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(57) Abstract

To transfer a multimedia programme in a DAB system, an audio stream is divided into successive segments of variable length, which are marked by means of individual stream marker IDs placed at segment boundaries. The boundaries between segments indicate a change in the multimedia presentation. A scene in the multimedia programme, which, when active, is what the user sees on the display of the receiver, contains links that are waiting to be activated. When a marker associated with one of the links and acting as an excitation is decoded from the audio stream, it activates the link concerned. As a result, either the scene is displayed or the link causes a transition to another scene, which is displayed on the screen. The transition is invisible to the user, so the user perceives the presentation as starting with the right scene.

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Multimedia Reception in a Digital Broadcasting System

The present invention relates to the transfer of a multimedia programme and in particular to the mechanisms used to initiate such transfer in a receiver in a digital broadcasting system.

In the Digital Audio Broadcasting (DAB) system, which has been developed to allow an efficient utilization of frequency bands, the transmission path is completely digital. The system is designed to replace the analogue broadcasting system commonly used at present, which is based on the use of frequency modulation. DAB defines a digital radio channel based on multiple carriers which is applicable for the transmission of both audio and data services. In a completely digital transmission channel, it is possible to transmit a continuous data or audio stream, or the channel may be a packet channel. Packet transmission is more flexible and permits easier transmission of data units of a limited length. The DAB system is defined in ETSI (European Telecommunication Standards Institute) standard 300 401, February, 1995.

From the user's point of view, the highest level of abstraction in the DAB system is called ensemble, Fig. 1. It contains all the services that are available to the user in a given frequency band. A change from one ensemble to another in the receiver is effected by tuning into a different frequency band, just as one changes channels in current FM radio reception. The ensemble is divided into services, exemplified in Fig. 1 by Alpha Radio 1, Beta Radio and Alpha Radio 2. In addition, there may be data services, although these are not shown in the figure. Each service is consists of one or more

service components, and each of these is placed in a subchannel, which may be either an audio channel or a data channel. For comparison, let it be stated that FM radio contains only one service and one service component (audio) in each channel. At the lowest level, the transmission frame, whose duration is either 24 ms or 96 ms depending on the DAB mode, consists of three chronologically consecutive parts. The first part is a Synchronizing Channel, which contains no service information. The next part is a Fast Information Channel FIC, which has a mode-specific fixed length. The last part is a Main Service Channel MSC, which contains all the subchannels. The position, size and number of subchannels within the MSC may vary, but the size of the MSC is constant. The MSC contains a maximum of 63 different audio and/or data subchannels. The subchannels are numbered on the basis of a so-called Channel Id from 0 to 62. Moreover, the MSC may contain an Auxiliary Information Channel AIC, which has a fixed channel number 63. The AIC may carry the same type of information as the FIC.

At the transmitting end, in addition to audio services, the service supplier may also offer e.g. multimedia services, hypermedia services, file-based services and hypertext. From the audio information and data provided by the service suppliers, the DAB operator generates a DAB transmission signal, which comprises successive transmission frames as shown in the lower part of Fig 1.

In the receiver, the information channel FIC and the MSC, which contains the audio and data services, are separated from each other from the transmission frame. The subchannels are separated, channel-decoded and then passed on for further processing. From the FIC channel

received, the customer obtains information about the services contained in the ensemble received and can thus select the service or services he/she wants. By combining subchannel service components in accordance with the application software, it is possible to compose e.g. a desired multimedia service.

As stated above, information can be transferred in packet mode, in which case data capacity can be reserved for service suppliers dynamically, or as a continuous stream. The maximum capacity in packet transfer is 1.728 Mbit/s. In continuous audio transfer, successive audio frames are transferred. Briefly speaking, to transfer information in data packets, the information data is first placed in the data field of a so-called data group. The data group contains header fields and after these a data field, in which the data to be transferred is placed. The length of the data field may vary and is at most 8191 bytes. The last field is the checksum of the data group. The data packets to be sent out to the transmission path are formed from the data group by simply chopping it into sections of equal length and placing each section in the data field of a data packet. Fill bits are used if the last data group section to be placed is shorter than the length of the data field of the data packet. The data packet length has one of four possible values, 24, 48, 72 or 96 bytes. Based on the packet headers, the data group can be assembled again in the receiver. Generally, a data group consists of the data fields of a number of packets transmitted in succession, but in the simplest case a single packet is sufficient to form a data group.

A continuous audio stream or data stream is transferred in frames, the structure of which is illustrated

by Fig. 2. At the transmitting end, audio samples coming in at a frequency of 48 kHz and encoded into 16-bit format are divided into sub-bands, and the samples of the sub-bands are coded into the audio frame by making use of the masking effect of the human ear so that the incoming bit rate 768 kbit/s is reduced e.g. in the case of a mono channel to a rate of about 100 kbit/s. The four-byte header of the frame contains information intended for the decoders in the receiver, such as synchronisation data, bit rate data, and sampling frequency data. A bit allocation field coming after the checksum indicates how the bits are allocated to each one of the audio field sub-bands containing 36 encoded samples and which bits have been removed from the samples in making use of the masking effect. A scale factor selection information field indicates how the group of audio samples has been scaled (normalized) in the decoder. After this there is a field that contains the audio bits proper. The information in it corresponds to 24 ms of audio. The field contains 36 encoded sub-band audio samples divided into twelve triplets, each of which contains 3 sub-band samples. Thus, four triplets corresponds to 12 ms of audio. After this there are fill bits if the number of audio bits amounts to less than the audio field length. Finally there are an X-PAD and an F-PAD field, the meanings of which are described next.

Fig. 3 presents the last part of the audio frame. Each audio frame contains bytes that transmit data relating to the programme (Programme Associated Data). This data is in synchronism with the audio data in the frame. The PAD-bytes of successive frames make up a so-called PAD channel. The field consisting of the two last bytes, called the fixed PAD field, is intended for the

transmission of real-time information related to audio, but it can also be used as a very slow data channel. The PAD channel can be extended by employing a so-called extended PAD field X-PAD, which is intended for the transmission of additional information to the listener, such as text associated with the audio, e.g. the lyrics of songs. The X-PAD field may be absent altogether, and its length in each frame can be four bytes, a so-called short X-PAD, in which case it is located in the frame area which is better protected against errors, indicated by the shading in the figure, or its length may change from frame to frame, in which case only a part (4 bytes) of it is in the well-protected area. Between the PAD fields there is a Scale Factor Error Check - Cyclic Redundancy Check field ScF-CRC associated with the audio field. The frame always has a fixed-length F-PAD field, and if an X-PAD field exists, its length is encoded in the F-PAD. The X-PAD field has at its beginning one or more contents indicators CI. The CI is a number which indicates the nature or application type of the data placed in the X-PAD data field or in its sub-fields. According to the specification, the maximum number of application types available is 287. Numbers 0, 2-11, 32 and 33 are defined under item 7.4.3 of the specification.

The DAB system allows the transmission of multimedia type services, but the multimedia techniques currently used are not adequate for this purpose. At present, each multimedia producer uses its own technical solutions for digital audio and video, presentation script language, coding, protocols, operating systems, etc. So far there is no standardized method for generating a complex, interactive multimedia presentation using the

producer's computer, storing it in a data medium, transmitting it over a transfer network and reproducing the presentation on another computer. The producer has to store e.g. a multimedia book on a compact disc in numerous different formats, such as CD-I (Compact Disc Interactive), MPEG-1 and QuickTime (a system used by Apple). A recording in appropriate format is then transferred to an industry-standard computer PC, a MacIntosh or a Unix computer, for these to be able to present the multimedia book. Transfer over a network or data exchange between heterogeneous systems is not possible. The main problem is a lack of international standards for the creation and presentation of the contents of multimedia. In particular, the final multimedia script lacks conditional links and spatial as well as temporal relationships between content elements. For example, the JPEG and MPEG standards only describe the contents of information objects, but they cannot be used to describe the relationships between the objects in a multimedia presentation. To solve this problem, in other words, to define and standardize the structural information of a multimedia presentation, the ISO (International Organization for Standardization) has established a working group called MHEG (Multimedia and Hypermedia Information Coding Experts Group), which has made a proposal for a multimedia standard, known by the same designation.

In its philosophy, the standard follows the layered structure of the OSI model, in which the abstract syntax and the transfer syntax are separated from each other. The standard is based on an object-oriented approach. It has been developed in five parts, of which the first part, called ASN.1 (Abstract Syntax Notation 1), is a complete definition of objects, whereas the fifth part

MHEG-5 describes the implementation at application level, with special focus on TV applications. ASN.1 is also used in MHEG-5. MHEG-5 is defined in the proposed standard ISO/IEC CD 13522-5, September 20, 1995. An MHEG-5 application is composed of scenes and objects common to different scenes. A scene is used to present information (text, audio, video, and so on), whose behaviour is based on the triggering of events. For example, pressing a button visible on the screen starts a video sequence or activates the sound. At least one scene is active at any given instant. Navigating within a presentation thus means moving from one scene to another.

To make the present invention easier to understand, certain MHEG concepts are now briefly described. Links are objects which contain a trigger for triggering an event and a reference to an action object, which again contains a list of elementary events. Thus, a link is associated with a given event. When a certain condition is encountered, the event is triggered and the elementary events (e.g. the starting, running and closing of a video sequence) are executed in the order prescribed by the list of elementary events. A container created for the transfer contains a combination of MHEG objects, so it can be thought of as a complex object consisting of simple basic objects. The container may contain e.g. JPEG, MPEG and text files. Containers can be linked to each other. For the receiver to be able to present the received multimedia programme correctly, it must be provided with a certain software package, called the MHEG engine. It is a process or a number of processes that are able to interpret the encoded MHEG objects in accordance with the specification.

Running an MHEG application on-demand in a multimedia receiver connected to a fixed network is basically quite simple. The receiver first identifies the starting object in the received data, downloads it and prepares it. The starting object may be any one of the objects in the container. Usually this is the first scene. After the starting object has been prepared, one or more linked objects are triggered, and this may result in the loading of several objects referenced by the elementary event. This is also the way an audio stream is started. The receiver naturally starts the reception of an audio stream right from the beginning.

The proposed MHEG multimedia is excellently suited for use in the DAB system. In this case, the principle could be as illustrated by Fig. 4. At the transmitting end, the service supplier encodes his multimedia service components, which may have a different internal format, to convert them into objects consistent with the MHEG specification. The objects can be placed in containers. The DAB operator places the containers or objects in a DAB multiplex and transmission frames to be transferred via a packet channel and/or as continuous audio and data. The receiver decodes the sub-channels from the multiplex and passes the objects decoded according to the MHEG specification to an MHEG engine, which decodes the multimedia presentation from them.

In the DAB system, however, the situation is more problematic as compared with a fixed network. A multimedia presentation is very likely to start with audio. Shortly after the start of the audio stream comes a starting image, which may be a still picture. However, as DAB is a broadcasting system, the receiver is frequently switched to a multimedia service in the middle

of a programme and therefore in the middle of an audio stream. The first part of the presentation is therefore not present in the memory of the receiver, so the starting image is missed and there are no mechanisms for invoking starting it. The only alternative is to wait for a retransmission so that reception can be started from the very beginning. However, there should be a starting mechanism that would allow multimedia reception even after transmission has already begun.

This invention presents a solution to the problem described above. The solution is characterized by what is said in the independent claims.

According to the invention, the audio stream is divided into successive segments of different lengths and the segments are marked. For the marking, a specific marker is provided at the boundary between segments. Segment boundaries indicate a change in the multimedia presentation. The change may be e.g. the disappearance of a still picture. A portion of a multimedia presentation that contains still pictures, video and text contains links. Besides the starting scene, such links are also present in other scenes. A marker in the audio stream activates a link in a given scene, whereupon the presentation continues as programmed by the producer. When the receiver is switched on, the decoder decodes the markers found in the audio stream and sends them to the MHEG engine. At the same time, the MHEG engine has received and decoded objects belonging to the presentation and generated a scene which is not displayed. The links in the scene are waiting to be activated, and when a marker associated with one of the links and acting as an excitation is decoded from the audio stream, it activates the link concerned. As a result, either the scene

is displayed or the link causes a transition to another scene, which is displayed. The transition is invisible to the user, so the user perceives the presentation as starting with the right scene.

In the following, the invention is described in greater detail by referring to the attached drawings, in which:

Fig. 1 presents the levels of abstraction in the DAB system;
Fig. 2 presents an audio frame;
Fig. 3 presents the PAD fields of the audio frame;
Fig. 4 illustrates MHEG transmission;
Fig. 5 presents the F-PAD field;
Fig. 6a indicates how a marker is encoded in a short X-PAD field;
Fig. 6b indicates how a marker is encoded in a variable-length X-PAD field.

As is known, in a multimedia programme there must be some way to indicate the file that the receiver has to load first and from which the multimedia presentation is to be started. In the present application, the starting file is referred to as start-up file. In conjunction with the DAB system, this start-up file is preferably notified to the receiver via the data transfer protocol for multimedia files by the method described in patent application FI 954752 by the applicant. Other methods can be used as long as the receiver is enabled to find and load the start-up file. The start-up file contains a link which automatically starts the reception of the audio stream as well.

First, according to the invention, the start-up file contains a number of links associated with events that are awaiting to be triggered. When a trigger appears, the link activates certain events as determined by the producer, so the result of these events has been accurately defined.

Second, according to the invention, specific stream marker IDs are included in the audio stream. The length of a stream marker ID is two bytes or preferably three bytes. The stream marker IDs divide the audio stream into segments of varying lengths. The service supplier places the stream marker IDs in the PAD fields of the audio frames in such a way that the segment boundaries are certain clearly distinguishable changes in the multimedia presentation, e.g. the audio stream portion between any given stream marker IDs refers to a given scene and within this scene to a given still picture. In other words, as long as the still picture is visible, the sound decoded in the audio frames between the markers is to be heard via the speakers of the receiver.

Now, when the user switches the receiver to multimedia reception in the middle of a multimedia transmission, the MHEG engine of the receiver first finds the start-up file among the incoming files and decodes it as described in the above-mentioned patent application. It contains the mechanisms and references to the required files that are needed for the preparation of the first scene, which is then prepared by the MHEG engine. The scene is associated with so-called presentables, which are objects that the user can see or hear. However, these presentables are not activated as yet and the scene is therefore not displayed on the screen of the receiver. The start-up file also contains a command to

start the reception of the audio stream associated with the multimedia, but in this case the reception begins in the middle of the audio stream. The first scene contains links that are triggered by a certain marker embedded in the audio stream. The receiver decodes the X-PAD fields of the audio frames and distinguishes the stream marker ID placed in the field and passes it to the MHEG engine. The MHEG engine directs the marker to the links, with the result that the marker triggers the events defined in at least one of the links. The events have been set in the MHEG language by the service supplier. They include loading the objects determined by the service supplier into the receiver and preparing them. The result is e.g. a new scene that the service supplier has meant to be displayed at this point of the audio stream. Its presentables are activated and the scene is displayed on the screen of the receiver. All the preceding actions are part of a chain of internal events in the programme that are not visible to the user. To the user's perception, the multimedia starts at the right point in relation to the audio. After this, the normal interactive procedure is followed. At this stage, objects that are no longer needed because the presentation has jumped from the starting scene directly to a later scene are cleared and removed.

As stated above, the stream marker ID is transferred in the X-PAD field of the audio frame. A stream marker ID is placed at each boundary between audio segments, in other words, the stream marker ID changes at each segment boundary. The stream marker ID refers to the audio information in the frame concerned as well as the audio information in subsequent frames until the stream marker ID changes. However, it is advantageous to

place the same stream marker ID at regular intervals in other frames within the segment as well because this allows faster start-up of the MHEG presentation. It is not necessary to provide every frame with a stream marker ID. In this case the procedure could be such that the receiver decodes an odd number of successive stream markers and the MHEG engine carries out a majority vote, the resulting stream marker ID being then used to activate the link. This provides an advantage when in the vicinity of a segment boundary, because it prevents "premature" progress in the multimedia presentation.

The stream marker ID can be encoded in the X-PAD field in the manner shown in Fig. 5, 6a and 6b. Fig. 5 presents the F-PAD part defined by the specification that comes at the end of the audio frame. This part begins with a 2-bit field, F-PAD type. If it has the value "00", this means according to the specification that the first two bits in the following 6-bit data field are reserved for an X-PAD indicator. If the indicator bits are "01", this means that an X-PAD field is included and that it is a so-called short X-PAD comprising 4 bytes. If the bits are "10", this means that an X-PAD field is included and that the field is of variable length, called variable X-PAD. From the above information, the decoder detects the presence of an X-PAD field and also learns its type. It then examines the contents indicator CI of the X-PAD.

In the case of a short X-PAD, Fig. 6a, there is first an 8-bit field which is reserved for an application type indicator. According to the invention, this field is filled with the decimal number 1 (binary number 00000001) to indicate that the three data fields of the X-PAD contain a stream marker ID as used in the inven-

tion. The bit pattern of the stream marker ID can be selected by the service supplier. 24 bits provide a sufficient scope of variation. In the case of a short X-PAD, contents indicator value 00000001 thus means that the next three bytes contain a stream marker ID.

In the case of a variable X-PAD, the contents indicator is as illustrated by Fig. 6b. Its length is two bytes and the Length field indicates the number of bytes included in the X-PAD. In particular, if the length indicator has the value "000", this means that the X-PAD comprises four bytes. The maximum is 48 bytes. According to the specification, the next 5-bit field is reserved for the application type. According to the invention, this field is given the value of decimal 1 (binary number 00001). The "application type external" field is not in use. In the case of a variable X-PAD, contents indicator value 000 00001 thus means that the X-PAD field is four bytes long and contains a stream marker ID and that the stream marker ID is given in the first three bytes. The last byte is a checksum CRC with the polynome $x^8 + x^4 + x^3 + x^2 + 1$ over the stream marker ID.

In the DAB specification, a meaning has already been defined for application type numbers 0, 2-11, 32 and 33, so the number of the application type referring to the stream marker ID must have a value other than those indicated above. The number 1 is still available and the applicant proposes that it be used for the purpose described in the present invention.

It is obvious to a person skilled in the art that technological development allows many different ways of implementing the basic idea of the invention. The invention and its embodiments are therefore not limited to

the examples described above but may be varied within the framework of the claims.

Claims

1. Multimedia programme which has been produced in a specific programming language that tells how monomedia programmes are spatially and temporally linked to each other and in which programme a monomedia stream contains stream marker IDs, the reception of each of which is an event that triggers functions defined in a given link, and in which multimedia programme a number of objects form a scene intended to be displayed on a display device,

characterized in that

the monomedia stream is an audio stream and the stream marker IDs placed in it divide the audio stream into segments of variable length, each boundary between segments indicating a change in the multimedia presentation,

the objects forming a scene in the multimedia presentation have been provided with links whose triggering event is the reception of a stream marker ID associated with the link, so that the triggering results in a transition from one scene to another in the multimedia presentation.

2. Multimedia programme as defined in claim 1, **characterized** in that the programming language is MHEG (Multimedia and Hypermedia information coding Expert Group).

3. Transfer of a multimedia programme in a DAB broadcasting system, in which

the audio stream of the programme is transmitted in audio frames which have at their end a first field F-PAD of fixed length, which is intended for the transfer of data associated with the programme and contains data in-

dicating whether a second field X-PAD for the transfer of data associated with the programme is present the at the end of the audio frame, said second field containing a contents indicator CI which indicates the nature of the data in the data field,

the rest of the multimedia components are transmitted as files, and the receiver assembles from the received programme a scene to be displayed on a display device,

characterized in that

the audio stream is divided into segments of variable length by providing those audio frames in the audio stream which involve a change in the multimedia presentation with an individual stream marker ID, which is decoded by the receiver and transferred to the software processing the multimedia presentation,

the objects forming a scene in the multimedia presentation contain links, the triggering event of at least one of which is the transfer of said individual stream marker ID to the software, such triggering causing the software to perform certain specified actions.

4. Transfer of a multimedia programme as defined in claim 3, **characterized** in that the specified actions cause the scene to be changed into a scene corresponding to the current audio stream.

5. Transfer of a multimedia programme as defined in claim 4, **characterized** in that, when the reception of the multimedia programme is started in the middle of the transmission, the first scene displayed on the display device is the scene corresponding to the current audio stream.

6. Transfer of a multimedia programme as defined in claim 3, **characterized** in that audio frames within the

segments also contain stream marker IDs, and that the stream marker ID at the beginning of the segment and those elsewhere in the segment refer to the same link.

7. Transfer of a multimedia programme as defined in claim 6, **characterized** in that, when the same segment contains several stream marker IDs, after removal of the CRC a majority vote is carried out and its result acts as a trigger that triggers the link.

8. Transfer of a multimedia programme as defined in claim 3, **characterized** in that the stream marker ID is placed in the second field X-PAD intended for the transfer of data associated with the programme.

9. Transfer of a multimedia programme as defined in claim 8, **characterized** in that the application type field included in the contents indicator CI contains an individual value indicating that the data field contains a stream marker ID and that the stream marker ID has been placed in the data field.

10. Transfer of a multimedia programme as defined in claim 3 or 9, **characterized** in that the stream marker ID is a 3-byte number.

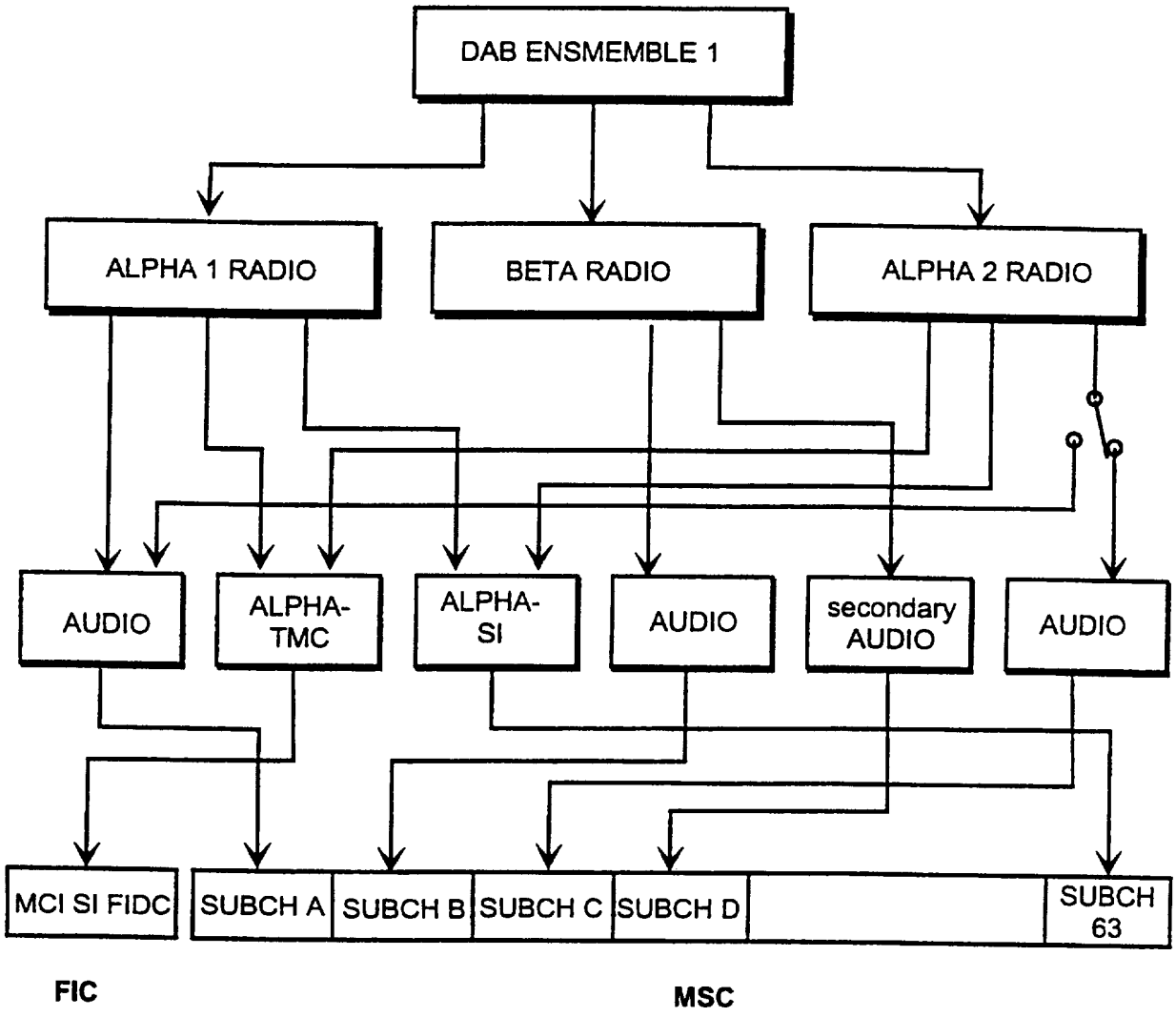
DAB ENSMEMBLE 1
ALPHA 1 RADIO
BETA RADIO
ALPHA 2 RADIO
AUDIO
ALPHA-TMC
ALPHA-SI
AUDIO
secondary AUDIO
AUDIO
MCI SI FIDC
SUBCH A
SUBCH B
SUBCH C
SUBCH D
SUBCH 63
FIC
MSC

Fig. 1

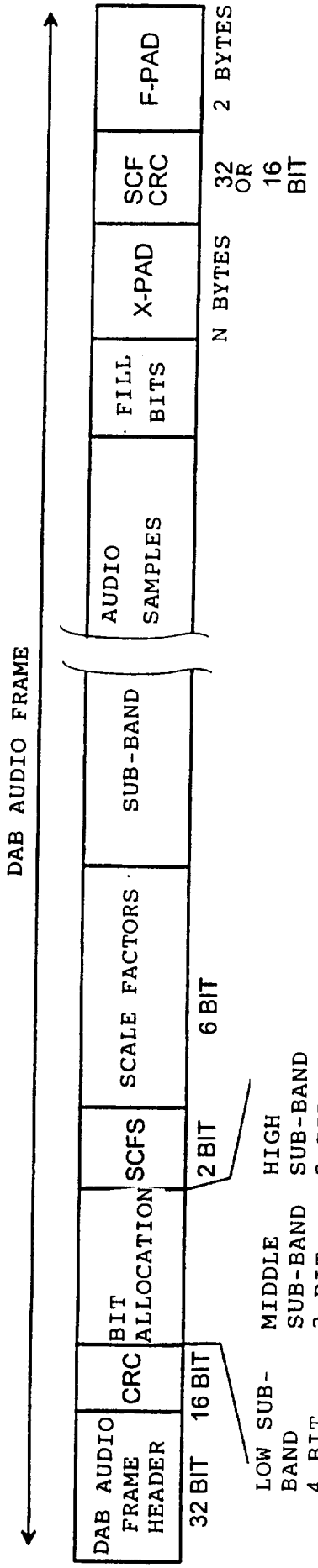
DAB AUDIO FRAME
DAB AUDIO FRAME HEADER
32 BIT
CRC
16 BIT
BIT ALLOCATION
SCFS
SCALE FACTORS
SUB-BAND
AUDIO SAMPLES
FILL BITS
X-PAD
SCF CRC
F-PAD
2 BYTES
32 OR 16 BIT
N BYTES
2 BIT
6 BIT
LOW SUB-BAND 4 BIT
MIDDLE SUB-BAND 2 BIT
HIGH SUB-BAND 2 BIT

Fig. 2

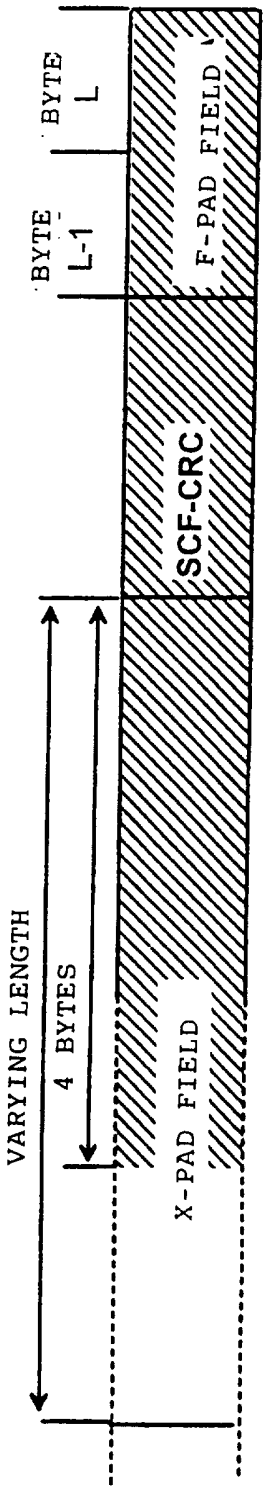
VARYING LENGTH
4 BYTES
BYTE L-1
BYTE L
SCF-CRC
F-PAD FIELD
X-PAD FIELD

Fig. 3

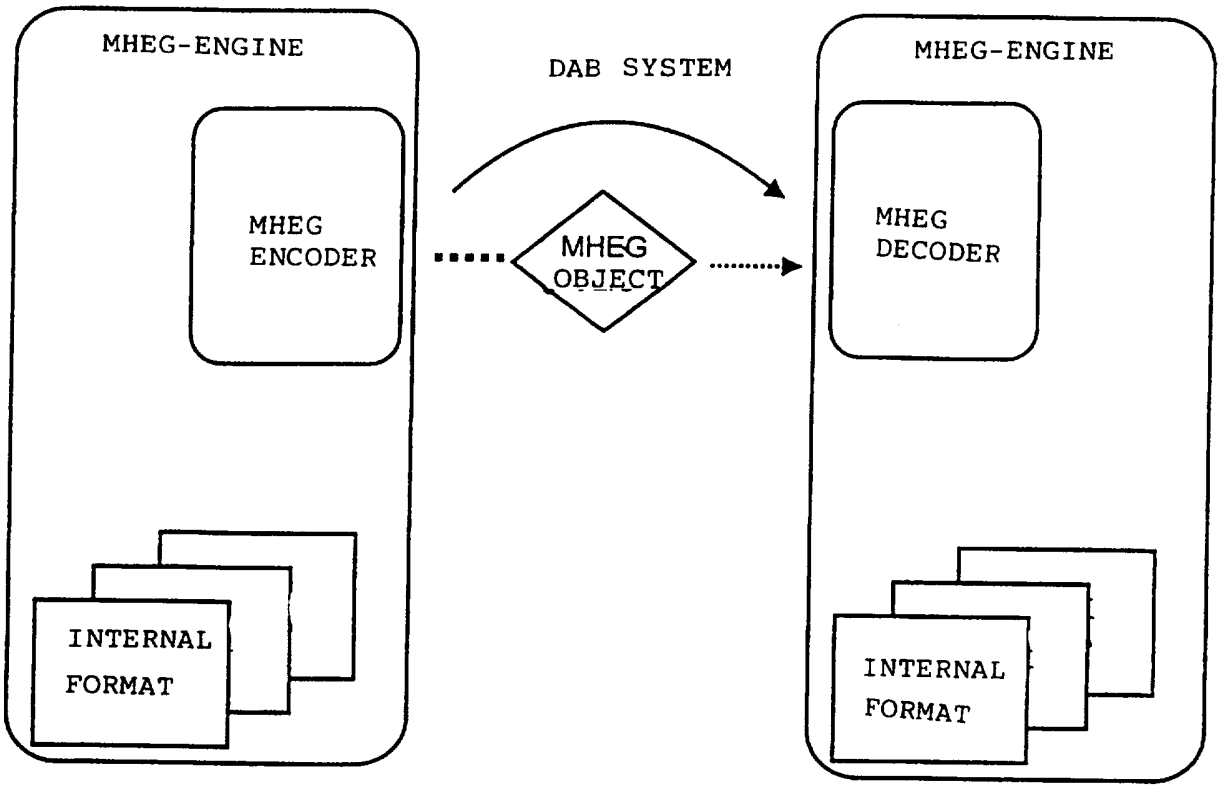

Fig. 4

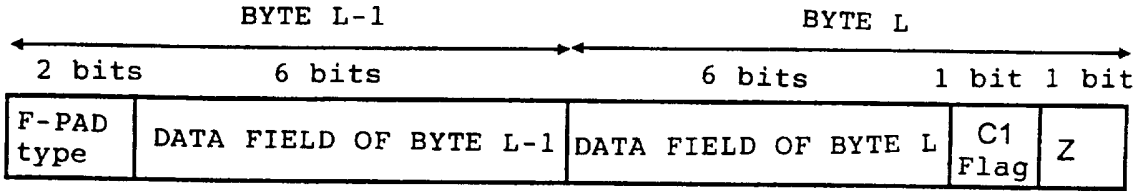

Fig. 5

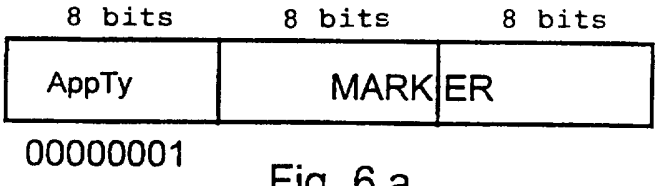

Fig. 6 a

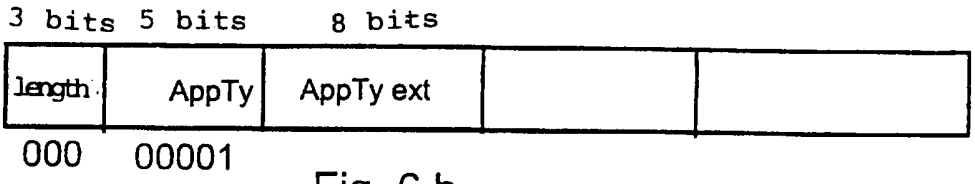

Fig. 6 b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00594

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04H 1/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04H, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	FR 2728089 A (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE-KR KOREA TELECOMMUNICATION AUTHORITY-KR), 14 June 1996 (14.06.96), page 6, line 12 - page 7, line 13, claim 1, abstract ---	1-10
A,P	EP 0731575 A2 (NOKIA TECHNOLOGY GMBH), 11 Sept 1996 (11.09.96), see the whole document. ---	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 April 1997	29 -04- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Peter Hedman Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/FI 96/00594

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2728089 A	14/06/96	NONE	
EP 0731575 A2	11/09/96	FI 97840 B	15/11/96
		FI 951106 A	10/09/96