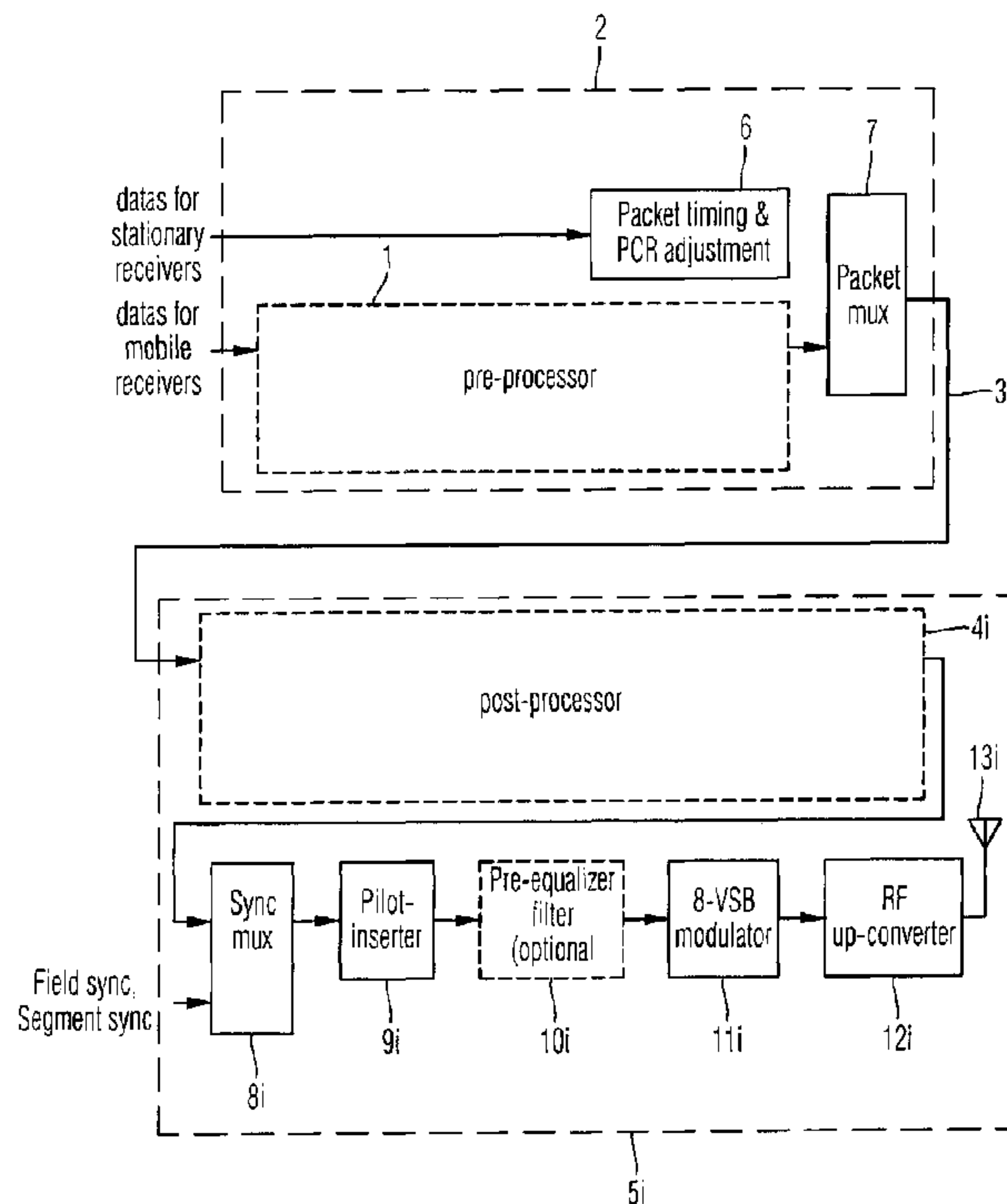




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(54) Titre : PROCÉDE ET SYSTÈME DE MAPPAGE SYNCHRONISÉ DE PAQUETS DE DONNÉES DANS UN FLUX DE DONNÉES ATSC  
 (54) Title: METHOD AND SYSTEM FOR SYNCHRONIZED MAPPING OF DATA PACKETS IN AN ATSC DATA STREAM



(57) **Abrégé/Abstract:**

Mapping data packets of a first data stream into data fields of a second data stream at several transmitters is provided by generating a first data stream with first data packets containing data associated with stationary receivers and second data packets containing data associated with mobile receivers in a head-end, where second data packets at the start of a group of consecutively transmitted second data packets contain placeholders into which signaling information is filled. A first data stream is transmitted from the head-end to each transmitter. Each transmitter extracts signaling information from the second data packets indicating in which data slot and in which data sub-frame of a received data frame the second data packet is transferred. Each transmitter inserts synchronization data in a specific data packet in each data slot containing second data packets. The first and second data packets are mapped consecutively into the second data stream.

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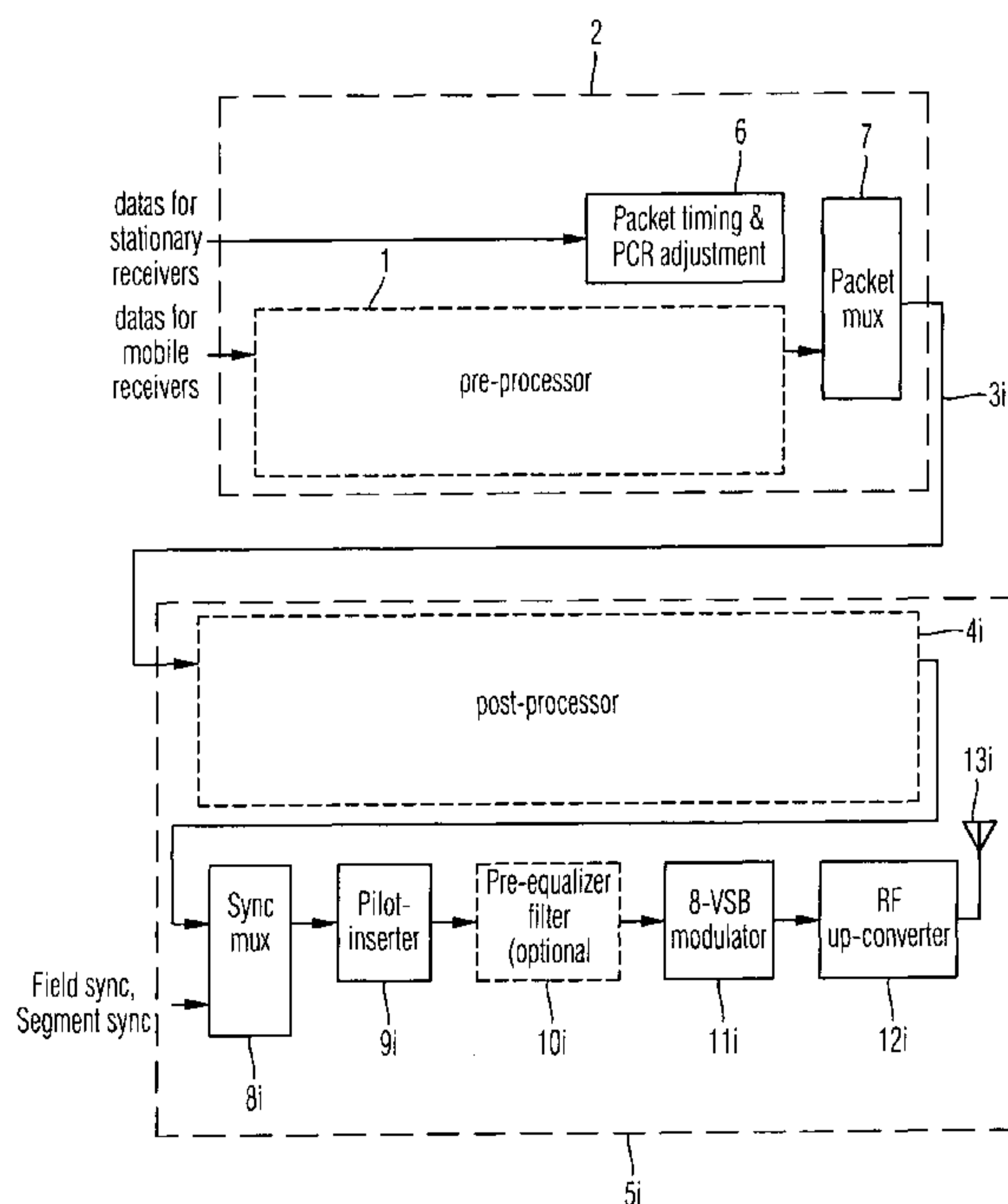


Fig. 1

(57) Abstract: Mapping data packets of a first data stream into data fields of a second data stream at several transmitters is provided by generating a first data stream with first data packets containing data associated with stationary receivers and second data packets containing data associated with mobile receivers in a head-end, where second data packets at the start of a group of consecutively transmitted second data packets contain placeholders into which signaling information is filled. A first data stream is transmitted from the head-end to each transmitter. Each transmitter extracts signaling information from the second data packets indicating in which data slot and in which data sub-frame of a received data frame the second data packet is transferred. Each transmitter inserts synchronization data in a specific data packet in each data slot containing second data packets. The first and second data packets are mapped consecutively into the second data stream.

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TITLE

**METHOD AND SYSTEM FOR SYNCHRONIZED MAPPING OF DATA  
PACKETS IN AN ATSC DATA STREAM**

5

**[0001]**

10 Field

**[0002]** The invention generally relates to communication systems, and more particularly to synchronized mapping of data packets in an ATSC data stream.

Related Art

15 **[0003]** In a transmission system for digital television corresponding to the Advanced Television Systems Committee Mobile Handheld (ATSC-M/H (A/153)) standard, the transmitted data stream contains both digital TV data for stationary receivers and digital TV data for mobile receivers. An example of such a transmission system is described in U.S. Patent Appln. No. 11/422,791.

20 **[0004]** FIG. 1 depicts a block diagram of an ATSC-M/H transmission system with pre- and post-processing. As shown in FIG. 1, the signal processing of digital TV data is performed in a pre-processor 1 at the head-end 2 (*e.g.*, in a studio) and is continued after transmission of the pre-processed digital TV data over a studio-

transmitter-link  $3_1, 3_2, \dots, 3_i, \dots, 3_n$  in a post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  at each remotely positioned transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$ . In the pre-processor 1, data for mobile receivers in IP data packets are encoded with a concatenated encoder using, for example, a Reed-Solomon encoder or a convolutional encoder or a cyclic redundancy check (CRC) which generates CRC bits. Pre-processor 1 also generates additional control and status data such as the length, the periodicity and the sequence number of data units for each service, the time marker for transmission time of each data unit, and so on. Encoded payload data for mobile receivers and additional control and status data are formatted in ATSC-like transport stream (TS) data packets with a packet identifier specified for mobile data at the end of pre-processing.

[0005] Markers in TS data packets with data for stationary receivers are modified by a packet timing and program clock reference (PCR) adjustment unit 6. Particularly, packet timing and PCR adjustment unit 6 performs packet timing and PCR adjustment taking into account the insertion of TS data packets with data for mobile receivers (*i.e.*, ATSC-M/H data packets) into the transport stream of TS data packets including data for stationary receivers (*i.e.*, normal ATSC data packets) using a consecutively positioned packet multiplexer 7.

[0006] In the post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  at each remote positioned transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$ , scrambling, interleaving and channel encoding of the ATSC-like transport stream are performed. Each post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  is followed by a synchronization multiplexer  $8_1, 8_2, \dots, 8_i, \dots, 8_n$  for inserting synchronizing data (*e.g.*, data field sync and data segment sync) in the transport data stream, a pilot inserter  $9_1, 9_2, \dots, 9_i, \dots, 9_n$  for inserting pilot symbols in the transport data stream, a pre-equalizer  $10_1, 10_2, \dots, 10_i, \dots, 10_n$ , an 8-VSB modulator  $11_1, 11_2, \dots, 11_i, \dots, 11_n$ , an RF-up-converter  $12_1, 12_2, \dots, 12_i, \dots, 12_n$  for RF signal processing and a transmitter antenna  $13_1, 13_2, \dots, 13_i, \dots, 13_n$ .

[0007] For post-processing of the data packets to be transmitted, each transmitter at the transmitter site needs some further information determined in the pre-processing stage. To synchronize the segment and frame structure of the transport data stream between each transmitter and each receiver, segment and frame synchronization data are inserted by a synchronization multiplexer at the transmitter site at particular positions in the data stream. This is determined in the pre-processing stage at the head-end.

**[0008]** As described in U.S. Patent Appln. No. 12/024,238,

a VSB frame initialization packet (VFIP) is transmitted once every 20 VSB Frames from the head-end to each transmitter to signal the start of a new VSB super frame in an ATSC data stream. Upon reception of a VFIP in a last data slot of a data field, the exciter is signaled to start a new VSB super frame and a new VSB data field after the last bit of VFIP is received. It would be advantageous to increase the effectiveness of the data transmission between the head-end and each transmitter and reduce any delay in the post-processing due to the delay in the arrival of a VFIP that may be caused by each transmitter.

10

### BRIEF DESCRIPTION OF THE INVENTION

**[0009]** One aspect of the present invention provides a method and a system for signaling the start of each VSB data field in an ATSC data stream to each exciter at the transmitter site without any further loss of data rate and delay in post-processing.

**[0010]** In an ATSC transmission system, between several transmitters and at least one receiver, a data stream of consecutively transmitted data frames having, for example, 5 sub-frames each, where each subframe contains 156 data packets, and each data packet has 188 bytes, is generated corresponding to FIG. 2. In a so-called first data packet, only digital data for stationary receivers are transferred, whereas so-called second data packets contain only data for mobile receivers. The second data packets are organized in ATSC-M/H groups (Advanced Television Systems Committee Mobile/Handheld groups) including 118 consecutively transmitted data packets in a data slot. These data slots contain 118 data packets with data for mobile receivers and 38 data packets with data for stationary receivers, or contain 156 data packets with data for stationary receivers only.

**[0011]** A multiplexer in the head-end generates a first data stream having first and second packets and each transmitter transmits a second data stream having consecutively arranged ATSC-like VSB data fields. For a correct synchronized mapping of the first and second data packets in the first data stream to the second data stream containing the consecutively transmitted ATSC-like VSB data fields, signaling between the head-end and each transmitter has to be performed.

**[0012]** To provide signaling to the exciter at each transmitter as to whether a transmitted data packet belongs to an ATSC-M/H group, preferably each data packet has a packet identifier identifying the data packet as a first data packet which is not a

member of a ATSC-M/H group or as a second data packet which is a member of a ATSC-M/H group.

[0013] The multiplexer, which generates the first data stream with first and second data packets at the head-end, preferably inserts signaling information indicating, in  
5 which data slot and in which sub-frame of an ATSC-M/H data frame in the first data stream the respective ATSC-M/H group is transferred, in specific placeholders in second data packets at the start of the respective ATSC-M/H group. This is done to signal the exciter at each transmitter with the correct time-alignment of each ATSC-M/H group to a corresponding VSB data field in the second data stream transmitted  
10 from each transmitter of the ATSC-M/H transmission system. These placeholders are specific dummy bytes in the data packets, especially 13 dummy bytes in the first two data packets, in an ATSC-M/H group, which do not have any meaning in the transmission channel between the head-end and each transmitter and thus can be used for inband signaling information. Advantageously, this does not dissipate additional  
15 bandwidth of the transmission channel.

[0014] Each transmitter preferably extracts this signaling information from each placeholder in the received first data stream and in case of an identified ATSC-M/H group a synchronizing information (*i.e.*, a data field sync) is inserted to a specific data packet in a data slot transferring the ATSC-M/H group, *i.e.*, the 38<sup>th</sup> data packet  
20 in a data slot transferring the ATSC-M/H group.

[0015] In case of signaling information extracted from placeholders in a data slot received at the start of a data frame, the 38<sup>th</sup> data packet in the ATSC-M/H group with the synchronizing information (*i.e.*, a data field sync) is mapped preferably to the data packet transmitted at the start of a odd-numbered VSB data field in the  
25 second data stream according to the ATSC standard. The data packets in the surrounding of the 38<sup>th</sup> data packet of the ATSC-M/H group are consequently mapped to the data packets surrounding the data packet transmitted at the start of the odd-numbered VSB data field in the second data stream.

[0016] In case of signaling information extracted from placeholders in a data slot  
30 received at an even-numbered position of a data frame, the synchronizing information inserted in the 38<sup>th</sup> data packet in the ATSC-M/H group is preferably mapped to a data packet transmitted at the start of a VSB data field in the second data stream according to the ATSC standard. The data packets surrounding the 38<sup>th</sup> data packet of the ATSC-M/H group are consequently mapped to the data packets

surrounding the firstly transmitted data packet of the new VSB data field in the second data stream.

[0017] In case of signaling information extracted from placeholders in a data slot received at an odd-numbered position of a data frame, the synchronizing information inserted in the 38<sup>th</sup> data packet in the ATSC-M/H group is preferably mapped to the 157<sup>th</sup> transmitted data packet of a VSB data field in the second data stream according to the ATSC-M/H standard. The data packets surrounding the 38<sup>th</sup> data packet of the M/H group are consequently mapped to the data packets surrounding the 157<sup>th</sup> transmitted data packet of the new VSB data field in the second data stream.

[0018] The mapping of the data slots containing only first data packets between two ATSC-M/H groups to the VSB data fields in the second data stream is preferably oriented to the mapping of the ATSC-M/H groups to the VSB data fields in the second data stream. Thus the 38<sup>th</sup> data packet in a data slot containing only first data packets, which is received in an even-numbered position of a data frame, contains a frame synchronizing information and is mapped to the data packet at the start of a VSB data field in the second data stream. The first data packets surrounding these 38<sup>th</sup> data packets are consequently mapped to the data packets surrounding the data packet transmitted at the start of the VSB data field in the second data stream. The 38<sup>th</sup> data packet in a data slot containing only first data packets, which is received in an odd-numbered position of a data frame, is mapped to the 157<sup>th</sup> transmitted data packet of a VSB data field in the second data stream. The first data packets surrounding these 38<sup>th</sup> data packets are consequently mapped to the data packets surrounding the 157<sup>th</sup> transmitted data packet of the VSB data field in the second data stream.

[0019] To continuously establish and maintain such a mapping structure – mapping of two data slots of the first data stream into one VSB data field of the second data stream, whereby the 38<sup>th</sup> data packet of a data slot in an even-numbered position in the data frame of the first data stream is mapped to the data packet transmitted at the start of the VSB data field and the 38<sup>th</sup> data packet of a data slot in an odd-numbered position in the data frame of the first data stream is mapped to the 157<sup>th</sup> transmitted data packet of the VSB data field – a loss of one or more first or second data packets in the first data stream has to be prevented. In case first or second data packets are lost, preferably the following measures are performed:



[0020] Each second data packet has a continuity-counter in its packet header, which is incremented from the second data packet at the start of the ATSC-M/H group to the second data packet at the end of the ATSC-M/H group, thus enabling the identifying of a second data packet lost in the studio-transmitter-link (STL) and  
5 refilling of the ATSC-M/H group with a dummy second data packet in case of a lost second data packet. The loss of a first data packet in the STL can be identified by comparing the counted number of received first data packets between two received ATSC-M/H groups with the integer multiple of 156 data packets (*i.e.*, the number of data packets in a data slot) plus (optionally) 38 data packets (*i.e.*, the number of first  
10 data packets in a data slot with 118 second data packets) and can be corrected by refilling a number of dummy data packets corresponding the identified number of lost first data packets in the data stream.

[0021] The signaling information transferred in specific dummy bytes of the data packets, especially in 13 dummy bytes of the first two data packets of an ATSC-M/H  
15 group contains following exemplary information created at the head-end and used only at the transmitters:

[0022] • the time point of synchronized transmission of the first bits of each ATSC-M/H group of the second data stream in each transmitter in the ATSC-M/H transmission system working as single frequency network is determined at the frame  
20 formatter at the head-end and has to be transferred to the exciters and

[0023] • information indicating an second operation mode, in which only data for stationary receivers are transmitted, after a first operation mode, in which both data for stationary receivers and both data for mobile receivers are transmitted.

[0024] In a case where a specific number of data frames of the first data stream are  
25 received— for example 10 data frames – without any identified second data packets, each receiver is preferably switched to the second operation mode in which only data for stationary receivers are transmitted. Thus no further additional dummy data packets have to be inserted in the second data stream for establishing and maintaining the typical mapping structure of ATSC-M/H groups in the VSB data fields of the  
30 second data stream.

[0025] For security reasons, the signaling information is preferably decoded with a cyclic-redundancy-check (CRC). The CRC-sum of the signaling information is also transferred in the dummy bytes of the first two data packets of an ATSC-M/H group. The received signaling information is checked with the CRC-sum for correctness in

each transmitter. In case of correctly transmitted ATSC-M/H groups, the synchronizing information are inserted in the 38<sup>th</sup> data packets of each data slot and the mapping is performed.

5 [0026] After extracting the signaling information from the unreserved dummy bytes in the first two data packets in each ATSC-M/H group, a preselected value is preferably inserted to each dummy byte by each transmitter.

10 [0027] In another aspect of the present invention, a system for generating an inband signal is provided including a pre-processor and post-processor. The pre-processor receives transport stream packets, replaces dummy bytes of one or more of the transport stream packets with signaling data, and transmits transport stream packets including the signaling data over a communications link. The post-processor is in communication with the pre-processor through the communications link and receives the transport stream packets including the signaling data, decodes the signaling data, and identifies at least one of a location of a mobile/handheld group, a subframe of the mobile/handheld group, and a slot number of the mobile/handheld group, based on the signaling data.

15 [0028] In yet another aspect of the present invention, a method is provided for carrying signaling information including receiving, by a pre-processor, transport stream packets, replacing dummy bytes of one or more of the transport stream packets with signaling data. The transport stream packets including the signaling data are, in turn, transmitted over a communications link and received by a post-processor. The signaling data is decoded and at least one of a location of a mobile/handheld group, a subframe of the mobile/handheld group, and a slot number of the mobile/handheld group are identified, based on the signaling data.

20 [0029] In yet another embodiment, a method is provided which cause a pre-processor, to generate an inband signal, including receiving transport stream packets, replacing dummy bytes of one or more of the transport stream packets with signaling data. The method further provides transmitting the transport stream packets including the signaling data over a communications link to a post-processor which receives the transport stream packets including the signaling data, decodes the signaling data, and identifies at least one of a location of a mobile/handheld group, a subframe of the mobile/handheld group, and a slot number of the mobile/handheld group, based on the signaling data.

25

30

[0030] In a further embodiment, a method is provided for causing a post-processor to process an inband signal including receiving, from a communications link, transport stream packets including signaling data and decoding the signaling data. At least one of a location of a mobile/handheld group, a subframe of the mobile/handheld group, and a slot number of the mobile/handheld group is identified based on the signaling data, where the transport stream packets including signaling data is generated by a pre-processor. The pre-processor receives transport stream packets, replace dummy bytes of one or more of the transport stream packets with the signaling data, and transmits the transport stream packets including the signaling data onto a communications link.

[0031] Computer-readable medium containing instructions for causing a computer system to perform the methods described herein are also provided.

[0032] The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the following drawings.

[0033] FIG. 1 is a block diagram of an ATSC-M/H transmission system with pre- and post-processing,

[0034] FIG. 2 is a data structure of an ATSC-M/H data frame,

[0035] FIG. 3 is a data structure of an ATSC-M/H group,

[0036] FIG. 4 is a data structure of the first two data packets of an ATSC-M/H group,

[0037] FIG. 5 is a data structure of an embodiment showing a synchronized mapping between first and second data stream, and

[0038] FIG. 6 is a flowchart of an embodiment of a process for providing synchronized mapping of data packets for mobile receivers in an ATSC-M/H data stream.

#### DETAILED DESCRIPTION

[0039] FIG. 6, depicts a flowchart of an exemplary process for providing synchronized mapping of data packets for mobile receivers in an ATSC-M/H data stream in accordance with one aspect of the present invention. With reference to FIGs. 1 and 6, initially, in step S10, a first transport data stream containing first data packets with digital MPEG-encoded video data for stationary TV receivers and second data packets with digital MPEG-encoded video data for mobile TV receivers

are generated by a packet multiplexer 7 in the head-end 2. The source-encoding of the digital video data is performed in an MPEG4-encoder (not shown). Typically, the source-encoding is performed according to the MPEG4-H.264 standard for the video data and according to the MPEG4-AAC-HE standard for the respective audio data.

5 [0040] After the sequencing of the first and second data packets in the first data stream, in step S20, the packet multiplexer 7 inserts signaling information in specific dummy bytes of the first two data packets of each ATSC-M/H group.

[0041] FIG. 3 is a data structure of an ATSC-M/H group and FIG. 4 is a data structure of the first two data packets of an ATSC-M/H group. With reference to both  
10 FIGs. 3 and 4, according to the ATSC-M/H standard, an ATSC-M/H group with a data structure corresponding to FIG. 3 is created in the pre-processor 1 in the ATSC-M/H-channel of the head-end 2. In total, 45 dummy bytes are placed in the data packets of an ATSC-M/H group for making the size of the ATSC-M/H group divisible by 2, 3 or 4 in the transmission between transmitters and receivers.

15 Particularly, the dummy bytes in the first two data packets include 8 dummy bytes in the 1<sup>st</sup> data packet and 5 dummy bytes in the 2<sup>nd</sup> data packet characterized by the number "2" in FIG. 4 and indicated by an arrow in the data structure of an ATSC-M/H group in FIG. 3. For the transmission between transmitters and receivers, these dummy bytes preferably have a fixed pre-selected value e. g. 0xAF . In the  
20 transmission channel between the head-end and each transmitter, the dummy bytes have no meaning and thus can serve for transferring inband signaling information between head-end and each transmitter.

[0042] The first 12 dummy bytes transfer signaling information and the 13<sup>th</sup> dummy byte transfers the cycle-redundancy-check-sum over the signaling information for  
25 security reason.

[0043] The signaling information transferred in the dummy bytes of the first two data packets of an ATSC-M/H group includes the following data:

[0044] • the data slot number and the sub-frame number, in which the respective ATSC-M/H group is transferred in a data frame of the first data stream,

30 [0045] • the time point of synchronized transmission for the first bits of the 38<sup>th</sup> data packet in an ATSC-M/H group in each exciter as absolute or referenced GPS time,

[0046] • the control information for switching each exciter from a first operation mode, in which data for stationary and mobile receivers are transmitted, to a second operation mode, in which only data for stationary receivers are transmitted,

[0047] • the number of ATSC-M/H groups in the current ATSC-M/H data frame,

[0048] • the identifier for the second data packet at the start of an ATSC-M/H group, and

[0049] • the identifier for the first ATSC-M/H group in an ATSC data frame and the packet multiplexer 7 inserts in the header of each second data packet in a first mode a fixed packet identifier (PID) for each ATSC-M/H data packet. In a second mode the packet multiplexer 7 selects a PID for each ATSC-M/H data packet from a set of preselected packet identifiers which is not already used in a first data packet for stationary receivers.

[0050] The generated and modified first data stream is transmitted from the head-end 2 to each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  over each a studio-transmitter-link (STL)  $3_1, 3_2, \dots, 3_i, \dots, 3_n$ , as shown in step S30.

[0051] A respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  identifies each second data packet in the received first data stream based on the packet identifier (PID) in the header of each received data packet. The respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  is able to detect a ATSC-M/H-specific PID in the second mode by identifying 118 consecutively transmitted ATSC-M/H group data packets. An ATSC-M/H group containing 118 consecutively transmitted second data packets (*i.e.*, ATSC-M/H data packets) is correspondingly identified in the received first data stream by a respective transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  in step S40.

[0052] If a group of less than 118 consecutively transmitted second data packets is identified by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  in step S40, the missing number of second data packets is lost in the respective studio-transmitter-link (STL)  $3_1, 3_2, \dots, 3_i, \dots, 3_n$ . The respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  is able to detect the lost second data packets by checking the continuity-number in the header of all received second data packets, which is incremented from the 1<sup>st</sup> ATSC-M/H data packet at the start to the 118<sup>th</sup> ATSC-M/H data packet at the end of an ATSC-M/H group. In case of a missing continuity-number and thus a lost second data packet, in step S50, a dummy data packet without any relevant data is inserted in the respective ATSC-M/H group

of the first data stream by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$ .

[0053] If any second data packet is not identified by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  for more than a specific pre-selected number of received ATSC data frames – for example for more than 10 ATSC data frames – the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  is switched to a second operation mode. In this mode only ATSC data frames for stationary TV receivers are transmitted and thus no dummy data packets are inserted in the first data stream in a case where data packets have been lost. If the signaling information in the actual received ATSC-M/H group that signals the number of ATSC-M/H groups in the current ATSC-M/H data frame reports no further ATSC-M/H groups in the current ATSC-M/H data frame, the respective transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  is also switched to the second operation mode dealing only with data for stationary TV receivers.

[0054] In the case of an identified ATSC-M/H group, the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  extracts, in step S60, the data slot number and the sub-frame number in which the identified ATSC-M/H group is transmitted in the current received ATSC data frame of the first data stream. The number of data slots resp. of sub-frames is the position of the data slot resp. of the sub-frame in the ATSC-M/H data frame incremented from the data slot resp. from the first transmitted sub-frame at the start of the respective ATSC-M/H data frame.

[0055] Before extracting the data slot number and the sub-frame number from signaling information of the received ATSC-M/H group the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  the device has to decode the received 12 bytes of signaling information by calculating the cyclic-redundancy-check-sum of the received 12 bytes signaling information and to compare the calculated CRC-sum with the reference CRC-sum in the 13<sup>th</sup> byte of signaling information. Only in case of a correct received and checked signaling information a valid selection of the data slot number and of the sub-frame number in the actual received ATSC-M/H group can be performed by means of the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  and a switching of the exciters of each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  from a second operation mode to a first operation mode enabling the transmission of first and second data packets is performed.

[0056] On the basis of the extracted data slot number and the extracted sub-frame number of the actual received ATSC-M/H group, the position of each second data packet of the received ATSC-M/H group in a VSB data field of the second data stream transmitted from each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  to each receiver is

5 determined in step S70 by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$ . The mapping of the extracted data slot number and the extracted sub-frame number of the actual received ATSC-M/H to the position in a VSB data field corresponds to following assignment as shown in FIG. 5:

[0057] • the 38<sup>th</sup> data packet (#37) in the ATSC-M/H group received in the first

10 data slot of the first sub-frame in the actual received ATSC-M/H data frame is mapped to the first position for a data packet in a VSB data field in an odd-numbered position in the second data stream,

[0058] • the 38<sup>th</sup> data packet in the ATSC-M/H group received in an even-numbered position in the actual received ATSC-M/H data frame is mapped to the

15 first position for a data packet in a VSB data field in the second data stream, and

[0059] • the 38<sup>th</sup> data packet in the ATSC-M/H group received in an odd-numbered position in the actual received ATSC-M/H data frame is mapped to the 157<sup>th</sup> position for a data packet in a VSB data field in the second data stream.

[0060] The 37 second data packets (#0 - #36) transferred at the start of each ATSC-

20 M/H group and the 118 second data packets (#38 - #155) transferred at the end of each ATSC-M/H group are correspondingly positioned in the surrounding positions for data packets in the VSB data fields in the second data stream.

[0061] In step S80, the received first data packets with data for stationary TV receivers between two identified ATSC-M/H groups are identified in the received

25 first data stream and counted. The counted number of received first data packets between two identified ATSC-M/H groups has to be an integer multiple of 156 data packets (*i.e.*, the number of first data packets in a data slot containing only first data packets) plus, optionally, 38 data packets (*i.e.*, the number of first data packets in a data slot with first and second data packets) – in the case of a correct transmission. If

30 one or more first data packets are lost in the respective studio-transmitter-link (STL)  $3_1, 3_2, \dots, 3_i, \dots, 3_n$ , the corresponding number of dummy data packets has to be inserted in the VSB data fields between the VSB data fields transferring each an ATSC-M/H group to continuously establish and maintain the mapping data structure.

**[0062]** In step S90, the position of each first data packet received in the first data stream is determined by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$ . This is accomplished by calculating a number of VSB data fields reserved for transferring first data packets between the two VSB data fields each transferring second data packets of an ATSC-M/H group. The position of each consecutively transmitted first data packet in one of the calculated VSB data fields is determined on the basis of the calculated number of VSB data fields reserved for first data packets.

**[0063]** In step S100, the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  inserts synchronization information to each 38<sup>th</sup> second data packet (*i.e.*, to each 38<sup>th</sup> ATSC-M/H data packet) in each ATSC-M/H group corresponding to the ATSC-M/H standard. This synchronization information is a data field sync for synchronizing the start and the center of a VSB data field containing second data packets corresponding to the ATSC-M/H standard. The synchronization of VSB data fields containing first data packets is not defined by a standard. Thus the exciters in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  are allowed to insert a specific synchronizing information in an arbitrary position of a VSB data field with first data packets transferring data for stationary TV receivers.

**[0064]** In step S110, the second data stream is generated by the respective post-processor  $4_1, 4_2, \dots, 4_i, \dots, 4_n$  in each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  by mapping the first and second data packets received in the first data stream to the positions in each consecutively transmitted VSB data field of the second data stream, which are determined in steps S70 and S90.

**[0065]** After the mapping procedure, the dummy bytes in the first two data packets of each ATSC-M/H group in the second data stream are rewritten with a pre-selected value, preferably with the value 0xAF, for a correct detection of these dummy bytes by each receiver.

**[0066]** Each VSB data field in the second data stream is synchronously transmitted by the antenna  $13_1, 13_2, \dots, 13_i, \dots, 13_n$  of each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  at a synchronized time point. The synchronized time point is determined in the head-end 2 and transmitted to each transmitter  $5_1, 5_2, \dots, 5_i, \dots, 5_n$  for ATSC-M/H data as part of the signaling information in the first two data packets of an ATSC-M/H group.



[0067] Further signaling information between the head-end and each transmitter of the single frequency network, which are not specifically described in the patent application, are contemplated.

5 [0068] The specification and drawings are accordingly to be regarded in an illustrative rather than in a restrictive sense. It will, however, be evident that various modifications and changes may be made thereto, in a computer program product or software, hardware or any combination thereof.

10 [0069] Software embodiments of the present invention may be provided as a computer program product, or software, that may include an article of manufacture on a machine accessible or machine readable medium having instructions. The instructions on the machine accessible or machine readable medium may be used to program a computer system or other electronic device. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs, and magneto-optical disks or other type of media/machine-readable medium suitable for storing or transmitting electronic instructions. The techniques described herein are not limited to any particular software configuration. They may find applicability in any computing or processing environment. The terms "machine accessible medium" or "machine readable medium" used herein shall include any medium that is capable of storing, encoding, or transmitting a sequence of instructions for execution by the machine and that cause the machine to perform any one of the methods described herein. Furthermore, it is common in the art to speak of software, in one form or another (*e.g.*, program, procedure, process, application, module, unit, logic, and so on) as taking an action or causing a result. Such expressions are merely a shorthand way of stating that the execution of the software by a processing system causes the processor to perform an action to produce a result.

25 [0070] While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example, and not limitation. It will be apparent to persons skilled in the relevant art(s) that various changes in form and detail can be made therein. Thus, the present invention should not be limited by any of the above described exemplary embodiments. The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

30

[0071] In addition, it should be understood that the figures illustrated in the attachments, which highlight the functionality and advantages of the present invention, are presented for example purposes only. The architecture of the present invention is sufficiently flexible and configurable, such that it may be utilized (and  
5 navigated) in ways other than that shown in the accompanying figures.

[0072] Further, the purpose of the foregoing Abstract is to enable the U.S. Patent and Trademark Office and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence  
10 of the technical disclosure of the application. The Abstract is not intended to be limiting as to the scope of the present invention in any way. It is also to be understood that the steps and processes recited in the claims need not be performed in the order presented.

## IN THE CLAIMS

1. A method for mapping data packets of a first data stream into data fields of a second data stream at several transmitters, comprising:

generating a first data stream with first data packets containing data associated with stationary receivers and second data packets containing data associated with mobile receivers in a head-end, whereby second data packets at the start of a group of consecutively transmitted second data packets contain placeholders into which signaling information is filled;

transmitting said first data stream from said head-end to each of said transmitters;

extracting, by each transmitter, said signaling information from said second data packets indicating in which data slot and in which data sub-frame of a received data frame said second data packet is transferred;

inserting, by each transmitter, synchronization data in a specific data packet in each data slot containing second data packets;

checking a number of received second data packets of an ATSC-M/H group for completeness using a continuity counter in a header of each second data packet and/or a number of received first data packets of a data slot for completeness;

inserting a number of second data packets containing a dummy data packet in said data slot corresponding to the number of lost second data packets in an ATSC-M/H group of said data slot and/or a number of first data packets containing dummy data packets in said data slot corresponding to the number of lost first data packets in said data slot; and mapping said first and second data packets consecutively into said second data stream.

2. The method according to claim 1,

wherein said specific data packet with synchronization data at the start of a received data frame is positioned at the start of an odd-numbered data field in said second data stream.

3. The method according to claim 1,

wherein said specific data packet with synchronization data in a data slot at an even-numbered position in a data frame is mapped to the first data packet of a data field in said second data stream.

4. The method according to claim 1,

5 wherein said specific data packet with synchronizing data in a data slot at an odd-numbered position in a received data frame is mapped to the 157<sup>th</sup> data packet of a data field in said second data stream.

5. The method according to claim 1,

10 wherein said first data stream comprises ATSC-M/H data frames and said second data stream includes VSB data fields and an ATSC-M/H group including 118 consecutively positioned second data packets in a data slot, the second data packets having data associated with mobile receivers.

6. The method according to claim 1,

15 wherein before extracting said signaling information from said second data packet identifying, by each transmitter, the first data packets and second data packets based on the corresponding packet identifier.

7. The method according to claim 1,

20 wherein after extracting said signaling information, decoding said signaling information using a cycle redundancy check information transmitted at the end of said signaling information to determine a correct transmission of said signaling information.

8. The method according to claim 1,

wherein the specific data packet in each data slot in which synchronizing information is inserted is the 38<sup>th</sup> data packet of the data slot.

9. The method according to any of claim 1,

25 wherein said signaling information further includes an ATSC system time associated with each transmitter.

10. The method according to claim 1,  
wherein said signaling information contains an information for switching each transmitter from a first operation mode in which data for mobile and stationary receivers are transmitted to a second operation mode in which only data for stationary receivers are  
5 transmitted.
11. The method according to claim 10,  
wherein after receiving a specific number of data frames of the first data stream without any identified second data packets, each transmitter is switched to said second operation mode.
- 10 12. The method according to claim 1,  
wherein each placeholder with signaling data in the first two received second data packets are rewritten with a pre-selected value after extracting said signaling information.
13. A system for mapping data packets of a first data stream into data fields of a second data stream at several transmitters, comprising:  
15 a head-end operable to generate a first data stream with first data packets containing data associated with stationary receivers and second data packets containing data associated with mobile receivers, whereby second data packets at the start of a group of consecutively transmitted second data packets contain placeholders into which signaling information is filled;  
20 said head-end further operable to transmit said first data stream to each of said transmitters; and  
wherein each transmitter is operable to extract said signaling information from said second data packets indicating in which data slot and in which data sub-frame of a received data frame said second data packet is transferred, insert synchronization data in  
25 a specific data packet in each data slot containing second data packets, check a number of received second data packets of an ATSC-M/H group for completeness using a continuity counter in a header of each second data packet and/or a number of received first data packets of a data slot for completeness, insert a number of second data packets containing

a dummy data packet in said data slot corresponding to the number of lost second data packets in an ATSC-M/H group of said, data slot and/or a number of first data packets containing dummy data packets in said data slot corresponding to the number of lost first data packets in said data slot, and map said first and second data packets consecutively  
5 into said second data stream.

14. The system according to claim 13,  
wherein said specific data packet with synchronization data at the start of a received data frame is positioned at the start of an odd-numbered data field in said second data stream.

10 15. The system according to claim 13,  
wherein said specific data packet with synchronization data in a data slot at an even-numbered position in a data frame is mapped to the first data packet of a data field in said second data stream.

15 16. The system according to claim 13,  
wherein said specific data packet with synchronizing data in a data slot at an odd-numbered position in a received data frame is mapped to the 157<sup>th</sup> data packet of a data field in said second data stream.

17. The system according to claim 13,  
wherein said first data stream comprises ATSC-M/H data frames and said second  
20 data stream includes VSB data fields and an ATSC-M/H group including 118 consecutively positioned second data packets in a data slot, the second data packets having data associated with mobile receivers.

18. The system according to claim 13,  
wherein before each transmitter extracts said signaling information from said  
25 second data packet identifying, the first data packets and second data packets based on the corresponding packet identifier.

19. The system according to claim 13, further comprising:  
a decoder operable to decode said signaling information using a cycle redundancy check information transmitted at the end of said signaling information to determine a correct transmission of said signaling information.
- 5 20. The system according to claim 13,  
wherein the specific data packet in each data slot in which synchronizing information is inserted is the 38<sup>th</sup> data packet of the data slot.
21. The system according to any of claim 13,  
wherein said signaling information further includes an ATSC system time  
10 associated with each transmitter.
22. The system according to claim 13,  
wherein said signaling information contains an information for switching each transmitter from a first operation mode in which data for mobile and stationary receivers are transmitted to a second operation mode in which only data for stationary receivers are  
15 transmitted.
23. The system according to claim 22,  
wherein after receiving a specific number of data frames of the first data stream without any identified second data packets, each transmitter is switched to said second operation mode.
- 20 24. The system according to claim 13,  
wherein each placeholder with signaling data in the first two received second data packets are rewritten with a pre-selected value after extracting said signaling information.
25. A computer-readable medium having stored thereon sequences of instructions, the sequences of instructions including instructions which when executed by a computer  
25 system causes the computer system to perform:

generating a first data stream with first data packets containing data associated with stationary receivers and second data packets containing data associated with mobile receivers in a head-end, whereby second data packets at the start of a group of consecutively transmitted second data packets contain placeholders into which signaling information is filled;

transmitting said first data stream from said head-end to a plurality of transmitters;

extracting, by each transmitter, said signaling information from said second data packets indicating in which data slot and in which data sub-frame of a received data frame said second data packet is transferred;

inserting, by each transmitter, synchronization data in a specific data packet in each data slot containing second data packets;

checking a number of received second data packets of an ATSC-M/H group for completeness using a continuity counter in a header of each second data packet and/or a number of received first data packets of a data slot for completeness;

inserting a number of second data packets containing a dummy data packet in said data slot corresponding to the number of lost second data packets in an ATSC-M/H group of said data slot and/or a number of first data packets containing dummy data packets in said data slot corresponding to the number of lost first data packets in said data slot; and

mapping said first and second data packets consecutively into a second data stream.

26. The computer-readable medium according to claim 25,

wherein said specific data packet with synchronization data at the start of a received data frame is positioned at the start of an odd-numbered data field in said second data stream.

27. The computer-readable medium according to claim 25,

wherein said specific data packet with synchronization data in a data slot at an even-numbered position in a data frame is mapped to the first data packet of a data field in said second data stream.



28. The computer-readable medium according to claim 25,  
wherein said specific data packet with synchronizing data in a data slot at an odd-numbered position in a received data frame is mapped to the 157<sup>th</sup> data packet of a data field in said second data stream.
- 5 29. The computer-readable medium according to claim 25,  
wherein said first data stream comprises ATSC-M/H data frames and said second data stream includes VSB data fields and an ATSC-M/H group including 118 consecutively positioned second data packets in a data slot, the second data packets having data associated with mobile receivers.
- 10 30. The computer-readable medium according to claim 25,  
wherein before extracting said signaling information from said second data packet identifying, by each transmitter, the first data packets and second data packets based on the corresponding packet identifier.
- 15 31. The computer-readable medium according to claim 25,  
wherein after extracting said signaling information, decoding said signaling information using a cycle redundancy check information transmitted at the end of said signaling information to determine a correct transmission of said signaling information.
- 20 32. The computer-readable medium according to claim 25,  
wherein the specific data packet in each data slot in which synchronizing information is inserted is the 38<sup>th</sup> data packet of the data slot.
33. The computer-readable medium according to any of claim 25,  
wherein said signaling information further includes an ATSC system time associated with each transmitter.
- 25 34. The computer-readable medium according to claim 25,  
wherein said signaling information contains an information for switching each transmitter from a first operation mode in which data for mobile and stationary receivers

are transmitted to a second operation mode in which only data for stationary receivers are transmitted.

35. The computer-readable medium according to claim 34,  
wherein after receiving a specific number of data frames of the first data stream  
5 without any identified second data packets, each transmitter is switched to said second  
operation mode.

36. The computer-readable medium according to claim 25,  
wherein each placeholder with signaling data in the first two received second data  
packets are rewritten with a pre-selected value after extracting said signaling information.

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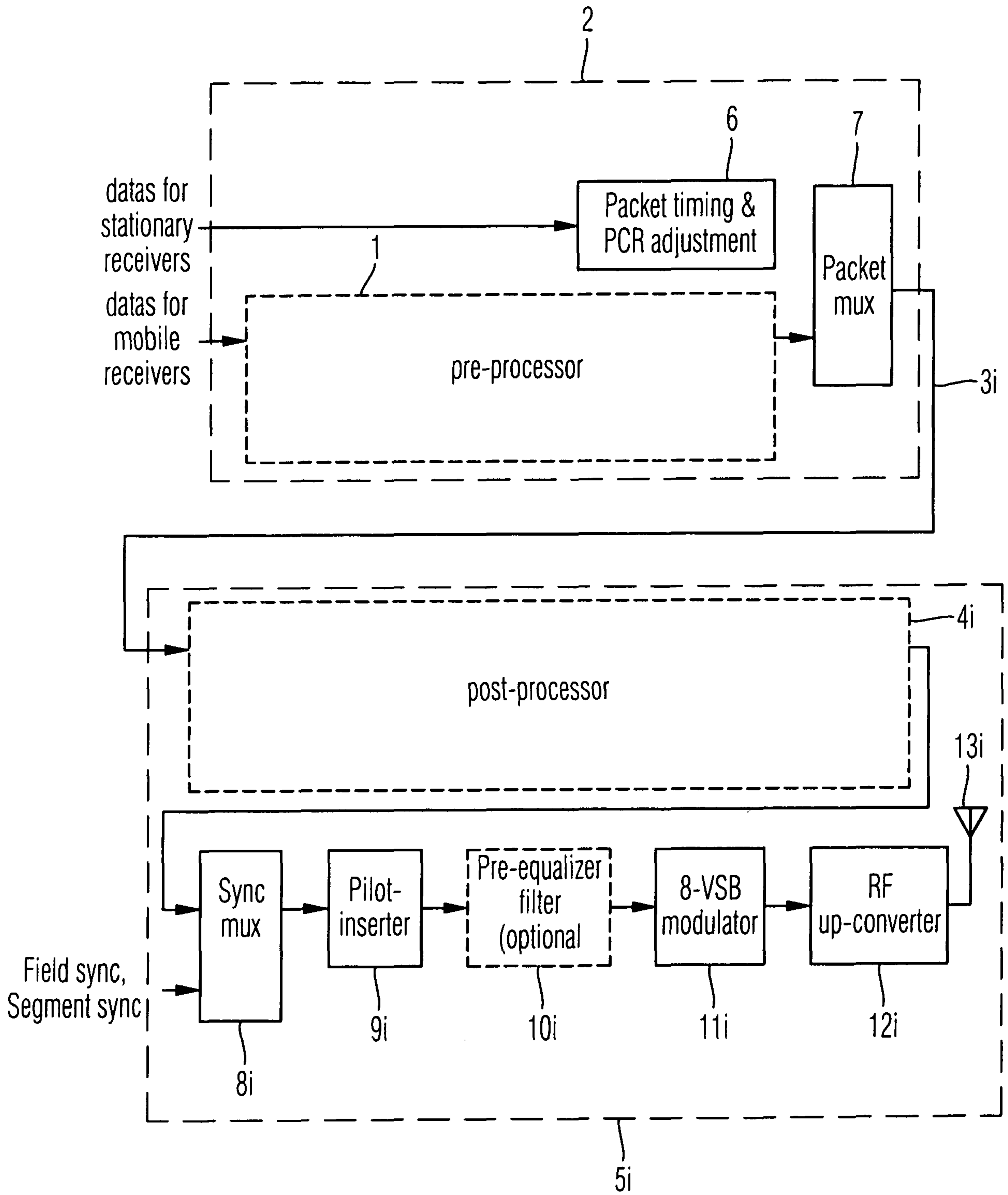


Fig. 1

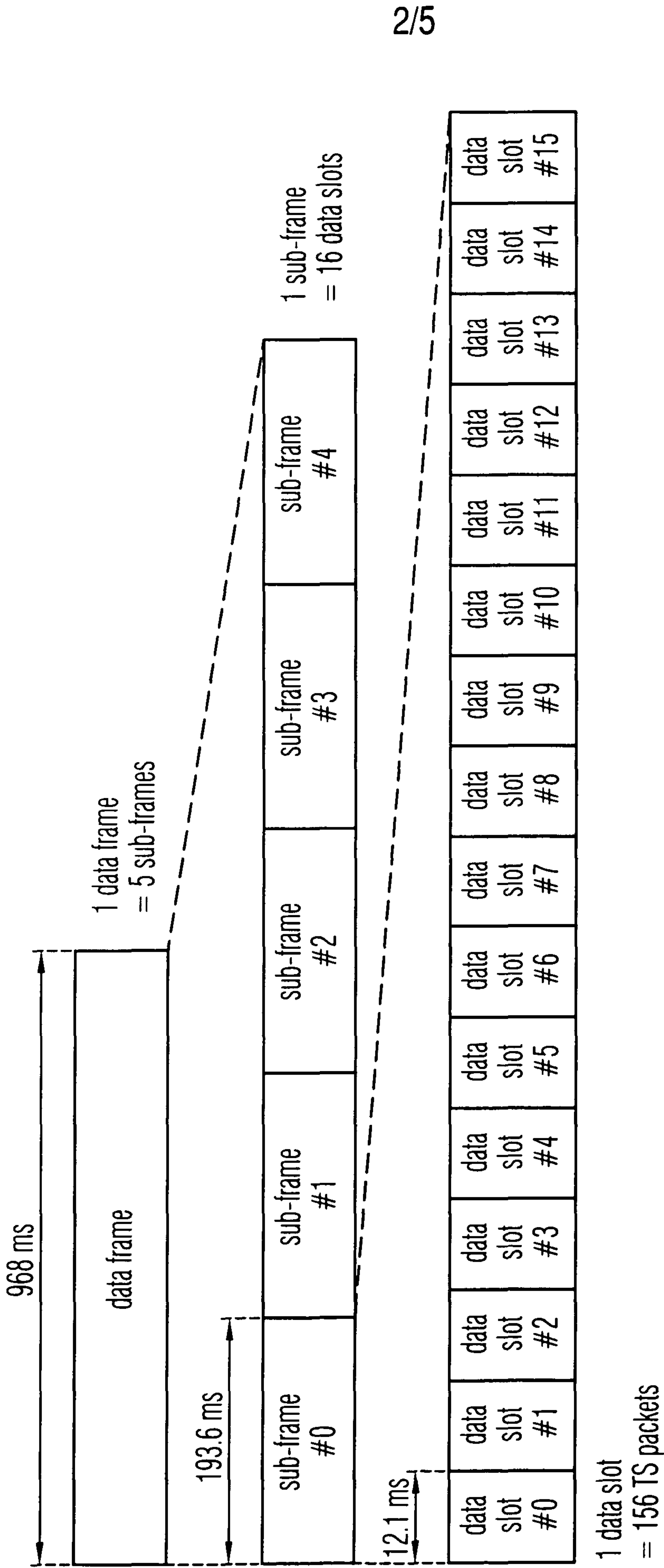


Fig. 2



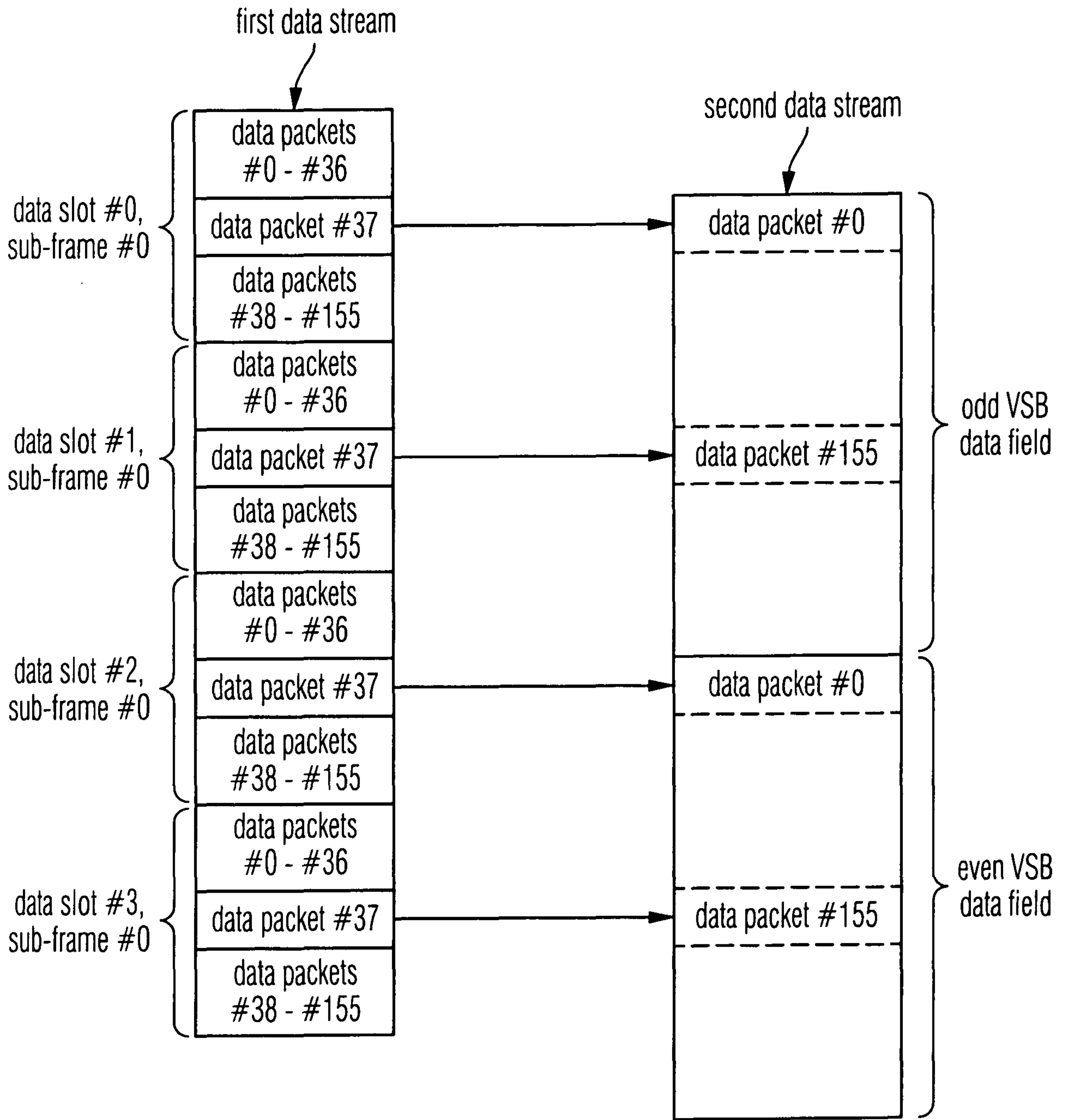


Fig. 5

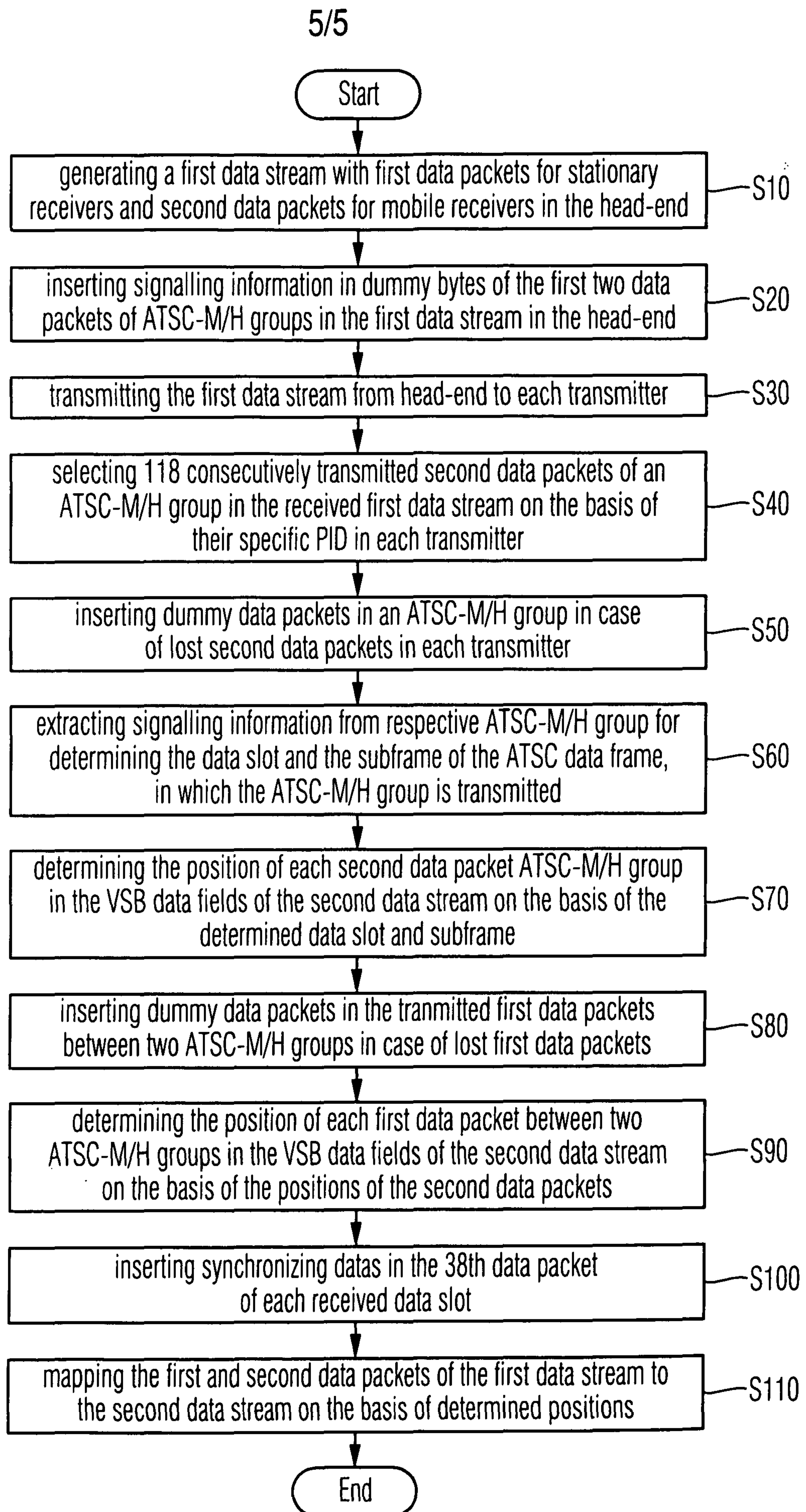


Fig. 6

