

System for transmitting a packetized message, transmitter and receiver for use in such a system, and methods of transmitting and receiving a packetized message.

The invention relates to a system for transmitting a message divided into packets from a transmitter to at least one receiver, which system comprises:

- a transmitter for transmitting the packets,
- at least one receiver for:
 - 5 - receiving the transmitted packets,
 - composing the message from the received packets,
 - processing the composed message.

The invention also relates to a transmitter and a receiver for use in such a system, and methods of transmitting and receiving a packetized message.

10 Such a system is known from the Alert-C Traffic Message Coding Protocol, Proposed Pre-Standard, November 1990. This Protocol describes a system for the transmission of a message, which message covers more than a single RDS group and is also referred to as a multi-group message. During information transmission *via* this system and, in general, during information transmission *via* an imperfect channel, errors may occur in the
15 reception of transmitted messages. If the information transmission has been organized in groups of data (for example bits) and one message covers a plurality of groups (*i.e.* multi-group messages), as in the afore-mentioned system, it is very likely that such a message is received with an error. A solution for this is to transmit the message repeatedly, *i.e.* so often that the probability of the complete message being received correctly is sufficiently high (for
20 example, a probability of over 95 % that the message will be received correctly). In the known system a message is regarded as being received correctly if the message has been received two times with bit-by-bit identity. In all other cases in which only a part of the message has been received without any errors, this part is no longer used but the message should again be received two times with bit-by-bit identity. If the risk of an error in the
25 message is fairly high many repetitions will be required for a reliable reception. On the one hand, this limits the usable length of a message (too long a message has too great a risk of being received incorrectly) and, on the other hand, it limits the information capacity of the channel because a substantial part of the information capacity is used for the repeated transmission of the same message.

It is an object of the invention to provide a system for the transmission of multi-group messages, which messages can be received with an increased reliability.

To this end a system in accordance with the invention is characterized in
5 that each of the packets includes an identifier for identifying a packet as part of the message. By assigning an identifier to each group of a message groups having the same identifier can be identified as parts of the same message. This is because it enables the groups belonging to a particular multi-group message to be accumulated in a suitable receiver during the repeated
10 transmissions of the message without the need for an error-free reception of the complete message in one time. As a matter of fact, the risk that all the groups in a message are received incorrectly is much smaller than that a single group is received incorrectly. As a result, it is possible that even though the message cannot be received completely in one time the message can be reconstructed wholly from parts of the message accumulated over a plurality of transmissions of the message. In addition, it is now possible to allow longer
15 multi-group messages without the risk of an incorrectly received message becoming unacceptably high.

An embodiment of a system in accordance with the invention is characterized in that each of the packets includes a further identifier, which differs for each packet, for identifying the different packets belonging to the message.
20 This has the advantage that it is simple to distinguish between the different groups belonging to the same message. This simplifies the accumulation of the groups because it is now possible to determine more rapidly and more simply whether the group just received has already or has not yet been received. In principle, it is also possible to make a distinction between the different groups through a bit-by-bit comparison. However, this requires more
25 work than the comparison of a further identifier, as proposed in the measure in accordance with the invention.

An embodiment of a system in accordance with the invention is characterized in that the message is a multi-group message with Group Type Code 8A. The system in accordance with the invention is very suitable for use in the Radio Data
30 System, where such a problem occurs particularly with the multi-group messages of the Traffic Message Channel (TMC) with Group Type Code 8A.

Yet another embodiment of the system in accordance with the invention is characterized in that the identifier comprises a Location code and Extent code included in the message.

In a TMC message the combination of Location code and Extent code is unique for each message. Using this unique part of the message as an identifier and repeating this part in each group of the message yields an identifier by means of which groups having the same Location and Extent codes can be identified as parts of the same message.

5 The invention will now be described in more detail with reference to the accompanying drawings. In the drawings:

Figure 1 gives an example of an RDS TMC message,

Figure 2 is a block diagram of a receiver in accordance with the invention,

10 Figure 3 is a flow chart of the processing of a multi-group message in accordance with the present state of the art,

Figure 4 is a flow chart of the processing of a multi-group message in accordance with the invention.

In these Figures like elements bear the same reference symbols.

15 Figure 1 shows an example of an RDS TMC message. The invention is particularly suitable for use in the RDS system. In the RDS system a message comprises four blocks A, B, C and D (see Figure 1). This is called a group. Since these blocks have a given length and it is nevertheless required to transmit longer messages, it is possible to transmit messages which cover a plurality of groups and which are referred to as multi-group
20 messages. In addition to the above-mentioned group there are also RDS groups which define a category of messages. For example, the RDS group 8A has been reserved for the Traffic Message Channel, in which messages relating to, for example, current traffic situations can be transmitted in coded form.

25 This RDS group 8A also provides a possibility of transmitting multi-group messages. In, for example, Block B a bit G (=B3) has been reserved for this purpose, which is a single group standard message identifier (see Figure 1). If this bit is 0, this means that the message covers a plurality of groups. For a complete reception of the messages all the groups forming part of the message should successively be received correctly by the receiver. To increase the reliability of the reception of a message each individual group is repeated a
30 number of times. For example: if the message comprises the groups a[1], a[2], ..., a[n], the following will be transmitted: a[1], a[1], a[1], a[2], a[2], a[2], ..., a[n], a[n], a[n]. In accordance with the present standard the message should be accepted only if each group has been correctly received 2 times in a single transmission, which means that the bits of the groups correspond 2 times. In any other case, in which only a part of the message has been

received correctly, it is not allowed to use the correctly received part. As soon as an error occurs in one of the groups the whole message should be received again right from the beginning. Despite the repeated transmission this method of transmitting multi-group messages is very susceptible to errors and in practice this susceptibility to errors limits the length of multi-group messages, because the message should not be too long for an acceptable error probability.

In the revised version, in accordance with the invention, of a TMC message in RDS group 8A each group of a particular multi-group message includes a similar unique part or identifier, by means of which it is possible to recognize that a particular group forms part of this particular message. This makes it possible to accumulate the complete message during a number of repetitions of the whole message, without the need to correctly receive all the groups consecutively and contiguously. Moreover, each group may include an additional code, for example a sequence number, by means of which a distinction can be made between the different groups in the message.

The invention utilises the recognition of the fact that certain elements in the message are unique for a message and that by repeating these elements in all the groups of the message a simple identification of groups belonging to a message is possible. In the case of an RDS TMC message in accordance with the Alert-C protocol the combination of Location code and Extent code can be used for this unique part. If the coding is extended to include EUROAD messages, a data base reference is added to the unique part in the latter case.

In a TMC group, as shown in Figure 1, bits B0..B4, C0..C15 and D0..D16 are available as data bits. In a revised version of RDS Group Type 8A in accordance with the invention the bits B4 and B3 could now be used as follows to specify different types of messages:

Table 1. Designation of bits B4 and B3 of block B in RDS group 8A.

B4	B3	Designation
0	0	Single group
0	1	Multi-group
1	0	New services
1	1	EUROAD

The new services could be presented, for example, in accordance with the Alert-Plus protocol. The single-group message, the multi-group message and EUROAD may be composed in accordance with the Alert-C protocol. This means *inter alia* that the single-group message can remain unchanged.

- 5 Block D in the multi-group message and the EUROAD message contains the Location code in all the groups, except for the multi-group message whose address code (=B2..B0) is 111, after which blocks C and D are used for a Service Label. The Multi-group message (B4=0 and B3=1) comprises 3 Multi-groups, which Multi-groups may consist of maximum 5 groups with the proposed coding. By the choice of another coding it is, of course, possible to select another maximum number of groups per Multi-group. In the first Multi-groups 1, 2 and 3 of the multi-group message block C includes the Diversion, Extent and Event codes as defined in the Alert-C protocol. The first group of Multi-groups 1, 2 and 3 can be indicated by the following address code (= bits B2..B0):

15	B2	B1	B0	
	1	1	0	= Multi-group 3
	1	0	1	= Multi-group 2
	1	0	0	= Multi-group 1

- 20 The second group of the Multi-groups 1, 2 and 3 can be indicated with the address code (= B2..B0) 011. In this case the group C comprises the following bits:
- a first free bit,
 - the Extent code (4 bits),
 - a sequence number n (2 bits), which refers to the Multi-group:
- 25 n=1 refers to the address code 100 (= Multi-group 1),
 n=2 refers to the address code 101 (= Multi-group 2),
 n=3 refers to the address code 110 (= Multi-group 3).
- a message-length indicator l (3 bits), which indicates how many groups will follow yet:
- 30 l=3 (maximum): 8A groups with address codes 010, 001 and 000 will follow,
 l=2: 8A groups with address codes 001 and 000 will follow,
 l=1: an 8A group with address code 000 will follow.

The free first bit could be used as follows:

Bit=0 is followed by a label and data in remaining free bits of group C,

Bit=1 is followed by the Duration (as known from the Alert-C protocol) in the remaining free bits.

In Multi-groups 1, 2 and 3 block C includes the Diversion code (1 bit), the Extent code (4 bits) and the Event code (11 bits), as defined in the Alert-C protocol. This coding thus allows three different Events to be transmitted for one location. This could be extended to 4, for example by including the service label in the new services (with B4=1 and B3=0) or by limiting the multi-group message to 4 subgroups instead of the present 5 subgroups.

The remaining 50 bits, with bits B2..B0 in the form of 011, 010, 001 and 000 as address codes, are available for the transmission of additional TMC information.

In the EUROAD message (B4=1 and B3=1) bits B2..B0 are used as a reference number for a data base, enabling the same Location codes to be used in for example several countries or regions by the use of different data-base reference numbers for different countries or regions. The first bit in block C may indicate the kind of information in block C. For example, if the first bit is 0 this bit will be followed by the Extent and the Event codes (4 and 11 bits, respectively), as known from the Alert-C protocol. If this bit is 1 the Extent code will also follow but the 11 bits normally used for the Event code can be used freely. Thus, with such a EUROAD message a TMC message is obtained, which can also be used beyond national or regional boundaries without the collected information being invalidated.

In the case that B4=1 and B3=0, there will be 33 free bits left for future services such as Alert-Plus, which may be regarded as an extension to Alert-C, by means of which further useful information can be transmitted.

For information about the Location, Extent, Event and Diversion codes reference is made to the Alert-C protocol for TMC messages: Alert-C Traffic Message Coding Protocol, Proposed Pre-Standard, November 1990 and to the Applicant's European Patent Application bearing the Application number 94203691.4.

Figure 2 shows a block diagram of a receiver in accordance with the invention. The receiver comprises a receiving section 1 for receiving an FM-modulated carrier wave, by means of which RDS information is transmitted by modulation on a 57 kHz carrier wave. This RDS information is demodulated in an RDS demodulator 2, after which the data contained in the RDS information is decoded in a decoder 3 and is processed as indicated in Figure 3. The complete TMC message is subsequently transferred to a user interface 6 for acoustic or visual reproduction, for example as described in the Applicant's

earlier European Patent Application bearing the Application number 94203691.4. If desired, the message may also be processed further by a controller 4. This controller is further used for controlling the receiving section 1. It is obviously that, for example, the TMC decoder 3 may form part of an algorithm of the controller 4, so that a separate TMC decoder can be
5 dispensed with. If desired, a 2-tuner receiver design can be used, where for example a first tuner is used for reproducing the current program and the second tuner is used specifically for receiving RDS information by tuning to a carrier wave modulated with RDS information. The receiver in accordance with the invention stores the correct (error-free) groups of the message and upon reception of each subsequent group effects a comparison to ascertain
10 whether the unique part is identical to that of the groups already stored (to determine whether the group forms part of the message). If it is not identical, the group is not further processed to complete the message. If it is identical, it is examined whether the group corresponds to a previously received group of the message. This comparison can be effected by comparing the complete message or by merely comparing the additional code, if present. If the comparison
15 is positive (the group corresponds to a previously received group), the group is not processed any further. If the comparison is negative, the group is stored as part of the message. When the message is complete the message can be further processed for reproduction etc. If desired, the individual groups already stored may be further processed should the information in the individual groups allow this.

20 Thus, an advantage of the invention resides in the fact that the reliability of the reception of a complete multi-group message is increased by enabling the individual groups to be accumulated, from which subsequently the complete message can be reconstructed. Since the reliability of the reception of a single group is substantially higher than the reliability of the reception of a complete multi-group message, the complete message
25 can be received more rapidly at the receiver end, despite the fact that the received groups exhibit errors. Thus, it is yet possible to achieve a reliable reception of the message with less repetitions of the complete message. If desired, each group may also be provided with an additional code, for example a sequence number, at the transmitter end in order to simplify identification of the different groups within a multi-group message. However, this is not
30 essential because, in principle, the entire group may be compared with previously received groups. Thus, it is also possible to identify the various groups on the basis of this comparison. Some advantages of the invention, the higher reliability and the more rapid reception of a message with less repetitions, are obtained in that if now an error occurs in a

particular group the entire message need not be rejected but only this group should be received again to complete the message.

Figure 3 is a flow chart of the processing of a multi-group message in accordance with the present state of the art.

- 5 In Block I new (received) RDS TMC data is read in. In Block II it is examined whether or not this is a following TMC message on the basis of a Continuity Index, which has then been incremented by 1 in comparison with the preceding message. If this is the case (option Y), it is checked in block III whether the message is complete. If it is not complete (option N in Block III), the incomplete message is discarded in Block IV. If it is complete (option Y in
- 10 Block III) the entire message is accepted for further processing (Block V for reproduction etc.). In Block VI the received TMC data is temporarily stored in a memory. Subsequently, it is ascertained in block VII whether the message is complete. Complete is to be understood to mean that all the groups $a[1]..a[n]$ have been received correctly two times with the same Continuity Index, *i.e.* in the same TMC message.
- 15 From this flow chart it follows that the message must have been received correctly at once in a single transmission in order to be processed further. If this is not the case, the entire message, including the correctly received part of the message, is deleted.

Figure 4 shows a flow chart of the processing of a multi-group message in accordance with the invention. This flow chart can be implemented in the receiver shown in

20 Figure 2.

- In Block VIII the new RDS TMC data is read in. In Block IX it is examined whether it concerns a following message. This is indicated by another Location code. If it is a following message (option Y in Block IX), it is examined in Block X whether the preceding message is complete. If it is complete (option Y in Block X), the message is ready for further processing
- 25 (Block XI). If in Block IX the message appears not to be a following message (option N in block IX) the received data is temporarily stored in a memory. In Block XIII it is subsequently examined whether a group $a[i]$ has been received correctly, for example in that the same group has been received twice in succession without any differences. In the case of a correct reception the group $a[i]$ is stored in a further memory in Block XIV. Subsequently,
- 30 it is ascertained in Block XV if all the groups of the message have been received. If this is the case (option Y in Block XV), the message is declared to be complete. If not (option N in Block XV), the accumulation of the groups continues until a following TMC message is received. Thus, it may happen that a message is not complete. However, the risk of this is substantially smaller than in the method of Figure 3 because now correctly received groups

of a message are no longer discarded if another group of the message has been received incorrectly. This accumulation of groups belonging to the same message results in a higher reliability of reception of the message, so that for example the length of the message may be increased with the same error probability, or less repetitions of the message or parts thereof are required. Moreover, it is also possible to combine processing steps, for example those of Blocks X, XI and XVI.

The invention is not limited to the examples given herein. For example, the system is not limited to RDS but is suitable for any system in which packetized messages are transmitted. Obviously, it is also possible to define an identifier which does not comprise the Location and the Extent code.

CLAIMS:

1. A system for transmitting a message divided into packets from a transmitter to at least one receiver, which system comprises:
 - a transmitter for transmitting the packets,
 - at least one receiver for:
 - 5 - receiving the transmitted packets,
 - composing the message from the received packets,
 - processing the composed message,characterized in that each of the packets includes an identifier for identifying a packet as part of the message.
- 10 2. A system as claimed in Claim 1, characterized in that each of the packets includes a further identifier, which differs for each packet, for identifying the different packets belonging to the message.
3. A system as claimed in Claim 1 or 2, characterized in that the system is the Radio Data System and in that the packet comprises an RDS group.
- 15 4. A system as claimed in Claim 3, characterized in that the message is a multi-group message with Group Type Code 8A.
5. A system as claimed in Claim 4, characterized in that the identifier comprises a Location code and Extent code included in the message.
6. A transmitter for transmitting a message in the form of packets, which
20 transmitter comprises:
 - means for dividing a message into packets,
 - means for assigning a similar identifier to each of the packets in order to identify the packets as parts of the message,
 - means for transmitting the packets.
- 25 7. A receiver for receiving a message divided into packets, which receiver comprises:
 - means for receiving packets,
 - means for composing the message from received packets having the same identifier,
 - means for processing the composed message.



8. A method of transmitting a message divided into packets from a transmitter to at least one receiver, which method comprises:

- dividing a message into packets,
- assigning an identifier to each of the packets in order to identify the packets as parts of the message,

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- transmitting the packets,
- receiving the transmitted packets,
- composing the message from received packets having the same identifier,
- processing the composed message.

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9. A method of transmitting a message divided into packets, which method comprises:

- dividing a message into packets,
- assigning an identifier to each of the packets in order to identify the packets as parts of the message,

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- transmitting the packets.

10. A method of receiving a message divided into packets, which method comprises:

- receiving the transmitted packets,
- composing the message from received packets having the same identifier,

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- processing the composed message.

