 hours
17	30 km	85 km	17	250	170 m	85 %	85 km	7 hours
18	35 km	90 km	18	300	180 m	90 %	90 km	8 hours
19	40 km	95 km	19	350	190 m	95 %	95 km	9 hours
20	45 km	100 km	20	400	200 m	100 %	100 km	10 hours

Binary Value	**Label 2**	**Label 3**	**Label 4 Quantifier 0**	**Label 4 Quantifier 1**	**Label 4 Quantifier 2**	**Label 4 Quantifier 3**	**Label 4 Quantifier 4**	**Label 4 Quantifier 5**
	Affected length	Speed limit	Small number	Numbers	Visibility	Probability	Speed	Time period
21	50 km	105 km	21	450	210 m	-	105 km	11 hours
22	55 km	110 km	22	500	220 m	-	110 km	12 hours
23	60 km	115 km	23	550	230 m	-	115 km	18 hours
24	65 km	120 km	24	600	240 m	-	120 km	24 hours
25	70 km	125 km	25	650	250 m	-	125 km	30 hours
26	75 km	130 km	26	700	260 m	-	130 km	36 hours
27	80 km	-	27	750	270 m	-	135 km	42 hours
28	85 km	-	28	800	280 m	-	140 km	48 hours
29	90 km	-	30	850	290 m	-	145 km	54 hours
30	95 km	-	32	900	300 m	-	150 km	60 hours
31	100 km	-	34	950	-	-	155 km	66 hours
0 (=32)	> 100 km	-	36	1000	-	0%	160 km	72 hours

Note 1:

The first value above is indicated in the quantifier by binary “1”, the second by “10”, etc. Where all possible values have been utilised, the highest is indicated by binary “0”.

Note 2:

As the values are not transmitted but form part of the receiver, the above values may be translated into other languages or even to another measuring system (e.g. length in miles).

ANNEX 3: LOCATION TYPES

The following table details the location type codes:

Code	Name	Comments
A1	Continent	If a location type has no subtypes, the type itself is assumed as subtype 0. So the
A2	Country group	Type Continent A1 has the subtype Continent with A1.0
A3	Country	
A4	(reserved for future use)	has been “Administrative Area”
A5	Water area	
A5.1	sea	If subtypes exist, it is recommended to not use the type itself (In this case, do not
A5.2	lake	use water area (A5.0) but choose between sea and lake).
A6	Fuzzy area	
A6.1	Tourist area	
A6.2	Metropolitan area	
A6.3	Industrial area	
A6.4	Traffic area	
A7	Order 1 area	
A8	Order 2 area	
A9	Order 3 area	
A10	Order 4 area	
A11	Order 5 area	
A12	Application Region	
L1	Road	
L1.1	Motorway	
L1.2	1st Class Road	The actual definition of 1st, 2nd, and 3rd Class roads is normally based on existing classifications within each country, and therefore differ from country to country. Authorities in each country are responsible for defining these levels.
L1.3	2nd Class Road	
L1.4	3rd Class Road	
L2	Ring-road	
L2.1	ring motorway	
L2.2	other ring-road	

Code	Name	Comments
L3	Order 1 segment	
L4	Order 2 segment	
L5	Urban street	
L6	Vehicular link	
L6.1	ferry	
L6.2	vehicular rail link	
P1	Junction	
P1.1	motorway intersection	
P1.2	motorway triangle	
P1.3	motorway junction	
P1.4	motorway exit	
P1.5	motorway entrance	
P1.6	flyover	
P1.7	underpass	
P1.8	roundabout	
P1.9	giratory	
P1.10	traffic lights	
P1.11	cross-roads	
P1.12	T-junction	
P2	Intermediate point	
P2.1	Distance marker	
P2.2	Traffic monitoring station	
P3	Other landmark point	
P3.1	tunnel	
P3.2	bridge	
P3.3	service area	
P3.4	rest area	
P3.5	view point	
P3.6	carpool point	
P3.7	park and ride site	
P3.8	car park	

Code	Name	Comments
P3.9	kiosk	
P3.10	kiosk with WC	
P3.11	petrol station	
P3.12	petrol station with kiosk	
P3.13	motel	
P3.14	border/frontier	
P3.15	customs post	
P3.16	toll plaza	
P3.17	ferry terminal	
P3.18	harbour	
P3.19	square	
P3.20	fair	
P3.21	garage	
P3.22	underground garage	
P3.23	retail park	
P3.24	theme park	
P3.25	tourist attraction	
P3.26	university	
P3.27	airport	
P3.28	station	
P3.29	hospital	
P3.30	church	
P3.31	stadium	
P3.32	palace	
P3.33	castle	
P3.34	town hall	
P3.35	exhibition/convention centre	
P3.36	communities	

Additional subtypes may be introduced in future; several countries have already found a need for the following subtypes:

- Industrial site
- Dam (road crossing or following on top of a dam)
- Dike (road crossing or following on top of a dike)
- Aqueduct (road running on top of an water transport bridge?)
- Ford (river crossing)
- Pass (high altitude mountain crossing)

More types will probably be defined in the future.

ANNEX 4: LOCATION TABLE ATTRIBUTES

The following gives an overview of which attributes exist for each of the location types defined in Ref. 3.

Cat	subtype description	code	road no.	road name	first name	second name	area ref.	linear ref.	negative offset ref.	positive offset ref.	urban	exit/junction no.	inter-section code
Area	Continent	A1.0	-	-	M	-	-	-	-	-	-		-
	Country group	A2.0	-	-	M	-	M	-	-	-	-		-
	Country	A3.0	-	-	M	-	m	-	-	-	-		-
	Other area (water area, fuzzy area, appl. region)	A5.1, 5.2, A6.1 - 6.4 A12.0	-	-	M	-	m	-	-	-	-		-
	nth order area (n= 1 to 5)	A7.0 - A11.0	-	-	M	-	m	-	-	-	-		-
Linear	Road	L1.1 - 1.4	m	m	m	m	M	-	-	-	-		-
	Ring road	L2.1, 2.2	m	m	O	-	M	-	-	-	-		-
	nth order segment (n=1,2)	L3.0 L4.0	m	m	M	M	-	M	m	m	-		-
	Urban street	L5.0	-	M	O	-	M	-	-	-	-		-
	Vehicular link	L6.1, L6.2	-	m	M	M	O	-	-	-	-		-
Point	Junction	P1.1 - P1.12		O	m	O	M	M	m	m	M	m	m
	Intermediate point	P2.1, P2.2		-	m	-	M	M	m	m	M	M	-
	Other landmark point[1]	P3.1 - P3.37	-	-	M	-	M	M	m	m	M		O

Explanations: M: Mandatory O: optional m: mandatory where it exists

Additional attributes, like co-ordinates or diversion numbers, may become mandatory in the future. This table in Annex 4 is intended for information and illustration purposes only. For more detailed information and for use as a reference consult Ref. 3.

Location tables have to be compiled for each country and then distributed to the different actors of the TMC Service. To make this possible without introducing to many problems, the data and format to be exchanged has been defined in Ref. 7.

ANNEX 5: FORMAT AND CONTENT OF RDS-TMC GROUPS

The table on the next page tries to give a bit-representation of all the possible RDS-groups involved in RDS-TMC messages. Not given here are groups 1A and 4A, which are already described in detail in Ref. 8. Not all of the elements mentioned in this table are described in this document, consult Ref. 1 for further information on these.

Message Type	X4	X3	X2	X1	X0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	Z8	Z7	Z6	Z5	Z4	Z3	Z2	Z1	Z0
Traffic info messages, Single Group User	S 0	G 1	DP			D	Dir	Ext			Eve											Loc															
MSM: First Group	S 0	G 0	CI			F 1	Dir	Ext			Eve											Loc															
MSM: Second Group	S 0	G 0	CI			F 0	SGI 1	GSI (N-		Fre																											
MSM: Subsequent Group	S 0	G 0	CI			F 0	SGI 0	GSI (N-		Fre																											
EUROAD: First Group	S 0	G 0	CI			F 1	Dir	Ext			Eve											EUR 1	1	1	1	1	1	Cou				Dat					
EUROAD: Second Group	S 0	G 0	CI			F 0	SGI 1	GSI (N-		Loc																DP			Fre								
EUROAD: Subsequent	S 0	G 0	CI			F 0	SGI 0	GSI (N-		Fre																											
System messages, group Tuning-Information 1	S 1	0	1	0	0	Ch								Ch								Ch								Ch						
Tuning-Information 2	S 1	0	1	0	1	Ch								Ch								Ch								Ch						
Tuning-Information 3	S 1	0	1	1	0	AF(								AF(								PI-														
Tuning-Information 4	S 1	0	1	1	1	Tun								Map								PI-														
Tuning-Information 5	S 1	1	0	0	0	PI-																PI-														
Tuning-Information 6	S 1	1	0	0	1	LTN						MGS				SID						PI-														
Not used anymore, (was systeminfo)	S 0	G 0	DP 0	0	0	(r																														
System information, Variant 0 (mandatory)	Gro 1	0	0	0	0	Var 0	0	(re		Loc						AFI	M	I	N	R	U	App 1	1	0	0	1	1	0	1	0	1	0	0	0	1	1	0
Variant 1 (optional)	Gro 1	0	0	0	0	Var 0	1	Gap- value		Service Identifier						Ta		Tw		Td		App 1	1	0	0	1	1	0	1	0	1	0	0	0	1	1	0

Abbreviations:

S = Tuning Information
G = Single Group User
DP =
LTN = Locationcode
ON = Other Network

F =
CI
SGI
GSI
MGS
TN

T =
FLT
D =
Dir
SID
PI