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(54) **DIGITAL BROADCASTING SYSTEM AND METHOD OF PROCESSING DATA IN DIGITAL BROADCASTING SYSTEM**

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(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.** **370/336**

(57) **ABSTRACT**

A digital broadcast receiver and a control method thereof are disclosed. The control method of the digital broadcast receiver includes receiving a broadcast signal into which mobile service data and main service data are multiplexed, extracting TPC signaling information and FIC signaling information from a data group in the received mobile service data, acquiring a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble, using the extracted FIC signaling information, and detecting IP address information required for channel tuning to the at least one virtual channel corresponding to the ensemble, using the acquired program table.

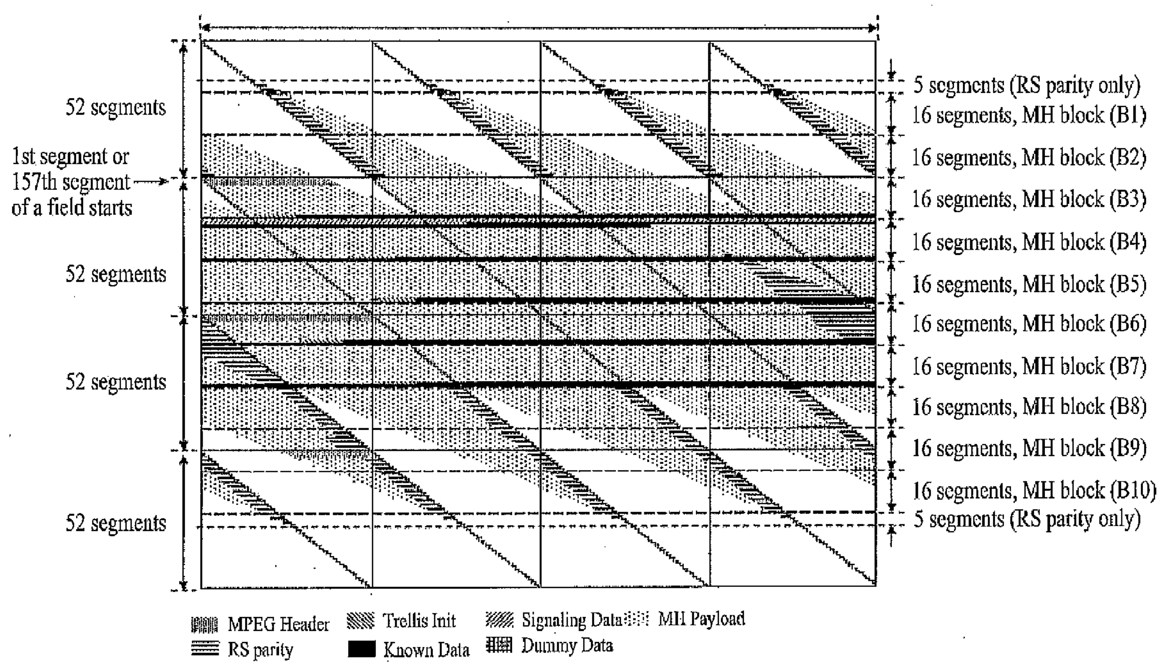
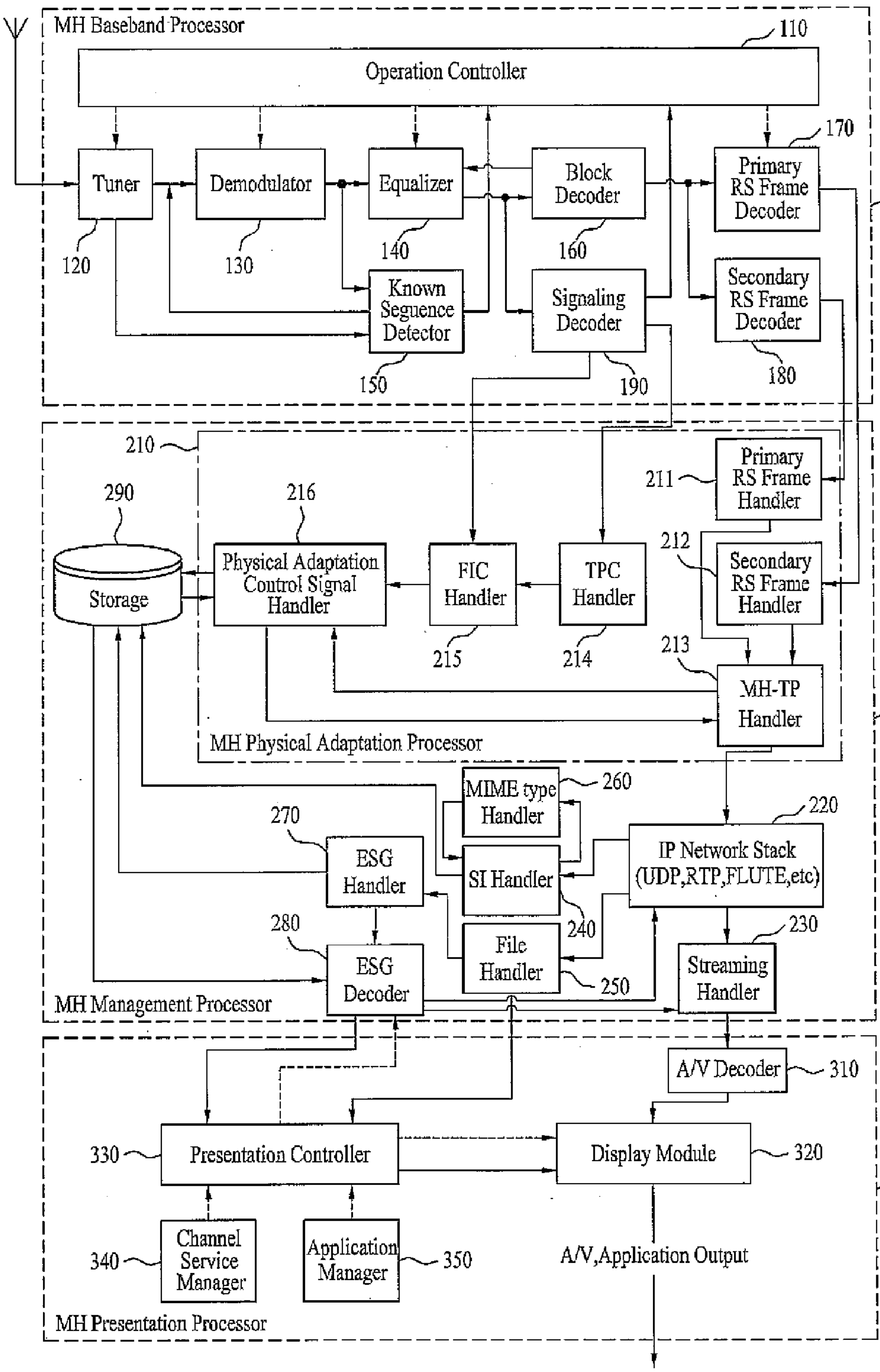
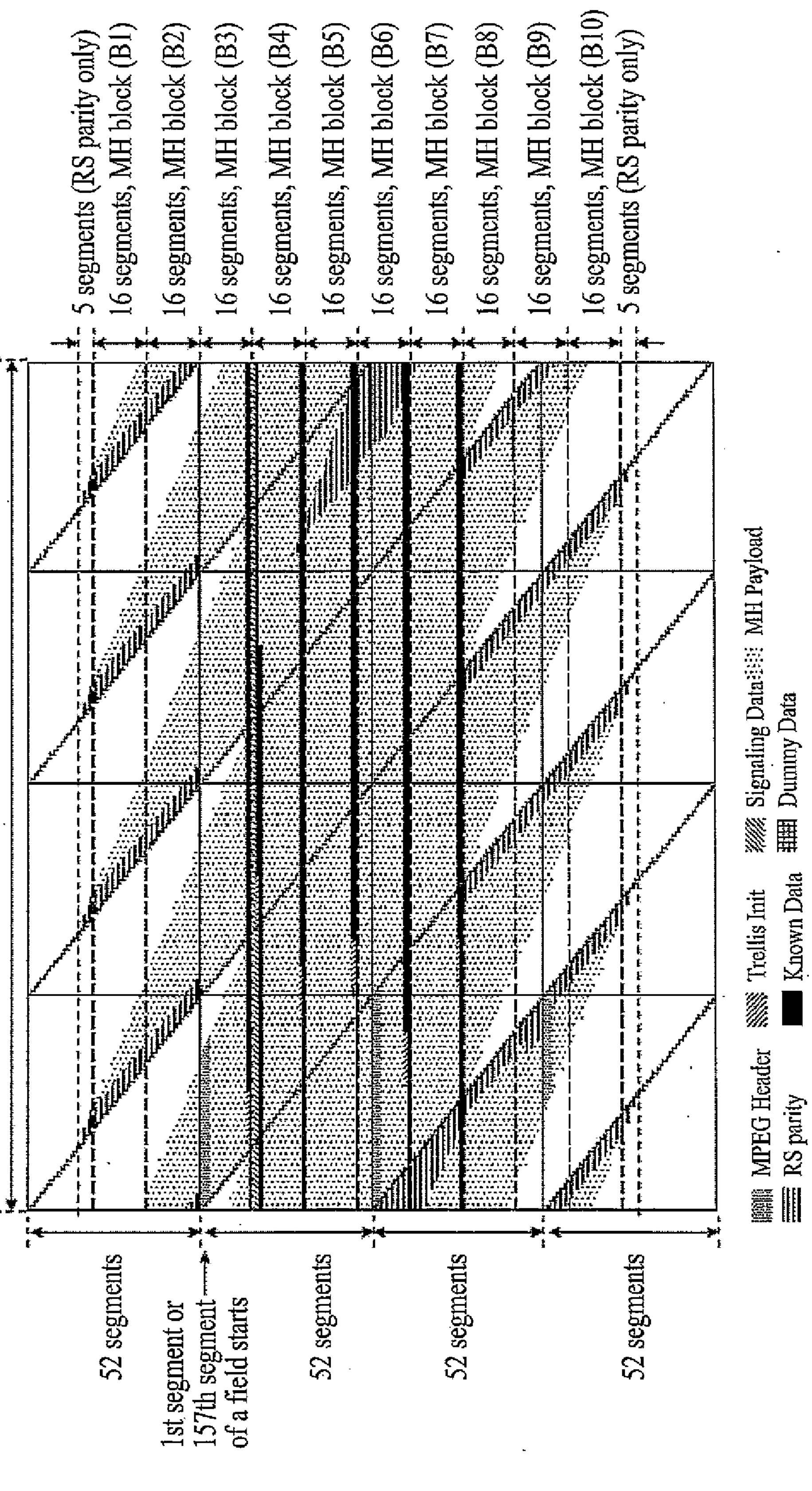


FIG. 1



MH Baseband Processor
110
Operation Controller
170
Tuner
Demodulator
Equalizer
Block Decoder
Primary RS Frame Decoder
100
120
130
140
160
Known Sequence Detector
Signaling Decoder
Secondary RS Frame Decoder
150
190
180
210
290
216
211
Primary RS Frame Handler
212
Storage
Physical Adaptation Control Signal Handler
FIC Handler
TPC Handler
Secondary RS Frame Handler
215
214
213
MH-TP Handler
200
MH Physical Adaptation Processor
MIME type Handler
260
220
270
ESG Handler
SI Handler
IP Network Stack (UDP,RTP,FLUTE,etc)
280
240
230
ESG Decoder
File Handler
250
Streaming Handler
MH Management Processor
A/V Decoder
310
330
Presentation Controller
Display Module
320
300
340
Channel Service Manager
Application Manager
350
A/V,Application Output
MH Presentation Processor

FIG. 2



5 segments (RS parity only)
16 segments, MH block (B1)
16 segments, MH block (B2)
16 segments, MH block (B3)
16 segments, MH block (B4)
16 segments, MH block (B5)
16 segments, MH block (B6)
16 segments, MH block (B7)
16 segments, MH block (B8)
16 segments, MH block (B9)
16 segments, MH block (B10)
5 segments (RS parity only)
52 segments
1st segment or 157th segment of a field starts
52 segments
52 segments
52 segments
MPEG Header
RS parity
Trellis Init
Known Data
Signaling Data
Dummy Data
MH Payload

FIG. 3

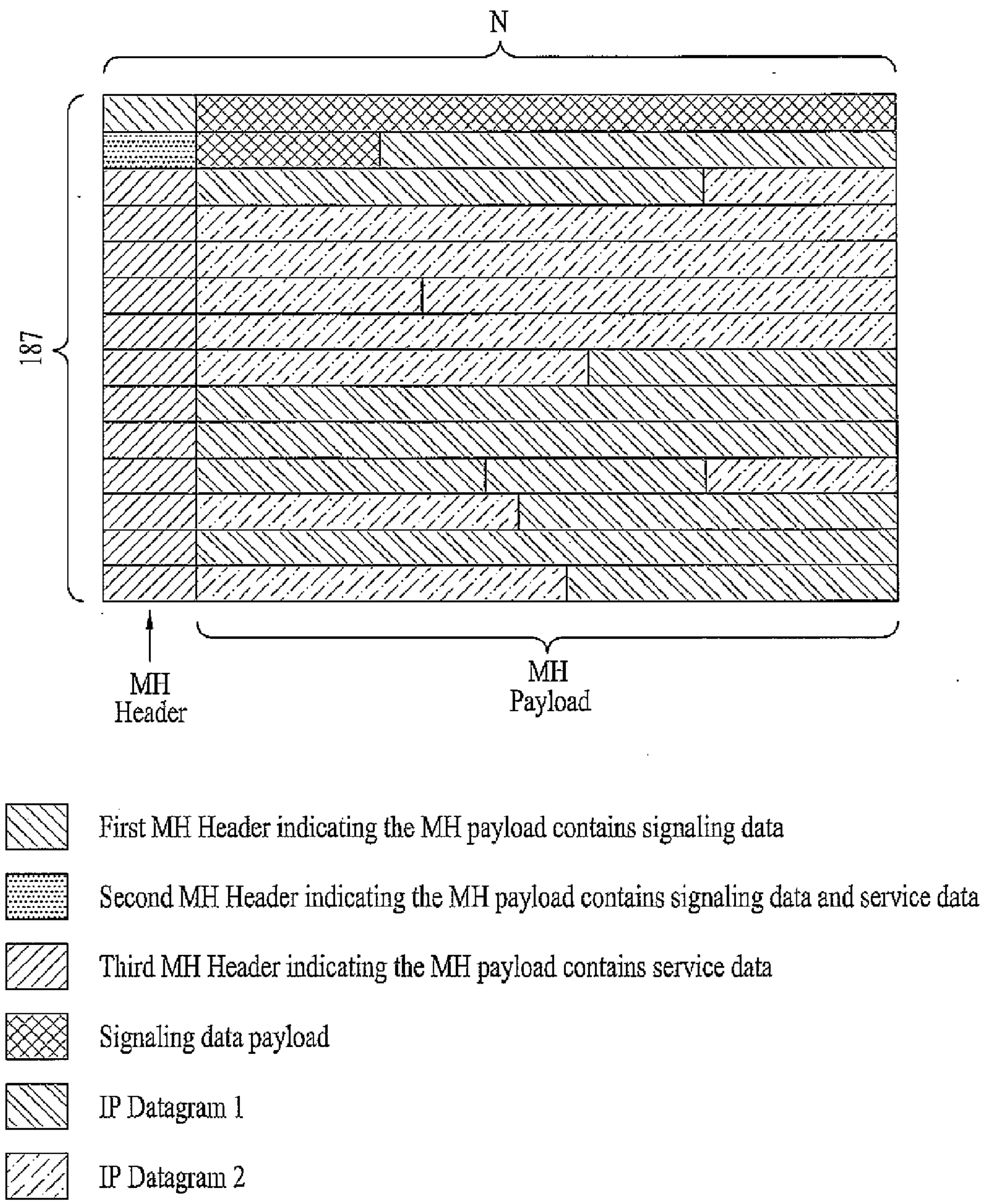
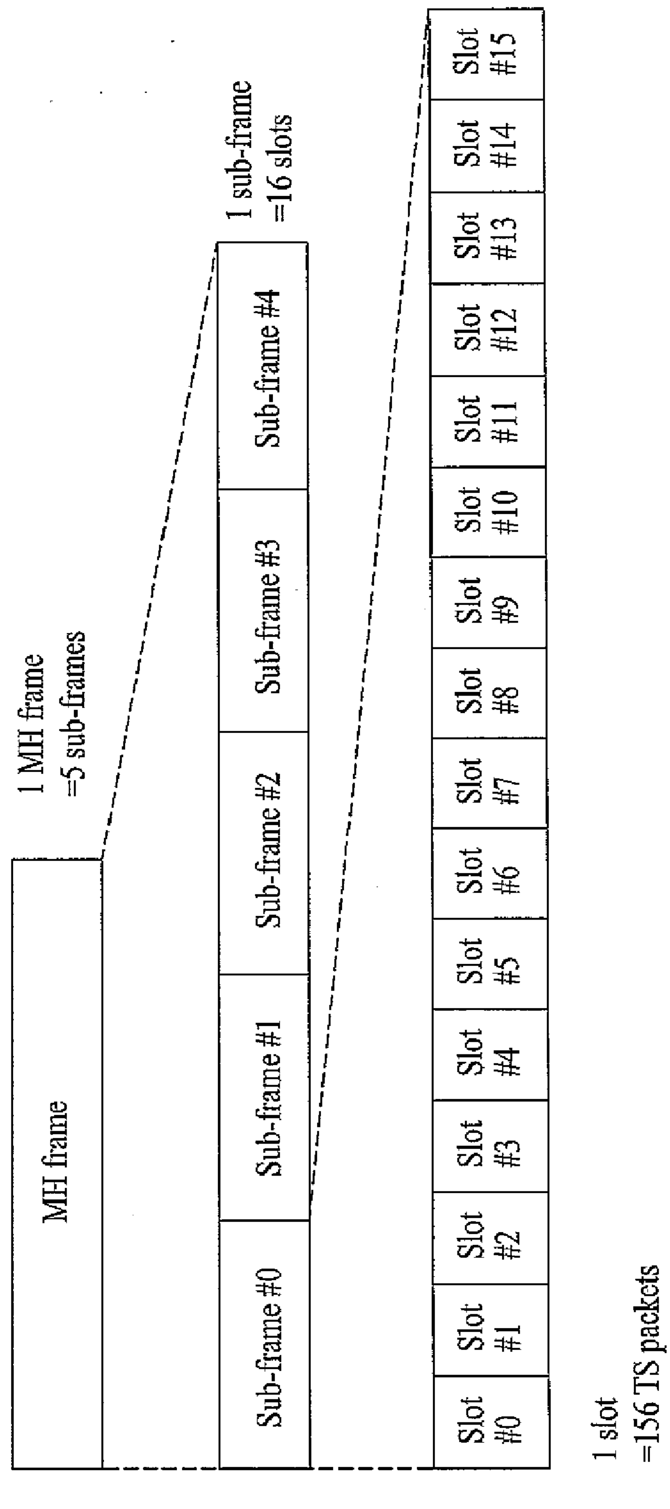

N
187
MH
Header
MH
Payload
First MH Header indicating the MH payload contains signaling data
Second MH Header indicating the MH payload contains signaling data and service data
Third MH Header indicating the MH payload contains service data
Signaling data payload
IP Datagram 1
IP Datagram 2

FIG. 4



1 MH frame
=5 sub-frames
MH frame
1 sub-frame
=16 slots
Sub-frame #0
Sub-frame #1
Sub-frame #2
Sub-frame #3
Sub-frame #4
Slot #0
Slot #1
Slot #2
Slot #3
Slot #4
Slot #5
Slot #6
Slot #7
Slot #8
Slot #9
Slot #10
Slot #11
Slot #12
Slot #13
Slot #14
Slot #15
1 slot
=156 TS packets

FIG. 5

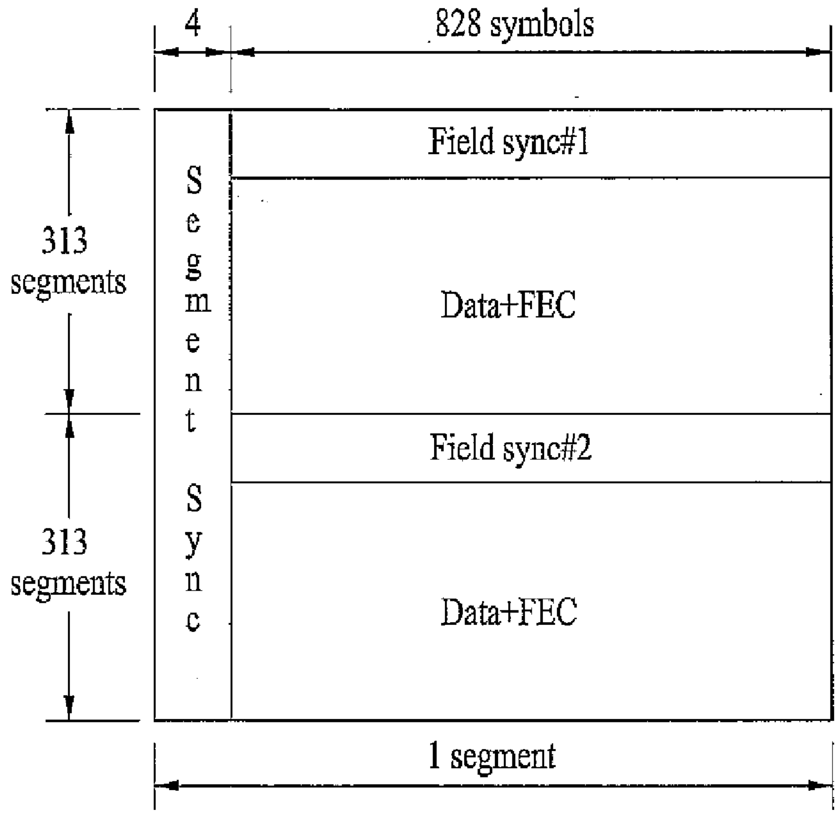

4
828 symbols
313
segments
313
segments
Segment Sync
Field sync#1
Data+FEC
Field sync#2
Data+FEC
1 segment

FIG. 6

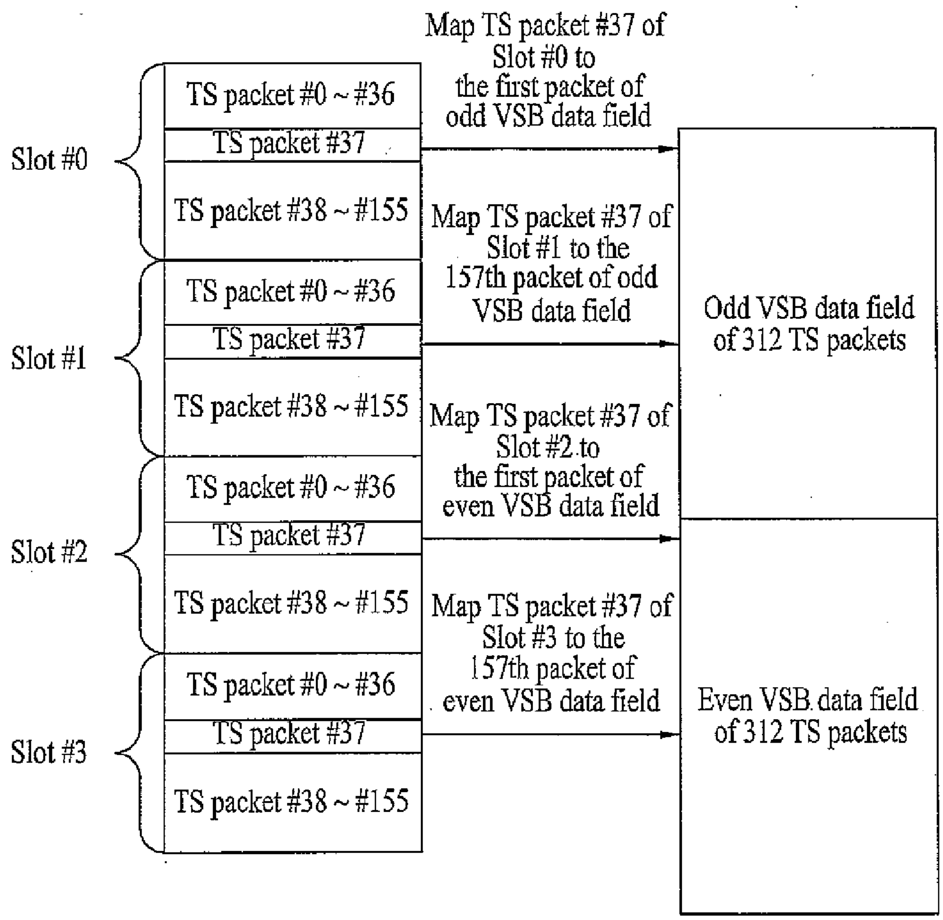

Map TS packet #37 of Slot #0 to the first packet of odd VSB data field
Map TS packet #37 of Slot #1 to the 157th packet of odd VSB data field
Map TS packet #37 of Slot #2 to the first packet of even VSB data field
Map TS packet #37 of Slot #3 to the 157th packet of even VSB data field
Slot #0
Slot #1
Slot #2
Slot #3
TS packet #0 ~ #36
TS packet #37
TS packet #38 ~ #155
Odd VSB data field of 312 TS packets
Even VSB data field of 312 TS packets

FIG. 7

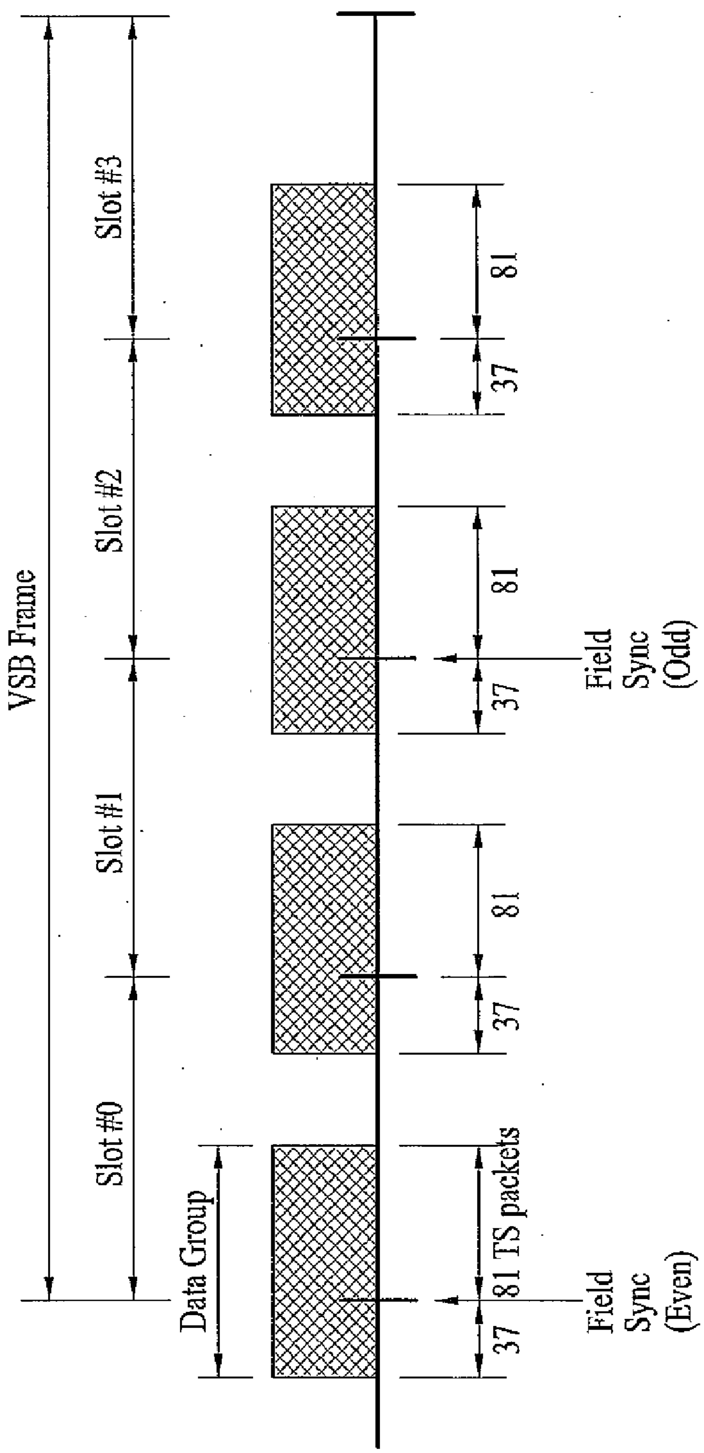
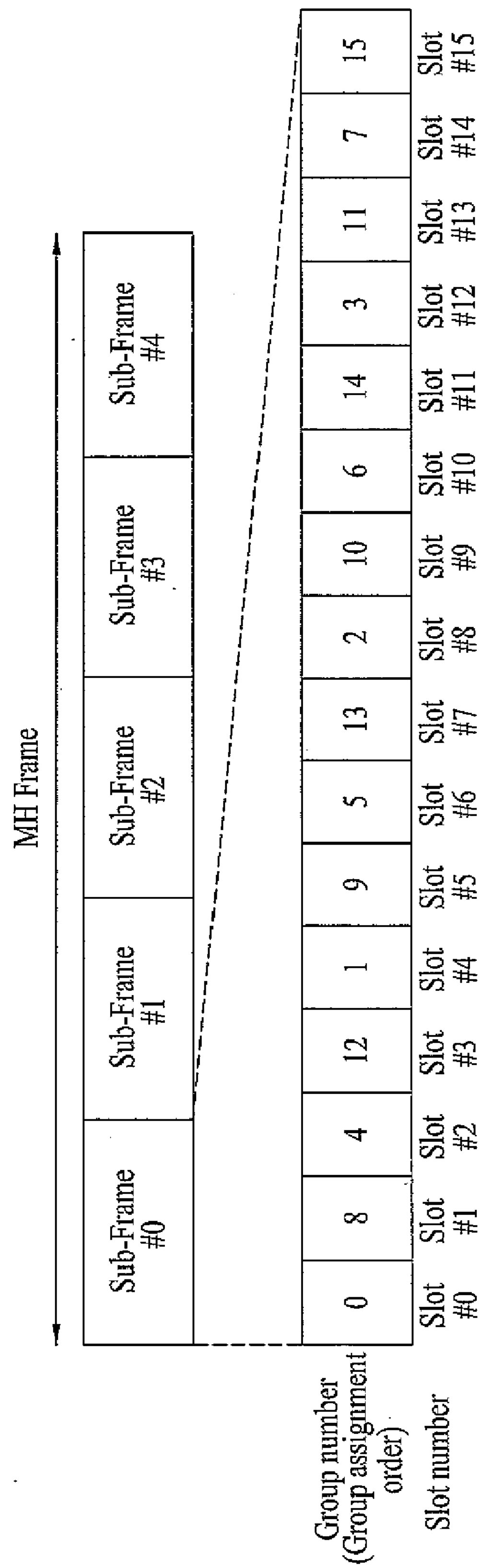

VSB Frame
Slot #0
Slot #1
Slot #2
Slot #3
Data Group
37
81 TS packets
37
81
37
81
37
81
Field Sync (Even)
Field Sync (Odd)

FIG. 8



MH Frame
Sub-Frame #0
Sub-Frame #1
Sub-Frame #2
Sub-Frame #3
Sub-Frame #4
Group number (Group assignment order)
Slot number
0
8
4
12
1
9
5
13
2
10
6
14
3
11
7
15
Slot #0
Slot #1
Slot #2
Slot #3
Slot #4
Slot #5
Slot #6
Slot #7
Slot #8
Slot #9
Slot #10
Slot #11
Slot #12
Slot #13
Slot #14
Slot #15

FIG. 9

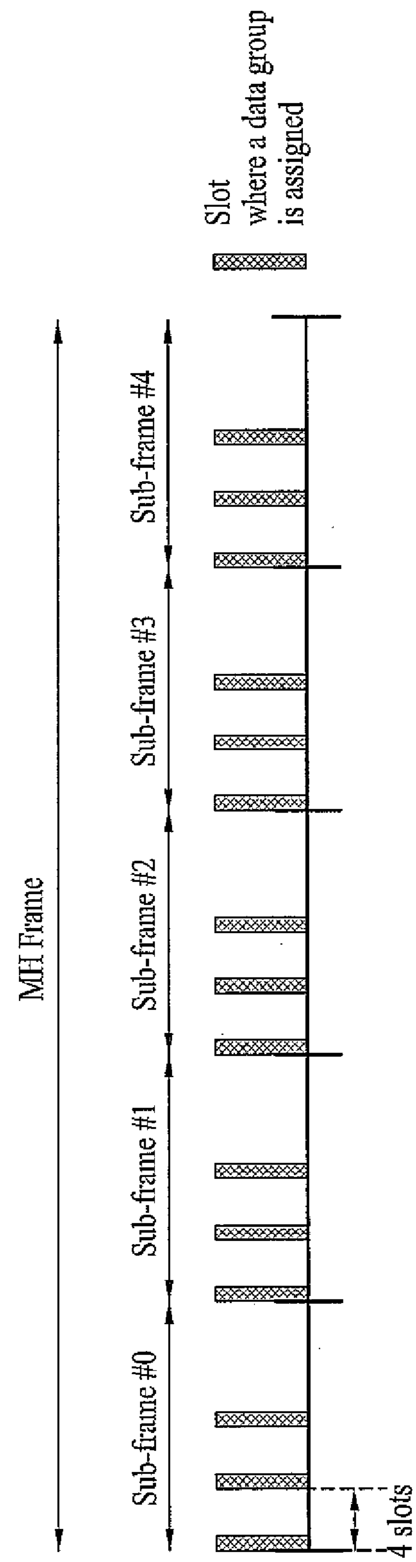

Slot
where a data group
is assigned
MH Frame
Sub-frame #0
Sub-frame #1
Sub-frame #2
Sub-frame #3
Sub-frame #4
4 slots

FIG. 10

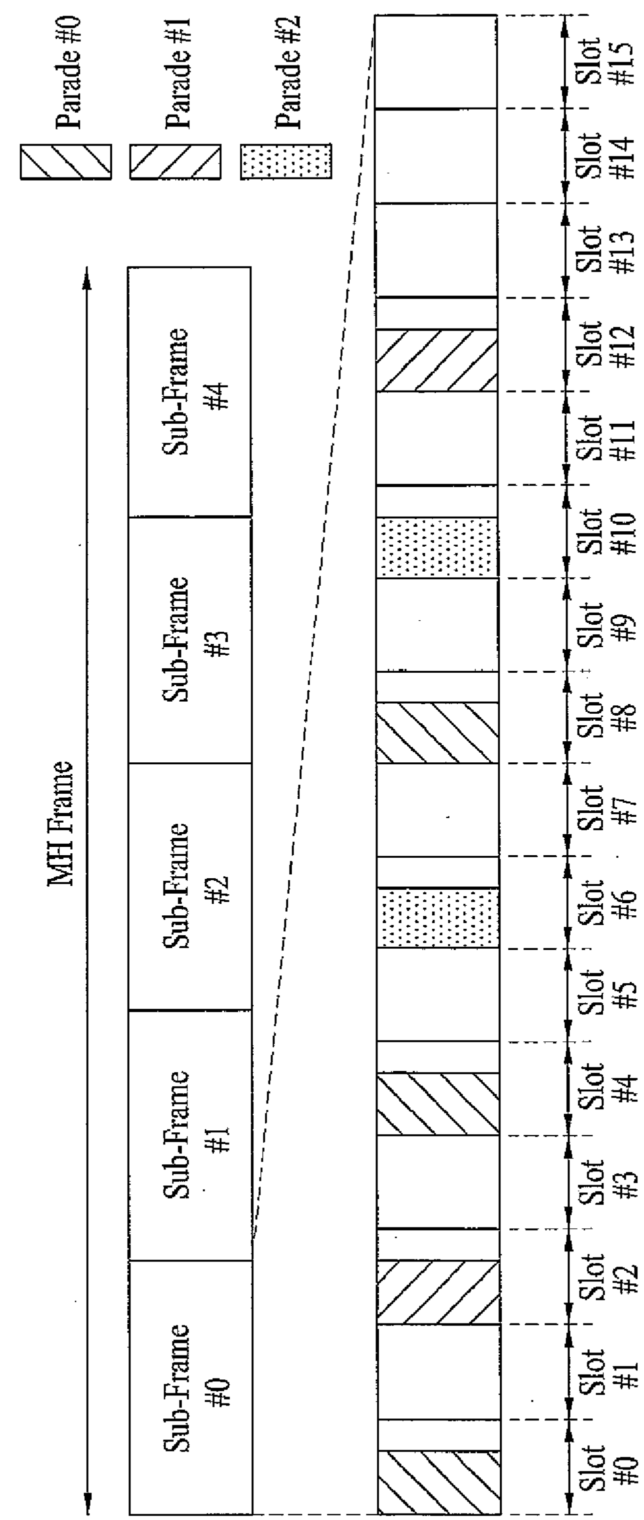

Parade #0
Parade #1
Parade #2
MH Frame
Sub-Frame #0
Sub-Frame #1
Sub-Frame #2
Sub-Frame #3
Sub-Frame #4
Slot #0
Slot #1
Slot #2
Slot #3
Slot #4
Slot #5
Slot #6
Slot #7
Slot #8
Slot #9
Slot #10
Slot #11
Slot #12
Slot #13
Slot #14
Slot #15

FIG. 11

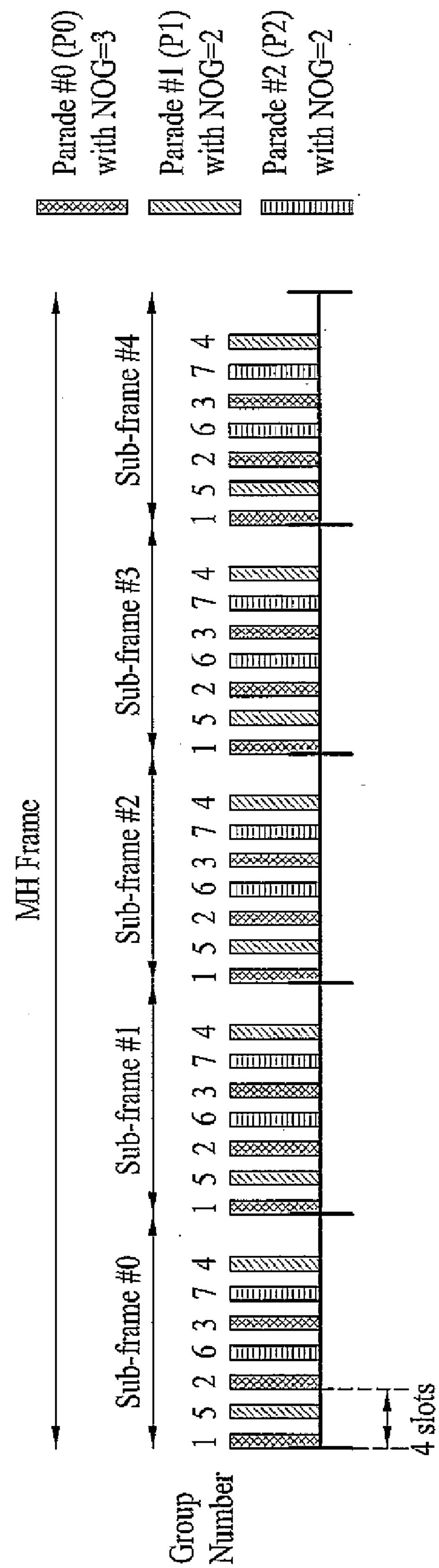

Parade #0 (P0) with NOG=3
Parade #1 (P1) with NOG=2
Parade #2 (P2) with NOG=2
MH Frame
Sub-frame #0
Sub-frame #1
Sub-frame #2
Sub-frame #3
Sub-frame #4
Group Number
1 5 2 6 3 7 4
1 5 2 6 3 7 4
1 5 2 6 3 7 4
1 5 2 6 3 7 4
1 5 2 6 3 7 4
4 slots

FIG. 12

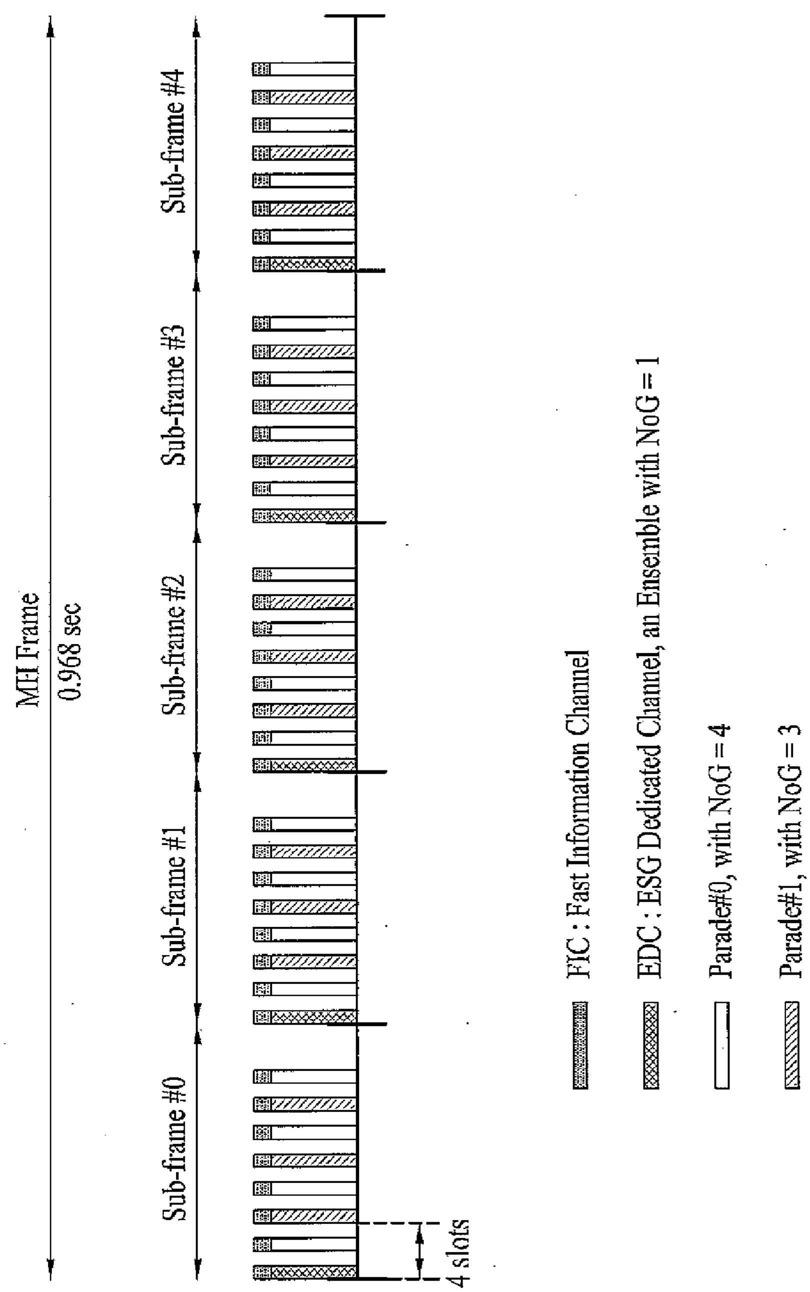

MH Frame
0.968 sec
Sub-frame #0
Sub-frame #1
Sub-frame #2
Sub-frame #3
Sub-frame #4
4 slots
FIC : Fast Information Channel
EDC : ESG Dedicated Channel, an Ensemble with NoG = 1
Parade#0, with NoG = 4
Parade#1, with NoG = 3

FIG. 13

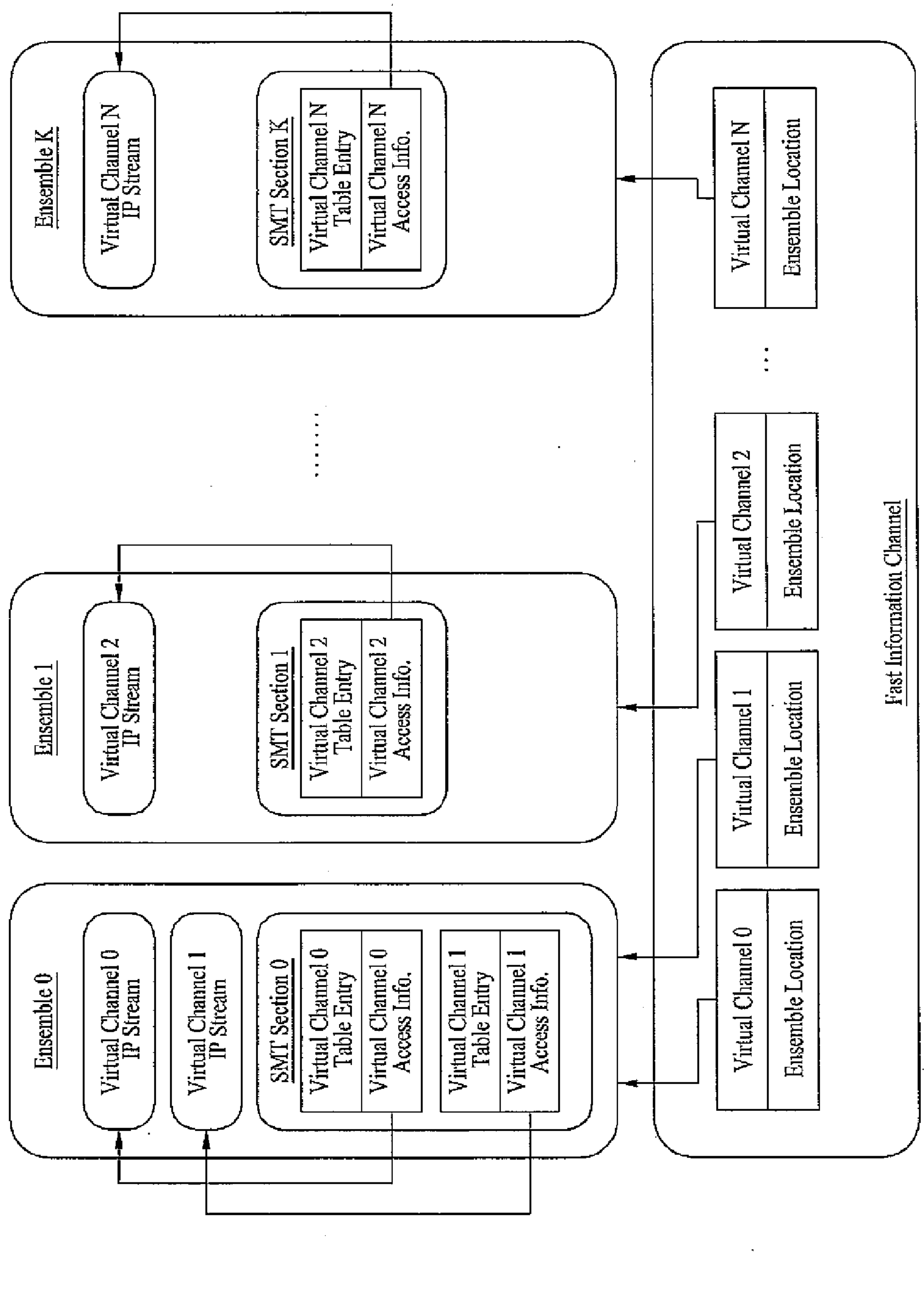

Ensemble 0
Virtual Channel 0 IP Stream
Virtual Channel 1 IP Stream
SMT Section 0
Virtual Channel 0 Table Entry
Virtual Channel 0 Access Info.
Virtual Channel 1 Table Entry
Virtual Channel 1 Access Info.
Ensemble 1
Virtual Channel 2 IP Stream
SMT Section 1
Virtual Channel 2 Table Entry
Virtual Channel 2 Access Info.
Ensemble K
Virtual Channel N IP Stream
SMT Section K
Virtual Channel N Table Entry
Virtual Channel N Access Info.
Virtual Channel 0
Ensemble Location
Virtual Channel 1
Ensemble Location
Virtual Channel 2
Ensemble Location
Virtual Channel N
Ensemble Location
Fast Information Channel

FIG. 14

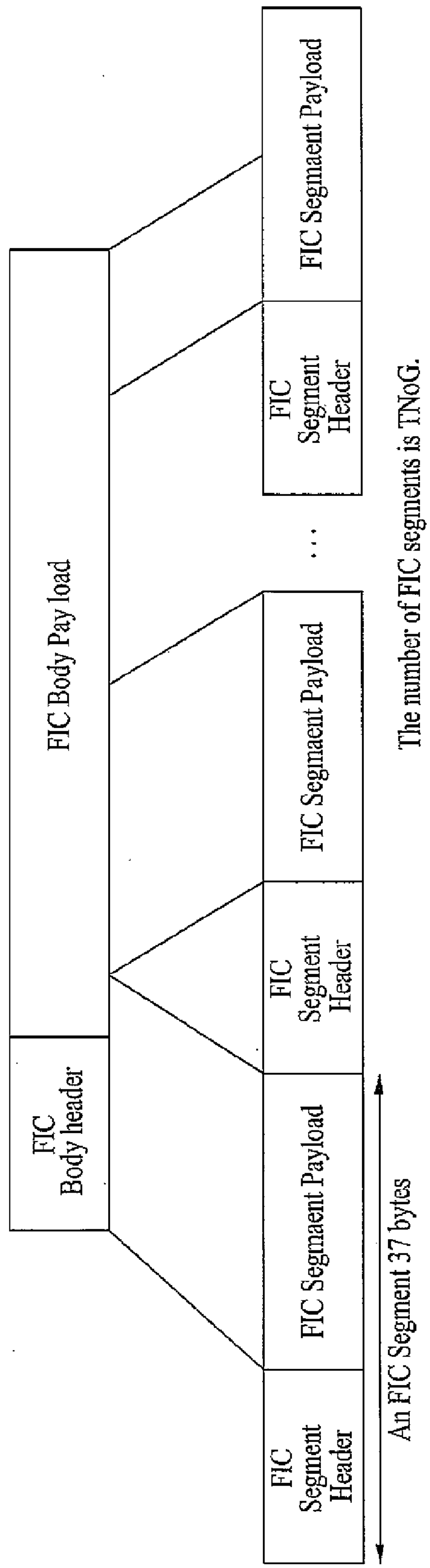

FIC Body header
FIC Body Pay load
FIC Segment Header
FIC Segmaent Payload
FIC Segment Header
FIC Segmaent Payload
...
FIC Segment Header
FIC Segmaent Payload
An FIC Segment 37 bytes
The number of FIC segments is TNoG.

FIG. 15

Syntax	# of bits
FIC_Segment () {	
FIC_type	2
Reserved	5
error_indicator	1
FIC_seg_number	4
FIC_last_seg_number	4
for (i=0:i<N:i++) {	
data_byte	8
}	
}	

FIG. 16

Region	Syntax	# of bits
A first region	if (FIC_seg_number == 0) {	
	current_next_indicator	1
	Reserved	2
	ESG_version	5
	transport_stream_id	16
	}	
A second region	while (ensemble_id ! = 0xFF)	
	ensemble id	8
	reserved	3
	SI_version	5
	num_channel	3
A third region	for (i=0:i< num_channel:i++) {	
	channel_type	5
	channel_activity	2
	CA_indicator	1
	Stand_alone_Semce_indtcator	
	major_channel_num	8
	minor_channel_num	8
	}	
	} // end of while	
	}	

FIG. 17

Syntax	No. of Bits	Format
service_map_table_section() {		
table_id	8	TBD
section_syntax_indicator	1	'0'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
reserved	3	'111'
version_number	5	uimsbf
section_number	8	uimsbf
last_section_number	8	uimsbf
SMT_protocol_version	8	uimsbf
ensemble_id	8	uimsbf
num_channels	8	uimsbf
for (i=0; i<num_channels; i++)		
{		
major_channel_number	8	uimsbf
minor_channel_number	8	uimsbf
short_channel_name	8*8	
service_id	16	uimsbf
service_type	6	uimsbf
virtual_channel_activity	2	uimsbf
num_components	5	uimsbf
IP_version_flag	1	bslbf
source_IP_address_flag	1	bslbf
virtual_channel_target_IP_address_flag	1	bslbf
if (source_IP_address_flag)		
source_IP_address	32 or 128	uimsbf
if (virtual_channel_target_IP_address_flag)		
virtual_channel_target_IP_address	32 or 128	uimsbf
for (j=0; j<num_components; j++)		
{		
RTP_payload_type	7	uimsbf
component_target_IP_address _flag	1	bslbf
if (component_target_IP_address _flag)		
component_target_IP_address	32 or 128	uimsbf
reserved	2	'11'
port_num_count	6	uimsbf
target_UDP_port_num	16	uimsbf
descriptors_length	8	uimsbf
for (k=0; k<descriptors_length; k++)		
{		
component_level_descriptor()		
}		
}		
descriptors_length	8	uimsbf
for (m=0; m<descriptors_length; m++)		
{		
virtual_channel_level_descriptor()		
}		
}		
descriptors_length	8	uimsbf
for (n=0; n<descriptors_length; n++) {		
{		
ensemble_level_descriptor()		
} ensemble_level_descriptor()		
}		

FIG. 18

Syntax	No. of Bits	Format
MH_audio_descriptor() {		
descriptor_tag	8	TBD
descriptor_length	8	uimsbf
channel_configuration	8	uimsbf
reserved	5	'11111'
sample_rate_code	3	uimsbf
reserved	2	'11'
bit_rate_code	6	uimsbf
ISO_639_language_code	3*8	uimsbf
}		

FIG. 19

Syntax	No. of Bits	Format
MH_RTP_payload_type_descriptor() {		
descriptor_tag	8	TBD
descriptor_length	8	uimsbf
reserved	1	'1'
RTP_payload_type	7	uimsbf
MIME_type_length	8	uimsbf
MIME_type()	var	
}		

FIG. 20

Syntax	No. of Bits	Format
MH_current_event_descriptor() {		
descriptor_tag	8	TBD
descriptor_length	8	uimsbf
current_event_start_time	4*8	uimsbf
current_event_duration	3*8	uimsbf
Title_length	8	uimsbf
Title_text()	var	
}		

FIG. 21

Syntax	No. of Bits	Format
MH_next_event_descriptor() {		
descriptor_tag	8	TBD
descriptor_length	8	uimsbf
next_event_start_time	4*8	uimsbf
next_event_duration	3*8	uimsbf
title_length	8	uimsbf
title_text()	var	
}		

FIG. 22

Syntax	No. of Bits	Format
MH_system_time_descriptor() {		
descriptor_tag	8	TBD
descriptor_length	8	uimsbf
system_time	32	uimsbf
GPS_UTC_offset	8	uimsbf
time_zone_offset_polarity_rate_code	1	bslbf
time_zone_offset	31	uimsbf
daylight_savings()	16	uimsbf
time_zone()	5*8	
}		

FIG. 23

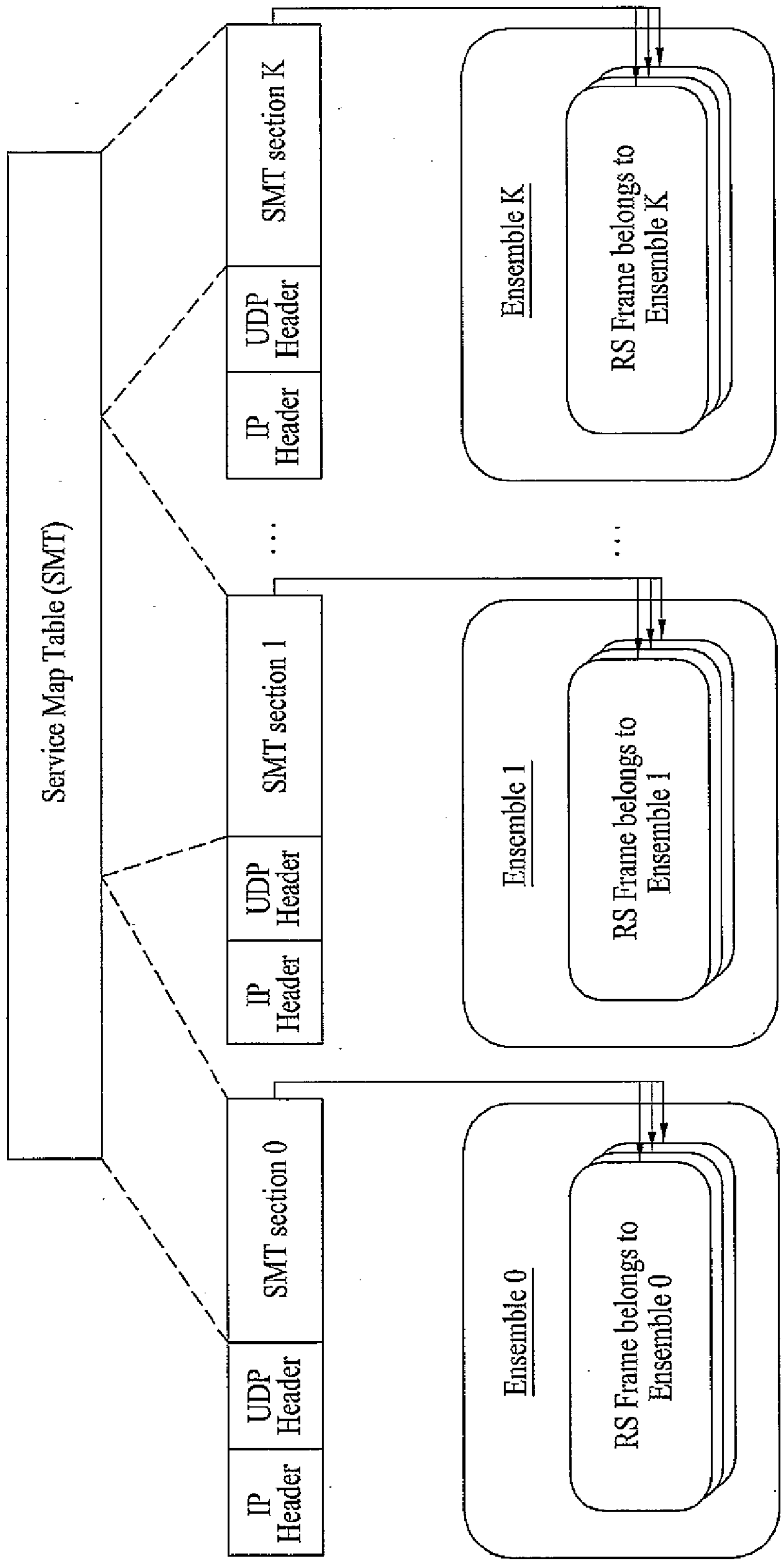

Service Map Table (SMT)
IP Header
UDP Header
SMT section 0
SMT section 1
SMT section K
Ensemble 0
RS Frame belongs to Ensemble 0
Ensemble 1
RS Frame belongs to Ensemble 1
Ensemble K
RS Frame belongs to Ensemble K

FIG. 24

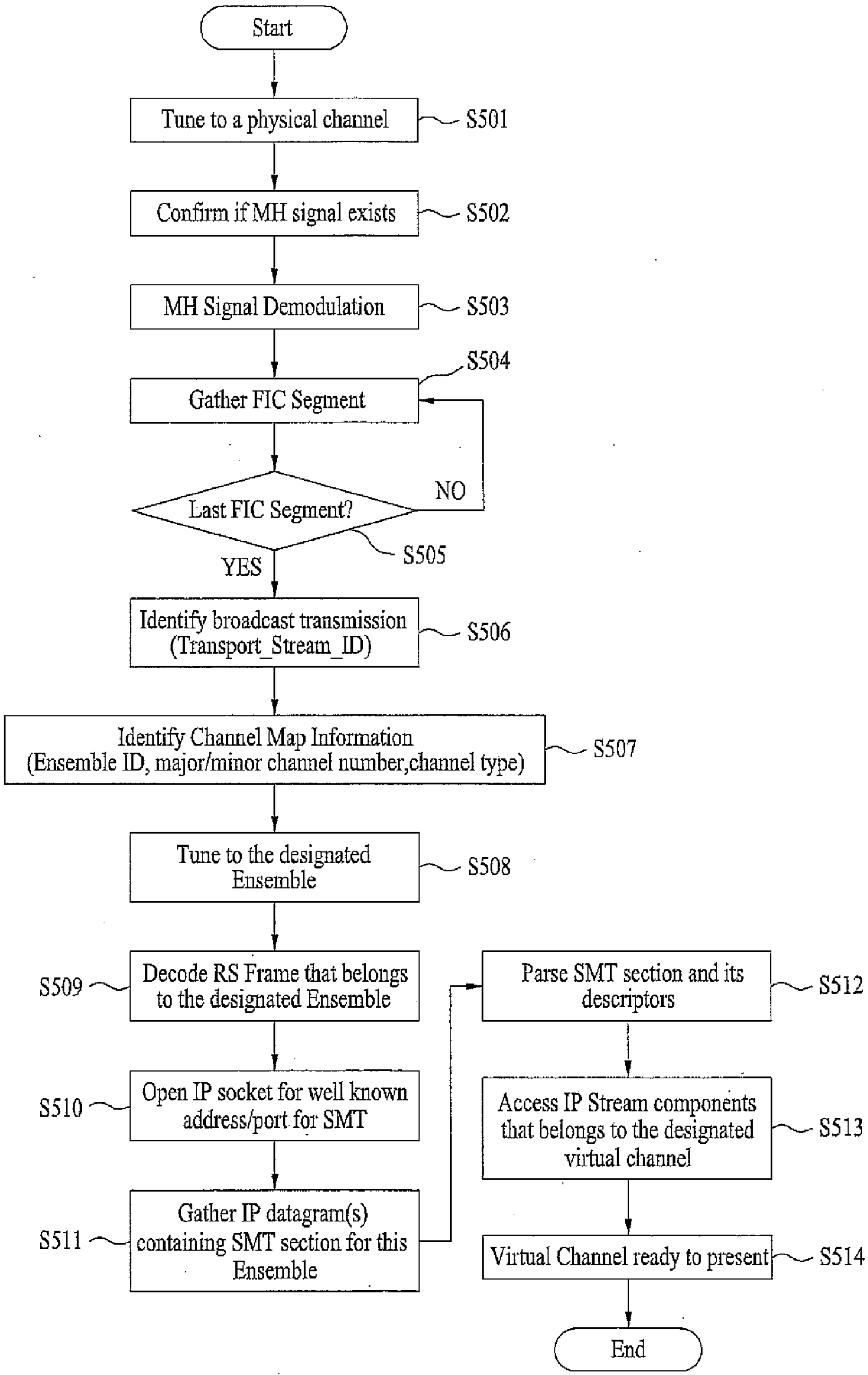

Start
Tune to a physical channel
S501
Confirm if MH signal exists
S502
MH Signal Demodulation
S503
Gather FIC Segment
S504
Last FIC Segment?
NO
YES
S505
Identify broadcast transmission (Transport_Stream_ID)
S506
Identify Channel Map Information (Ensemble ID, major/minor channel number,channel type)
S507
Tune to the designated Ensemble
S508
Decode RS Frame that belongs to the designated Ensemble
S509
Open IP socket for well known address/port for SMT
S510
Gather IP datagram(s) containing SMT section for this Ensemble
S511
Parse SMT section and its descriptors
S512
Access IP Stream components that belongs to the designated virtual channel
S513
Virtual Channel ready to present
S514
End

FIG. 25

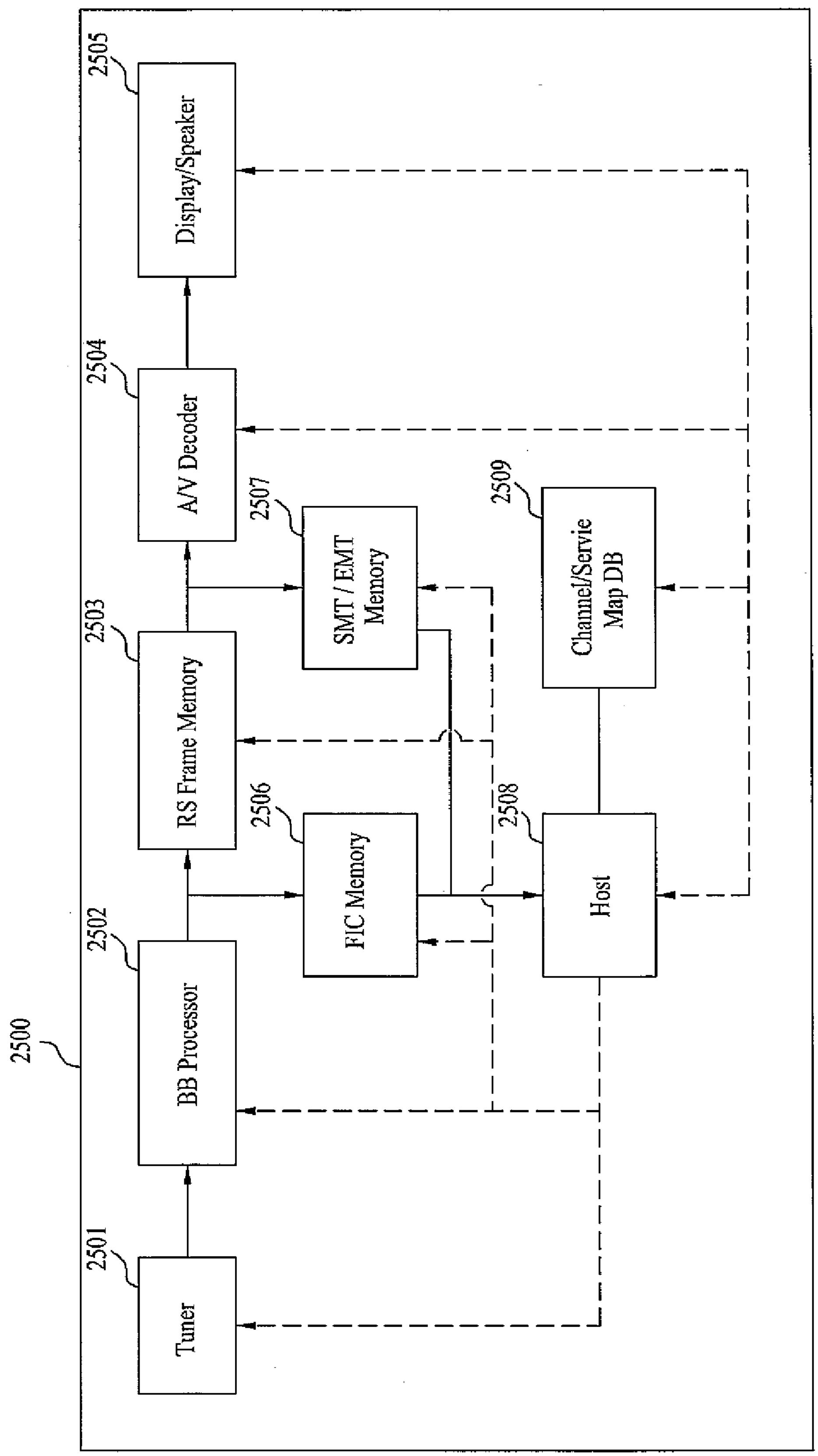

2500
2501
Tuner
2502
BB Processor
2503
RS Frame Memory
2504
A/V Decoder
2505
Display/Speaker
2506
FIC Memory
2507
SMT / EMT Memory
2508
Host
2509
Channel/Servie Map DB

FIG. 26

Syntax	No. of Bits	Format
ensemble_map_table_section() {		
table_id	8	TBD
section_syntax_indicator	1	'0'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
transport_stream_id	16	uimsbf
reserved	2	'111'
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
EMT_protocol_version	8	uimsbf
num_ensembles	8	uimsbf
for(i=0; i<num_ensembles;i++)		
{		
ensemble_id	8	uimsbf
num_channels	8	uimsbf
for (i=0; i<num_channels; i++)		
{		
major_channel_number	8	uimsbf
minor_channel_number	8	uimsbf
num_components	5	uimsbf
IP_version_flag	1	bslbf
source_IP_address_flag	1	bslbf
virtual_channel_target_IP_address_flag	1	bslbf
if (source_IP_address_flag)		
source_IP_address	32 or 128	uimsbf
if (virtual_channel_target_IP_address_flag)		
virtual_channel_target_IP_address	32 or 128	uimsbf
for (j=0; j<num_components; j++)		
{		
component_type	7	uimsbf
component_target_IP_address _flag	1	bslbf
if (component_target_IP_address _flag)		
component_target_IP_address	32 or 128	uimsbf
reserved	2	'11'
port_num_count	6	uimsbf
target_UDP_port_num	16	uimsbf
descriptors_length	8	uimsbf
for (k=0; k<descriptors_length; k++)		
{		
component_level_descriptor()		
}		
}		
descriptors_length	8	uimsbf
for (m=0; m<descriptors_length; m++)		
{		
virtual_channel_level_descriptor()		
}		
}		
descriptors_length	8	uimsbf
for (n=0; n<descriptors_length; n++) {		
{		
ensemble_level_descriptor()		
}		
}		
}		
}		

FIG. 27

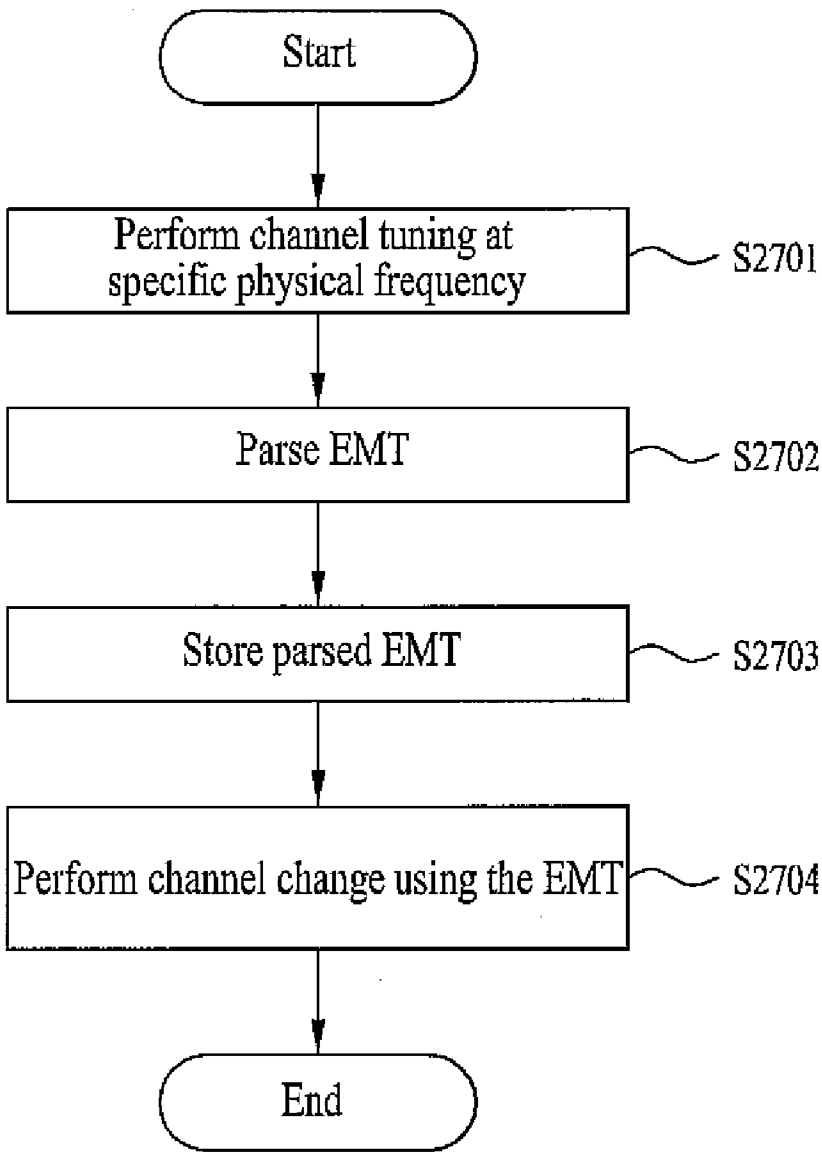
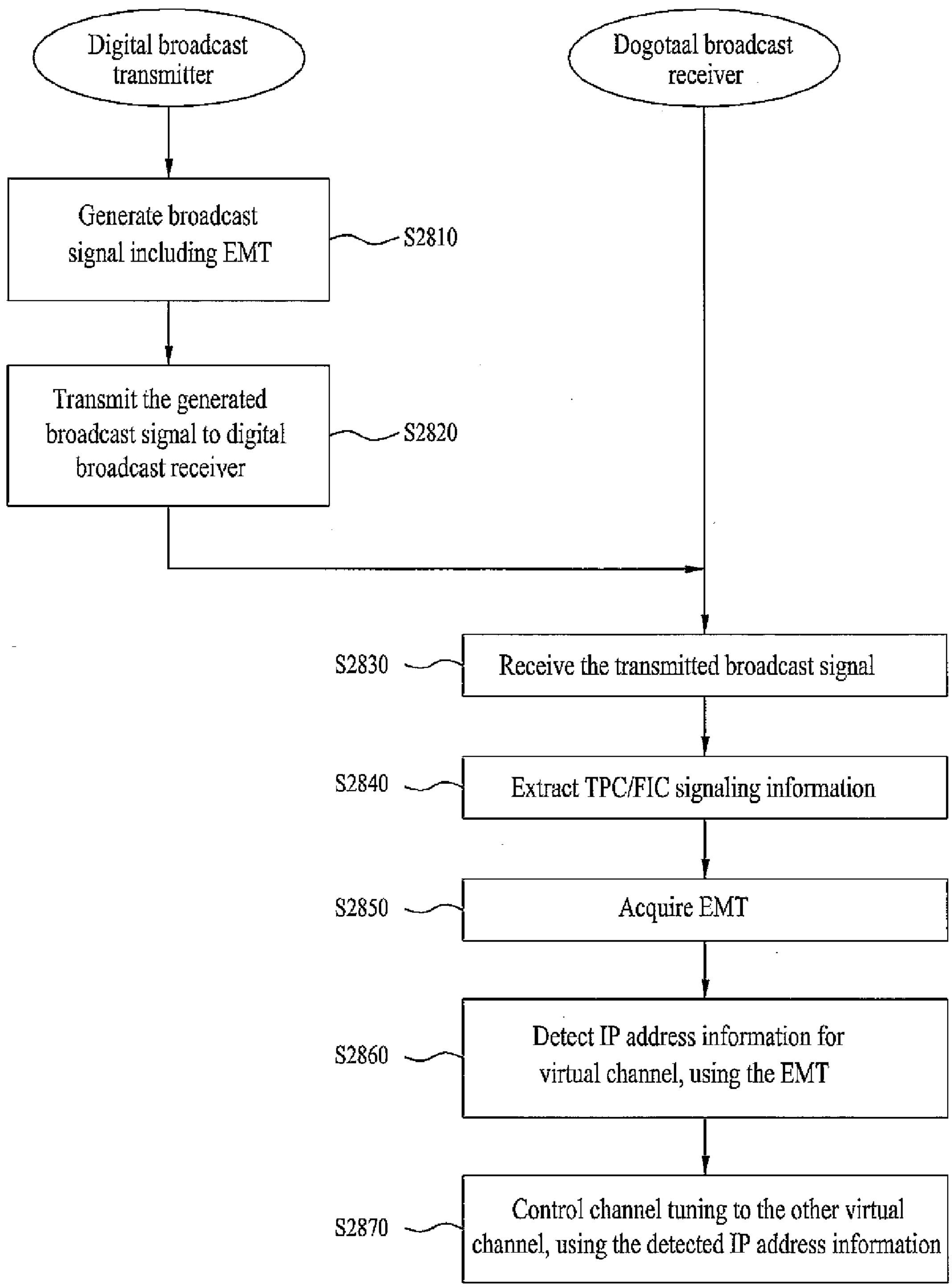

Start
Perform channel tuning at specific physical frequency
S2701
Parse EMT
S2702
Store parsed EMT
S2703
Perform channel change using the EMT
S2704
End

FIG. 28


Digital broadcast transmitter
Dogotaal broadcast receiver
Generate broadcast signal including EMT
S2810
Transmit the generated broadcast signal to digital broadcast receiver
S2820
S2830
Receive the transmitted broadcast signal
S2840
Extract TPC/FIC signaling information
S2850
Acquire EMT
S2860
Detect IP address information for virtual channel, using the EMT
S2870
Control channel tuning to the other virtual channel, using the detected IP address information

DIGITAL BROADCASTING SYSTEM AND METHOD OF PROCESSING DATA IN DIGITAL BROADCASTING SYSTEM

[0001] This application claims the priority benefit of Korean Application No. 10-2008-0092413, filed on Sep. 19, 2008, which is hereby incorporated by reference as if fully set forth therein.

[0002] This application claims the benefit of U.S. Provisional Application No. 60/974,084, filed on Sep. 21, 2007, U.S. Provisional Application No. 60/977,379, filed on Oct. 4, 2007, U.S. Provisional Application No. 61/016,497, filed on Dec. 24, 2007, U.S. Provisional Application No. 61/044,504, filed on Apr. 13, 2008, U.S. Provisional Application No. 61/076,686, filed on Jun. 29, 2008, and U.S. Provisional Application No. 61/090,874, filed on Aug. 21, 2008, which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The present invention relates to a digital broadcasting system, and more particularly, to a digital broadcast receiving system and a method for controlling the same.

[0005] 2. Discussion of the Related Art

[0006] A digital broadcasting system is configured of a digital broadcast transmitting system (or transmitter) and a digital broadcast receiving system (or receiver). Also, the digital broadcast transmitting system digitally processes data, such as broadcast programs, and transmits the processed data to the digital broadcast receiving system. Due to its various advantages, such as efficient data transmission, the digital broadcasting system is gradually replacing the conventional analog broadcasting systems.

[0007] However, the Vestigial Sideband (VSB) transmission mode, which is adopted as the standard for digital broadcasting in North America and the Republic of Korea, is a system using a single carrier method. Therefore, the receiving performance of the digital broadcast receiving system may be deteriorated in a poor channel environment. Particularly, since resistance to changes in channels and noise is more highly required when using portable and/or mobile broadcast receivers, the receiving performance may be even more deteriorated when transmitting mobile service data by the VSB transmission mode.

[0008] Furthermore, under a conventional mobile digital broadcasting environment, a considerable channel change time is taken in a digital broadcast receiver.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention is directed to a digital broadcast receiver and a control method thereof that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0010] An object of the present invention is to provide a digital broadcast receiver which is robust against a channel variation and noise, and a control method thereof.

[0011] Another object of the present invention is to provide a system capable of considerably enhancing the channel change speed of a digital broadcast receiver.

[0012] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0013] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a control method of a digital broadcast receiver comprises: receiving a broadcast signal into which mobile service data and main service data are multiplexed; extracting transmission parameter channel (TPC) signaling information and fast information channel (FIC) signaling information from a data group in the received mobile service data; acquiring a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble, using the extracted FIC signaling information; and detecting IP address information required for channel tuning to the at least one virtual channel corresponding to the ensemble, using the acquired program table.

[0014] In another aspect of the present invention, a control method of a digital broadcast receiver comprises: generating a broadcast signal including a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble; and transmitting the broadcast signal including the first program table to a digital broadcast receiver side, wherein the program table includes information defining a number of the ensembles transmitted at the physical frequency, information defining a number of the at least one virtual channel corresponding to the ensemble, and IP address information of the at least one virtual channel required for channel tuning.

[0015] In another aspect of the present invention, a digital broadcast receiver comprises: a reception unit for receiving a broadcast signal into which mobile service data and main service data are multiplexed; an extractor for extracting transmission parameter channel (TPC) signaling information and fast information channel (FIC) signaling information from a data group in the received mobile service data; an acquirer for acquiring a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble, using the extracted FIC signaling information; a detector for detecting IP address information required for channel tuning to the at least one virtual channel corresponding to the ensemble, using the acquired program table; and a controller for controlling channel tuning to a virtual channel that is different from a current virtual channel, using the detected IP address information, when an input signal of channel tuning to the virtual channel is received, wherein the current virtual channel and the other virtual channel correspond to ensembles transmitted at the physical frequency, respectively.

[0016] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings;

[0018] FIG. **1** illustrates a block diagram showing a structure of a digital broadcasting receiving system according to an embodiment of the present invention.

[0019] FIG. **2** illustrates an exemplary structure of a data group according to the present invention.

[0020] FIG. **3** illustrates an RS frame according to an embodiment of the present invention.

[0021] FIG. **4** illustrates an example of an MH frame structure for transmitting and receiving mobile service data according to the present invention.

[0022] FIG. **5** illustrates an example of a general VSB frame structure.

[0023] FIG. **6** illustrates a example of mapping positions of the first 4 slots of a sub-frame in a spatial area with respect to a VSB frame.

[0024] FIG. **7** illustrates a example of mapping positions of the first 4 slots of a sub-frame in a chronological (or time) area with respect to a VSB frame.

[0025] FIG. **8** illustrates an exemplary order of data groups being assigned to one of 5 sub-frames configuring an MH frame according to the present invention.

[0026] FIG. **9** illustrates an example of a single parade being assigned to an MH frame according to the present invention.

[0027] FIG. **10** illustrates an example of 3 parades being assigned to an MH frame according to the present invention.

[0028] FIG. **11** illustrates an example of the process of assigning 3 parades shown in FIG. **10** being expanded to 5 sub-frames within an MH frame.

[0029] FIG. **12** illustrates a data transmission structure according to an embodiment of the present invention, wherein signaling data are included in a data group so as to be transmitted.

[0030] FIG. **13** illustrates a hierarchical signaling structure according to an embodiment of the present invention.

[0031] FIG. **14** illustrates an exemplary FIC body format according to an embodiment of the present invention.

[0032] FIG. **15** illustrates an exemplary bit stream syntax structure with respect to an FIC segment according to an embodiment of the present invention.

[0033] FIG. **16** illustrates an exemplary bit stream syntax structure with respect to a payload of an FIC segment according to the present invention, when an FIC type field value is equal to '0'.

[0034] FIG. **17** illustrates an exemplary bit stream syntax structure of a service map table according to the present invention.

[0035] FIG. **18** illustrates an exemplary bit stream syntax structure of an MH audio descriptor according to the present invention.

[0036] FIG. **19** illustrates an exemplary bit stream syntax structure of an MH RTP payload type descriptor according to the present invention.

[0037] FIG. **20** illustrates an exemplary bit stream syntax structure of an MH current event descriptor according to the present invention.

[0038] FIG. **21** illustrates an exemplary bit stream syntax structure of an MH next event descriptor according to the present invention.

[0039] FIG. **22** illustrates an exemplary bit stream syntax structure of an MH system time descriptor according to the present invention.

[0040] FIG. **23** illustrates segmentation and encapsulation processes of a service map table according to the present invention.

[0041] FIG. **24** illustrates a flow chart for accessing a virtual channel using FIC and SMT according to the present invention.

[0042] FIG. **25** is a block diagram showing the configuration of a digital broadcast receiver according to one embodiment of the present invention.

[0043] FIG. **26** is a diagram illustrating an EMT according to one embodiment of the present invention.

[0044] FIG. **27** is a flowchart illustrating a control method of a digital broadcast receiver according to one embodiment of the present invention.

[0045] And, FIG. **28** is a flowchart illustrating a control method of a digital broadcast receiver and digital broadcast transmitter according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0046] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. In addition, although the terms used in the present invention are selected from generally known and used terms, some of the terms mentioned in the description of the present invention have been selected by the applicant at his or her discretion, the detailed meanings of which are described in relevant parts of the description herein. Furthermore, it is required that the present invention is understood, not simply by the actual terms used but by the meaning of each term lying within.

[0047] Among the terms used in the description of the present invention, main service data correspond to data that can be received by a fixed receiving system and may include audio/video (A/V) data. More specifically, the main service data may include A/V data of high definition (HD) or standard definition (SD) levels and may also include diverse data types required for data broadcasting. Also, the known data corresponds to data pre-known in accordance with a pre-arranged agreement between the receiving system and the transmitting system. Additionally, among the terms used in the present invention, "MH" corresponds to the initials of "mobile" and "handheld" and represents the opposite concept of a fixed-type system. Furthermore, the MH service data may include at least one of mobile service data and handheld service data, and can also be referred to as "mobile service data" for simplicity. Herein, the mobile service data not only correspond to MH service data but may also include any type of service data with mobile or portable characteristics. Therefore, the mobile service data according to the present invention are not limited only to the MH service data.

[0048] The above-described mobile service data may correspond to data having information, such as program execution files, stock information, and so on, and may also correspond to A/V data. Particularly, the mobile service data may correspond to A/V data having lower resolution and lower data rate as compared to the main service data. For example, if an A/V codec that is used for a conventional main service corresponds to a MPEG-2 codec, a MPEG-4 advanced video coding (AVC) or scalable video coding (SVC) having better image compression efficiency may be used as the A/V codec for the mobile service. Furthermore, any type of data may be transmitted as the mobile service data. For example, transport protocol expert group (TPEG) data for broadcasting real-time transportation information may be transmitted as the mobile service data.

[0049] Also, a data service using the mobile service data may include weather forecast services, traffic information services, stock information services, viewer participation quiz programs, real-time polls and surveys, interactive education broadcast programs, gaming services, services providing information on synopsis, character, background music, and filming sites of soap operas or series, services providing information on past match scores and player profiles and achievements, and services providing information on product information and programs classified by service, medium, time, and theme enabling purchase orders to be processed. Herein, the present invention is not limited only to the services mentioned above. In the present invention, the transmitting system provides backward compatibility in the main service data so as to be received by the conventional receiving system. Herein, the main service data and the mobile service data are multiplexed to the same physical channel and then transmitted.

[0050] Furthermore, the digital broadcast transmitting system according to the present invention performs additional encoding on the mobile service data and inserts the data already known by the receiving system and transmitting system (e.g., known data), thereby transmitting the processed data. Therefore, when using the transmitting system according to the present invention, the receiving system may receive the mobile service data during a mobile state and may also receive the mobile service data with stability despite various distortion and noise occurring within the channel.

[0051] FIG. **1** illustrates a block diagram showing a structure of a digital broadcasting receiving system according to an embodiment of the present invention. The digital broadcast receiving system according to the present invention includes a baseband processor **100**, a management processor **200**, and a presentation processor **300**. The baseband processor **100** includes an operation controller **110**, a tuner **120**, a demodulator **130**, an equalizer **140**, a known sequence detector (or known data detector) **150**, a block decoder (or mobile hand-held block decoder) **160**, a primary Reed-Solomon (RS) frame decoder **170**, a secondary RS frame decoder **180**, and a signaling decoder **190**. The operation controller **110** controls the operation of each block included in the baseband processor **100**.

[0052] By tuning the receiving system to a specific physical channel frequency, the tuner **120** enables the receiving system to receive main service data, which correspond to broadcast signals for fixed-type broadcast receiving systems, and mobile service data, which correspond to broadcast signals for mobile broadcast receiving systems. At this point, the tuned frequency of the specific physical channel is down-converted to an intermediate frequency (IF) signal, thereby being outputted to the demodulator **130** and the known sequence detector **140**. The passband digital IF signal being outputted from the tuner **120** may only include main service data, or only include mobile service data, or include both main service data and mobile service data.

[0053] The demodulator **130** performs self-gain control, carrier wave recovery, and timing recovery processes on the passband digital IF signal inputted from the tuner **120**, thereby modifying the IF signal to a baseband signal. Then, the demodulator **130** outputs the baseband signal to the equalizer **140** and the known sequence detector **150**. The demodulator **130** uses the known data symbol sequence inputted from the known sequence detector **150** during the timing and/or carrier wave recovery, thereby enhancing the demodulating performance. The equalizer **140** compensates channel-associated distortion included in the signal demodulated by the demodulator **130**. Then, the equalizer **140** outputs the distortion-compensated signal to the block decoder **160**. By using a known data symbol sequence inputted from the known sequence detector **150**, the equalizer **140** may enhance the equalizing performance. Furthermore, the equalizer **140** may receive feed-back on the decoding result from the block decoder **160**, thereby enhancing the equalizing performance.

[0054] The known sequence detector **150** detects known data place (or position) inserted by the transmitting system from the input/output data (i.e., data prior to being demodulated or data being processed with partial demodulation). Then, the known sequence detector **150** outputs the detected known data position information and known data sequence generated from the detected position information to the demodulator **130** and the equalizer **140**. Additionally, in order to allow the block decoder **160** to identify the mobile service data that have been processed with additional encoding by the transmitting system and the main service data that have not been processed with any additional encoding, the known sequence detector **150** outputs such corresponding information to the block decoder **160**.

[0055] If the data channel-equalized by the equalizer **140** and inputted to the block decoder **160** correspond to data processed with both block-encoding and trellis-encoding by the transmitting system (i.e., data within the RS frame, signaling data), the block decoder **160** may perform trellis-decoding and block-decoding as inverse processes of the transmitting system. On the other hand, if the data channel-equalized by the equalizer **140** and inputted to the block decoder **160** correspond to data processed only with trellis-encoding and not block-encoding by the transmitting system (i.e., main service data), the block decoder **160** may perform only trellis-decoding.

[0056] The signaling decoder **190** decodes signaling data that have been channel-equalized and inputted from the equalizer **140**. It is assumed that the signaling data inputted to the signaling decoder **190** correspond to data processed with both block-encoding and trellis-encoding by the transmitting system. Examples of such signaling data may include transmission parameter channel (TPC) data and fast information channel (FIC) data. Each type of data will be described in more detail in a later process. The FIC data decoded by the signaling decoder **190** are outputted to the FIC handler **215**. And, the TPC data decoded by the signaling decoder **190** are outputted to the TPC handler **214**.

[0057] Meanwhile, according to the present invention, the transmitting system uses RS frames by encoding units. Herein, the RS frame may be divided into a primary RS frame and a secondary RS frame. However, according to the embodiment of the present invention, the primary RS frame and the secondary RS frame will be divided based upon the level of importance of the corresponding data. The primary RS frame decoder **170** receives the data outputted from the block decoder **160**. At this point, according to the embodiment of the present invention, the primary RS frame decoder

170 receives only the mobile service data that have been Reed-Solomon (RS)-encoded and/or cyclic redundancy check (CRC)-encoded from the block decoder **160**.

[0058] Herein, the primary RS frame decoder **170** receives only the mobile service data and not the main service data. The primary RS frame decoder **170** performs inverse processes of an RS frame encoder (not shown) included in the digital broadcast transmitting system, thereby correcting errors existing within the primary RS frame. More specifically, the primary RS frame decoder **170** forms a primary RS frame by grouping a plurality of data groups and, then, correct errors in primary RS frame units. In other words, the primary RS frame decoder **170** decodes primary RS frames, which are being transmitted for actual broadcast services.

[0059] Additionally, the secondary RS frame decoder **180** receives the data outputted from the block decoder **160**. At this point, according to the embodiment of the present invention, the secondary RS frame decoder **180** receives only the mobile service data that have been RS-encoded and/or CRC-encoded from the block decoder **160**. Herein, the secondary RS frame decoder **180** receives only the mobile service data and not the main service data. The secondary RS frame decoder **180** performs inverse processes of an RS frame encoder (not shown) included in the digital broadcast transmitting system, thereby correcting errors existing within the secondary RS frame. More specifically, the secondary RS frame decoder **180** forms a secondary RS frame by grouping a plurality of data groups and, then, correct errors in secondary RS frame units. In other words, the secondary RS frame decoder **180** decodes secondary RS frames, which are being transmitted for mobile audio service data, mobile video service data, guide data, and so on.

[0060] Meanwhile, the management processor **200** according to an embodiment of the present invention includes an MH physical adaptation processor **210**, an IP network stack **220**, a streaming handler **230**, a system information (SI) handler **240**, a file handler **250**, a multi-purpose internet main extensions (MIME) type handler **260**, and an electronic service guide (ESG) handler **270**, and an ESG decoder **280**, and a storage unit **290**. The MH physical adaptation processor **210** includes a primary RS frame handler **211**, a secondary RS frame handler **212**, an MH transport packet (TP) handler **213**, a TPC handler **214**, an FIC handler **215**, and a physical adaptation control signal handler **216**. The TPC handler **214** receives and processes baseband information required by modules corresponding to the MH physical adaptation processor **210**. The baseband information is inputted in the form of TPC data. Herein, the TPC handler **214** uses this information to process the FIC data, which have been sent from the baseband processor **100**.

[0061] The TPC data is transmitted from the transmitting system to the receiving system via a predetermined region of a data group. The TPC data may include at least one of an MH ensemble ID, an MH sub-frame number, a total number of MH groups (TNoG), an RS frame continuity counter, a column size of RS frame (N), and an FIC version number. Herein, the MH ensemble ID indicates an identification number of each MH ensemble carried in the corresponding physical channel. The MH sub-frame number signifies a number identifying the MH sub-frame number in one MH frame, wherein each MH group associated with the corresponding MH ensemble is transmitted. The TNoG represents the total number of MH groups including all of the MH groups belonging to all MH parades included in one MH sub-frame. The RS frame continuity counter indicates a number that serves as a continuity indicator of the RS frames carrying the corresponding MH ensemble. Herein, the value of the RS frame continuity counter shall be incremented by 1 modulo 16 for each successive RS frame. N represents the column size of an RS frame belonging to the corresponding MH ensemble. Herein, the value of N determines the size of each MH TP. Finally, the FIC version number signifies the version number of an FIC body carried on the corresponding physical channel.

[0062] As described above, diverse TPC data are inputted to the TPC handler **214** via the signaling decoder **190** shown in FIG. **1**. Then, the received TPC data are processed by the TPC handler **214**. The received TPC data may also be used by the FIC handler **215** in order to process the FIC data. The FIC handler **215** processes the FIC data by associating the FIC data received from the baseband processor **100** with the TPC data. The physical adaptation control signal handler **216** collects FIC data received through the FIC handler **215** and SI data received through RS frames. Then, the physical adaptation control signal handler **216** uses the collected FIC data and SI data to configure and process IP datagrams and access information of mobile broadcast services. Thereafter, the physical adaptation control signal handler **216** stores the processed IP datagrams and access information to the storage unit **290**.

[0063] The primary RS frame handler **211** identifies primary RS frames received from the primary RS frame decoder **170** of the baseband processor **100** for each row unit, so as to configure an MH TP. Thereafter, the primary RS frame handler **211** outputs the configured MH TP to the MH TP handler **213**. The secondary RS frame handler **212** identifies secondary RS frames received from the secondary RS frame decoder **180** of the baseband processor **100** for each row unit, so as to configure an MH TP. Thereafter, the secondary RS frame handler **212** outputs the configured MH TP to the MH TP handler **213**. The MH transport packet (TP) handler **213** extracts a header from each MH TP received from the primary RS frame handler **211** and the secondary RS frame handler **212**, thereby determining the data included in the corresponding MH TP. Then, when the determined data correspond to SI data (i.e., SI data that are not encapsulated to IP datagrams), the corresponding data are outputted to the physical adaptation control signal handler **216**. Alternatively, when the determined data correspond to an IP datagram, the corresponding data are outputted to the IP network stack **220**.

[0064] The IP network stack **220** processes broadcast data that are being transmitted in the form of IP datagrams. More specifically, the IP network stack **220** processes data that are inputted via user datagram protocol (UDP), real-time transport protocol (RTP), real-time transport control protocol (RTCP), asynchronous layered coding/layered coding transport (ALC/LCT), file delivery over unidirectional transport (FLUTE), and so on. Herein, when the processed data correspond to streaming data, the corresponding data are outputted to the streaming handler **230**. And, when the processed data correspond to data in a file format, the corresponding data are outputted to the file handler **250**. Finally, when the processed data correspond to SI-associated data, the corresponding data are outputted to the SI handler **240**.

[0065] The SI handler **240** receives and processes SI data having the form of IP datagrams, which are inputted to the IP network stack **220**. When the inputted data associated with SI correspond to MIME-type data, the inputted data are outputted to the MIME-type handler **260**. The MIME-type handler **260** receives the MIME-type SI data outputted from the SI handler **240** and processes the received MIME-type SI data. The file handler **250** receives data from the IP network stack **220** in an object format in accordance with the ALC/LCT and FLUTE structures. The file handler **250** groups the received data to create a file format. Herein, when the corresponding file includes ESG (Electronic Service Guide), the file is outputted to the ESG handler **270**. On the other hand, when the corresponding file includes data for other file-based services, the file is outputted to the presentation controller **330** of the presentation processor **300**.

[0066] The ESG handler **270** processes the ESG data received from the file handler **250** and stores the processed ESG data to the storage unit **290**. Alternatively, the ESG handler **270** may output the processed ESG data to the ESG decoder **280**, thereby allowing the ESG data to be used by the ESG decoder **280**. The storage unit **290** stores the system information (SI) received from the physical adaptation control signal handler **210** and the ESG handler **270** therein. Thereafter, the storage unit **290** transmits the stored SI data to each block.

[0067] The ESG decoder **280** either recovers the ESG data and SI data stored in the storage unit **290** or recovers the ESG data transmitted from the ESG handler **270**. Then, the ESG decoder **280** outputs the recovered data to the presentation controller **330** in a format that can be outputted to the user. The streaming handler **230** receives data from the IP network stack **220**, wherein the format of the received data are in accordance with RTP and/or RTCP structures. The streaming handler **230** extracts audio/video streams from the received data, which are then outputted to the audio/video (A/V) decoder **310** of the presentation processor **300**. The audio/video decoder **310** then decodes each of the audio stream and video stream received from the streaming handler **230**.

[0068] The display module **320** of the presentation processor **300** receives audio and video signals respectively decoded by the A/V decoder **310**. Then, the display module **320** provides the received audio and video signals to the user through a speaker and/or a screen. The presentation controller **330** corresponds to a controller managing modules that output data received by the receiving system to the user. The channel service manager **340** manages an interface with the user, which enables the user to use channel-based broadcast services, such as channel map management, channel service connection, and so on. The application manager **350** manages an interface with a user using ESG display or other application services that do not correspond to channel-based services.

[0069] Meanwhile, the data structure used in the mobile broadcasting technology according to the embodiment of the present invention may include a data group structure and an RS frame structure, which will now be described in detail.

[0070] FIG. **2** illustrates an exemplary structure of a data group according to the present invention. FIG. **2** shows an example of dividing a data group according to the data structure of the present invention into 10 MH blocks (i.e., MH block **1** (B**1**) to MH block **10** (B**10**)). In this example, each MH block has the length of 16 segments. Referring to FIG. **2**, only the RS parity data are allocated to portions of the first 5 segments of the MH block **1** (B**1**) and the last 5 segments of the MH block **10** (B**10**). The RS parity data are excluded in regions A to D of the data group. More specifically, when it is assumed that one data group is divided into regions A, B, C, and D, each MH block may be included in any one of region A to region D depending upon the characteristic of each MH block within the data group (For example, the characteristic of each MH block can be an interference level of main service data).

[0071] Herein, the data group is divided into a plurality of regions to be used for different purposes. More specifically, a region of the main service data having no interference or a very low interference level may be considered to have a more resistant (or stronger) receiving performance as compared to regions having higher interference levels. Additionally, when using a system inserting and transmitting known data in the data group, wherein the known data are known based upon an agreement between the transmitting system and the receiving system, and when consecutively long known data are to be periodically inserted in the mobile service data, the known data having a predetermined length may be periodically inserted in the region having no interference from the main service data (i.e., a region wherein the main service data are not mixed). However, due to interference from the main service data, it is difficult to periodically insert known data and also to insert consecutively long known data to a region having interference from the main service data.

[0072] Referring to FIG. **2**, MH block **4** (B**4**) to MH block **7** (B**7**) correspond to regions without interference of the main service data. MH block **4** (B**4**) to MH block **7** (B**7**) within the data group shown in FIG. **2** correspond to a region where no interference from the main service data occurs. In this example, a long known data sequence is inserted at both the beginning and end of each MH block. In the description of the present invention, the region including MH block **4** (B**4**) to MH block **7** (B**7**) will be referred to as "region A (=B**4**+B**5**+B**6**+B**7**)". As described above, when the data group includes region A having a long known data sequence inserted at both the beginning and end of each MH block, the receiving system is capable of performing equalization by using the channel information that can be obtained from the known data. Therefore, region A may have the strongest equalizing performance among region A, B, C and D.

[0073] In the example of the data group shown in FIG. **2**, MH block **3** (B**3**) and MH block **8** (B**8**) correspond to a region having little interference from the main service data. Herein, a long known data sequence is inserted in only one side of each MH block B**3** and B**8**. More specifically, due to the interference from the main service data, a long known data sequence is inserted at the end of MH block **3** (B**3**), and another long known data sequence is inserted at the beginning of MH block **8** (B**8**). In the present invention, the region including MH block **3** (B**3**) and MH block **8** (B**8**) will be referred to as "region B (=B**3**+B**8**)". As described above, when the data group includes region B having a long known data sequence inserted at only one side (beginning or end) of each MH block, the receiving system is capable of performing equalization by using the channel information that can be obtained from the known data. Therefore, a stronger equalizing performance as compared to region C/D may be yielded (or obtained) in region B.

[0074] Referring to FIG. **2**, MH block **2** (B**2**) and MH block **9** (B**9**) correspond to a region having more interference from the main service data as compared to region B. A long known data sequence cannot be inserted in any side of MH block **2** (B**2**) and MH block **9** (B**9**). Herein, the region including MH block **2** (B**2**) and MH block **9** (B**9**) will be referred to as "region C (=B**2**+B**9**)". Finally, in the example shown in FIG.

2, MH block (B1) and MH block 10 (B10) correspond to a region having more interference from the main service data as compared to region C. Similarly, a long known data sequence cannot be inserted in any side of MH block 1 (B1) and MH block 10 (B10). Herein, the region including MH block 1 (B1) and MH block 10 (B10) will be referred to as "region D (=B1+B10)". Since region C/D is spaced further apart from the known data sequence, when the channel environment undergoes frequent and abrupt changes, the receiving performance of region C/D may be deteriorated.

[0075] Additionally, the data group includes a signaling information area wherein signaling information is assigned (or allocated). In the present invention, the signaling information area may start from the 1st segment of the 4th MH block (B4) to a portion of the 2nd segment. According to an embodiment of the present invention, the signaling information area for inserting signaling information may start from the 1st segment of the 4th MH block (B4) to a portion of the 2nd segment. More specifically, 276(=207+69) bytes of the 4th MH block (B4) in each data group are assigned as the signaling information area. In other words, the signaling information area consists of 207 bytes of the 1st segment and the first 69 bytes of the 2nd segment of the 4th MH block (B4). The 1st segment of the 4th MH block (B4) corresponds to the 17th or 173rd segment of a VSB field.

[0076] Herein, the signaling information may be identified by two different types of signaling channels: a transmission parameter channel (TPC) and a fast information channel (FIC). Herein, the TPC data may include at least one of an MH ensemble ID, an MH sub-frame number, a total number of MH groups (TNoG), an RS frame continuity counter, a column size of RS frame (N), and an FIC version number. However, the TPC data (or information) presented herein are merely exemplary. And, since the adding or deleting of signaling information included in the TPC data may be easily adjusted and modified by one skilled in the art, the present invention will, therefore, not be limited to the examples set forth herein. Furthermore, the FIC is provided to enable a fast service acquisition of data receivers, and the FIC includes cross layer information between the physical layer and the upper layer(s).

[0077] For example, when the data group includes 6 known data sequences, as shown in FIG. 2, the signaling information area is located between the first known data sequence and the second known data sequence. More specifically, the first known data sequence is inserted in the last 2 segments of the 3rd MH block (B3), and the second known data sequence is inserted in the 2nd and 3rd segments of the 4th MH block (B4). Furthermore, the 3rd to 6th known data sequences are respectively inserted in the last 2 segments of each of the 4th, 5th, 6th, and 7th MH blocks (B4, B5, B6, and B7). The 1st and 3rd to 6th known data sequences are spaced apart by 16 segments.

[0078] FIG. 3 illustrates an RS frame according to an embodiment of the present invention. The RS frame shown in FIG. 3 corresponds to a collection of one or more data groups. The RS frame is received for each MH frame in a condition where the receiving system receives the FIC and processes the received FIC and where the receiving system is switched to a time-slicing mode so that the receiving system can receive MH ensembles including ESG entry points. Each RS frame includes each service or IP streams of ESG, and SMT section data may exist in all RS frames. The RS frame according to the embodiment of the present invention consists of at least one MH transport packet (TP). Herein, the MH TP includes an MH header and an MH payload.

[0079] The MH payload may include mobile service data as well as signaling data. More specifically, an MH payload may include only mobile service data, or may include only signaling data, or may include both mobile service data and signaling data. According to the embodiment of the present invention, the MH header may identify (or distinguish) the data types included in the MH payload. More specifically, when the MH TP includes a first MH header, this indicates that the MH payload includes only the signaling data. Also, when the MH TP includes a second MH header, this indicates that the MH payload includes both the signaling data and the mobile service data. Finally, when MH TP includes a third MH header, this indicates that the MH payload includes only the mobile service data. In the example shown in FIG. 3, the RS frame is assigned with IP datagrams (for example, IP datagram 1 and IP datagram 2) for two service types.

[0080] FIG. 4 illustrates a structure of a MH frame for transmitting and receiving mobile service data according to the present invention. In the example shown in FIG. 4, one MH frame consists of 5 sub-frames, wherein each sub-frame includes 16 slots. In this case, the MH frame according to the present invention includes 5 sub-frames and 80 slots. Also, in a packet level, one slot is configured of 156 data packets (i.e., transport stream packets), and in a symbol level, one slot is configured of 156 data segments. Herein, the size of one slot corresponds to one half (½) of a VSB field. More specifically, since one 207-byte data packet has the same amount of data as one data segment, a data packet prior to being interleaved may also be used as a data segment. At this point, two VSB fields are grouped to form a VSB frame.

[0081] FIG. 5 illustrates an exemplary structure of a VSB frame, wherein one VSB frame consists of 2 VSB fields (i.e., an odd field and an even field). Herein, each VSB field includes a field synchronization segment and 312 data segments. The slot corresponds to a basic time unit for multiplexing the mobile service data and the main service data. Herein, one slot may either include the mobile service data or be configured only of the main service data. If the first 118 data packets within the slot correspond to a data group, the remaining 38 data packets become the main service data packets. In another example, when no data group exists in a slot, the corresponding slot is configured of 156 main service data packets. Meanwhile, when the slots are assigned to a VSB frame, an off-set exists for each assigned position.

[0082] FIG. 6 illustrates a mapping example of the positions to which the first 4 slots of a sub-frame are assigned with respect to a VSB frame in a spatial area. And, FIG. 7 illustrates a mapping example of the positions to which the first 4 slots of a sub-frame are assigned with respect to a VSB frame in a chronological (or time) area. Referring to FIG. 6 and FIG. 7, a 38th data packet (TS packet #37) of a 1st slot (Slot #0) is mapped to the 1st data packet of an odd VSB field. A 38th data packet (TS packet #37) of a 2nd slot (Slot #1) is mapped to the 157th data packet of an odd VSB field. Also, a 38th data packet (TS packet #37) of a 3rd slot (Slot #2) is mapped to the 1st data packet of an even VSB field. And, a 38th data packet (TS packet #37) of a 4th slot (Slot #3) is mapped to the 157th data packet of an even VSB field. Similarly, the remaining 12 slots within the corresponding sub-frame are mapped in the subsequent VSB frames using the same method.

[0083] FIG. 8 illustrates an exemplary assignment order of data groups being assigned to one of 5 sub-frames, wherein the 5 sub-frames configure an MH frame. For example, the method of assigning data groups may be identically applied to all MH frames or differently applied to each MH frame. Furthermore, the method of assigning data groups may be identically applied to all sub-frames or differently applied to each sub-frame. At this point, when it is assumed that the data groups are assigned using the same method in all sub-frames of the corresponding MH frame, the total number of data groups being assigned to an MH frame is equal to a multiple of '5'. According to the embodiment of the present invention, a plurality of consecutive data groups is assigned to be spaced as far apart from one another as possible within the sub-frame. Thus, the system can be capable of responding promptly and effectively to any burst error that may occur within a sub-frame.

[0084] For example, when it is assumed that 3 data groups are assigned to a sub-frame, the data groups are assigned to a 1st slot (Slot #**0**), a 5th slot (Slot #**4**), and a 9th slot (Slot #**8**) in the sub-frame, respectively. FIG. **8** illustrates an example of assigning 16 data groups in one sub-frame using the above-described pattern (or rule). In other words, each data group is serially assigned to 16 slots corresponding to the following numbers: 0, 8, 4, 12, 1, 9, 5, 13, 2, 10, 6, 14, 3, 11, 7, and 15. Equation 1 below shows the above-described rule (or pattern) for assigning data groups in a sub-frame.

$$j=(4i+O)\bmod 16 \qquad \text{Equation 1}$$

Herein, O=0 if i<4,
O=2 else if i<8,
O=1 else if i<12,
O=3 else.

[0085] Herein, j indicates the slot number within a sub-frame. The value of j may range from 0 to 15. Also, variable i indicates the data group number. The value of i may range from 0 to 15.

[0086] In the present invention, a collection of data groups included in a MH frame will be referred to as a "parade". Based upon the RS frame mode, the parade transmits data of at least one specific RS frame. The mobile service data within one RS frame may be assigned either to all of regions A/B/C/D within the corresponding data group, or to at least one of regions A/B/C/D. In the embodiment of the present invention, the mobile service data within one RS frame may be assigned either to all of regions A/B/C/D, or to at least one of regions A/B and regions C/D. If the mobile service data are assigned to the latter case (i.e., one of regions A/B and regions C/D), the RS frame being assigned to regions A/B and the RS frame being assigned to regions C/D within the corresponding data group are different from one another.

[0087] According to the embodiment of the present invention, the RS frame being assigned to regions A/B within the corresponding data group will be referred to as a "primary RS frame", and the RS frame being assigned to regions C/D within the corresponding data group will be referred to as a "secondary RS frame", for simplicity. Also, the primary RS frame and the secondary RS frame form (or configure) one parade. More specifically, when the mobile service data within one RS frame are assigned either to all of regions A/B/C/D within the corresponding data group, one parade transmits one RS frame. Conversely, when the mobile service data within one RS frame are assigned either to at least one of regions A/B and regions C/D, one parade may transmit up to 2 RS frames. More specifically, the RS frame mode indicates whether a parade transmits one RS frame, or whether the parade transmits two RS frames. Such RS frame mode is transmitted as the above-described TPC data. Table 1 below shows an example of the RS frame mode.

TABLE 1

RS frame mode	Description
00	There is only a primary RS frame for all Group Regions
01	There are two separate RS frames Primary RS frame for Group Region A and B Secondary RS frame for Group Region C and D
10	Reserved
11	Reserved

[0088] Table 1 illustrates an example of allocating 2 bits in order to indicate the RS frame mode. For example, referring to Table 1, when the RS frame mode value is equal to '00', this indicates that one parade transmits one RS frame. And, when the RS frame mode value is equal to '01', this indicates that one parade transmits two RS frames, i.e., the primary RS frame and the secondary RS frame. More specifically, when the RS frame mode value is equal to '01', data of the primary RS frame for regions A/B are assigned and transmitted to regions A/B of the corresponding data group. Similarly, data of the secondary RS frame for regions C/D are assigned and transmitted to regions C/D of the corresponding data group.

[0089] As described in the assignment of data groups, the parades are also assigned to be spaced as far apart from one another as possible within the sub-frame. Thus, the system can be capable of responding promptly and effectively to any burst error that may occur within a sub-frame. Furthermore, the method of assigning parades may be identically applied to all MH frames or differently applied to each MH frame. According to the embodiment of the present invention, the parades may be assigned differently for each sub-frame and identically for all sub-frames within an MH frame. However, according to the embodiment of the present invention, the parades may be assigned differently for each MH frame and identically for all sub-frames within an MH frame. More specifically, the MH frame structure may vary by MH frame units. Thus, an ensemble rate may be adjusted on a more frequent and flexible basis.

[0090] FIG. **9** illustrates an example of multiple data groups of a single parade being assigned (or allocated) to an MH frame. More specifically, FIG. **9** illustrates an example of a single parade, wherein the number of data groups included in a sub-frame is equal to '3', being allocated to an MH frame. Referring to FIG. **9**, 3 data groups are sequentially assigned to a sub-frame at a cycle period of 4 slots. Accordingly, when this process is equally performed in the 5 sub-frames included in the corresponding MH frame, 15 data groups are assigned to a single MH frame. Herein, the 15 data groups correspond to data groups included in a parade. Therefore, since one sub-frame is configured of 4 VSB frame, and since 3 data groups are included in a sub-frame, the data group of the corresponding parade is not assigned to one of the 4 VSB frames within a sub-frame.

[0091] For example, when it is assumed that one parade transmits one RS frame, and that a RS frame encoder (not shown) included in the transmitting system performs RS-encoding on the corresponding RS frame, thereby adding 24 bytes of parity data to the corresponding RS frame and transmitting the processed RS frame, the parity data occupy approximately 11.37% (=24/(187+24)×100) of the total RS code word length. Meanwhile, when one sub-frame includes 3 data groups, and when the data groups included in the parade are assigned, as shown in FIG. **9**, 15 data groups form an RS frame. Accordingly, even when an error occurs in an entire data group due to a burst noise within a channel, the percentile is merely 6.67% (=1/15×100). Therefore, the receiving system may correct all errors by performing an erasure RS decoding process. More specifically, when the erasure RS decoding is performed, a number of channel errors corresponding to the number of RS parity bytes may be corrected and bytes error among one RS code word that is less than the number of RS parity bytes may be corrected. By doing so, the receiving system may correct the error of at least one data group within one parade. Thus, the minimum burst noise length correctable by a RS frame is over 1 VSB frame.

[0092] Meanwhile, when data groups of a parade are assigned as shown in FIG. **9**, either main service data may be assigned between each data group, or data groups corresponding to different parades may be assigned between each data group. More specifically, data groups corresponding to multiple parades may be assigned to one MH frame. Basically, the method of assigning data groups corresponding to multiple parades is similar to the method of assigning data groups corresponding to a single parade. In other words, data groups included in other parades that are to be assigned to an MH frame are also respectively assigned according to a cycle period of 4 slots. At this point, data groups of a different parade may be sequentially assigned to the respective slots in a circular method. Herein, the data groups are assigned to slots starting from the ones to which data groups of the previous parade have not yet been assigned. For example, when it is assumed that data groups corresponding to a parade are assigned as shown in FIG. **9**, data groups corresponding to the next parade may be assigned to a sub-frame starting either from the 12th slot of a sub-frame. However, this is merely exemplary. In another example, the data groups of the next parade may also be sequentially assigned to a different slot within a sub-frame at a cycle period of 4 slots starting from the 3rd slot.

[0093] FIG. **10** illustrates an example of transmitting 3 parades (Parade #**0**, Parade #**1**, and Parade #**2**) via an MH frame. More specifically, FIG. **10** illustrates an example of transmitting parades included in one of 5 sub-frames, wherein the 5 sub-frames configure one MH frame. When the 1st parade (Parade #**0**) includes 3 data groups for each sub-frame, the positions of each data groups within the sub-frames may be obtained by substituting values '0' to '2' for i in Equation 1. More specifically, the data groups of the 1st parade (Parade #**0**) are sequentially assigned to the 1st, 5th, and 9th slots (Slot #**0**, Slot #**4**, and Slot #**8**) within the sub-frame. Also, when the 2nd parade includes 2 data groups for each sub-frame, the positions of each data groups within the sub-frames may be obtained by substituting values '3' and '4' for i in Equation 1. More specifically, the data groups of the 2nd parade (Parade #**1**) are sequentially assigned to the 2nd and 12th slots (Slot #**1** and Slot #**11**) within the sub-frame. Finally, when the 3rd parade includes 2 data groups for each sub-frame, the positions of each data groups within the sub-frames may be obtained by substituting values '5' and '6' for i in Equation 1. More specifically, the data groups of the 3rd parade (Parade #**2**) are sequentially assigned to the 7th and 11th slots (Slot #**6** and Slot #**10**) within the sub-frame.

[0094] As described above, data groups of multiple parades may be assigned to a single MH frame, and, in each sub-frame, the data groups are serially allocated to a group space having 4 slots from left to right. Therefore, a number of groups of one parade per sub-frame (NoG) may correspond to any one integer from '1' to '8'. Herein, since one MH frame includes 5 sub-frames, the total number of data groups within a parade that can be allocated to an MH frame may correspond to any one multiple of '5' ranging from '5' to '40'.

[0095] FIG. **11** illustrates an example of expanding the assignment process of 3 parades, shown in FIG. **10**, to 5 sub-frames within an MH frame. FIG. **12** illustrates a data transmission structure according to an embodiment of the present invention, wherein signaling data are included in a data group so as to be transmitted. As described above, an MH frame is divided into 5 sub-frames. Data groups corresponding to a plurality of parades co-exist in each sub-frame. Herein, the data groups corresponding to each parade are grouped by MH frame units, thereby configuring a single parade.

[0096] The data structure shown in FIG. **12** includes 3 parades, one ESG dedicated channel (EDC) parade (i.e., parade with NoG=1), and **2** service parades (i.e., parade with NoG=4 and parade with NoG=3). Also, a predetermined portion of each data group (i.e., 37 bytes/data group) is used for delivering (or sending) FIC information associated with mobile service data, wherein the FIC information is separately encoded from the RS-encoding process. The FIC region assigned to each data group consists of one FIC segments. Herein, each FIC segment is interleaved by MH sub-frame units, thereby configuring an FIC body, which corresponds to a completed FIC transmission structure. However, whenever required, each FIC segment may be interleaved by MH frame units and not by MH sub-frame units, thereby being completed in MH frame units.

[0097] Meanwhile, the concept of an MH ensemble is applied in the embodiment of the present invention, thereby defining a collection (or group) of services. Each MH ensemble carries the same QoS and is coded with the same FEC code. Also, each MH ensemble has the same unique identifier (i.e., ensemble ID) and corresponds to consecutive RS frames. As shown in FIG. **12**, the FIC segment corresponding to each data group may describe service information of an MH ensemble to which the corresponding data group belongs. When FIC segments within a sub-frame are grouped and deinterleaved, all service information of a physical channel through which the corresponding FICs are transmitted may be obtained. Therefore, the receiving system may be able to acquire the channel information of the corresponding physical channel, after being processed with physical channel tuning, during a sub-frame period. Furthermore, FIG. **12** illustrates a structure further including a separate EDC parade apart from the service parade and wherein electronic service guide (ESG) data are transmitted in the 1st slot of each sub-frame.

[0098] FIG. **13** illustrates a hierarchical signaling structure according to an embodiment of the present invention. As shown in FIG. **13**, the mobile broadcasting technology according to the embodiment of the present invention adopts a signaling method using FIC and SMT. In the description of the present invention, the signaling structure will be referred to as a hierarchical signaling structure. Hereinafter, a detailed description on how the receiving system accesses a virtual channel via FIC and SMT will now be given with reference to FIG. **13**. The FIC body defined in an MH transport (M1) identifies the physical location of each the data stream for each virtual channel and provides very high level descriptions of each virtual channel. Being MH ensemble level signaling information, the service map table (SMT) provides MH ensemble level signaling information. The SMT provides the IP access information of each virtual channel belonging to the respective MH ensemble within which the SMT is carried. The SMT also provides all IP stream component level information required for the virtual channel service acquisition.

[0099] Referring to FIG. **13**, each MH ensemble (i.e., Ensemble **0**, Ensemble **1**, . . . , Ensemble K) includes a stream information on each associated (or corresponding) virtual channel (e.g., virtual channel **0** IP stream, virtual channel **1** IP stream, and virtual channel **2** IP stream). For example, Ensemble **0** includes virtual channel **0** IP stream and virtual channel **1** IP stream. And, each MH ensemble includes diverse information on the associated virtual channel (i.e., Virtual Channel **0** Table Entry, Virtual Channel **0** Access Info, Virtual Channel **1** Table Entry, Virtual Channel **1** Access Info, Virtual Channel **2** Table Entry, Virtual Channel **2** Access Info, Virtual Channel N Table Entry, Virtual Channel N Access Info, and so on). The FIC body payload includes information on MH ensembles (e.g., ensemble_id field, and referred to as "ensemble location" in FIG. **13**) and information on a virtual channel associated with the corresponding MH ensemble (e.g., major_channel_num field and minor_channel_num field, and referred to as "Virtual Channel **0**", "Virtual Channel **1**", . . . , "Virtual Channel N" in FIG. **13**).

[0100] The application of the signaling structure in the receiving system will now be described in detail. When a user selects a channel he or she wishes to view (hereinafter, the user-selected channel will be referred to as "channel θ" for simplicity), the receiving system first parses the received FIC. Then, the receiving system acquires information on an MH ensemble (i.e., ensemble location), which is associated with the virtual channel corresponding to channel θ(hereinafter, the corresponding MH ensemble will be referred to as "MH ensemble θ" for simplicity). By acquiring slots only corresponding to the MH ensemble θ using the time-slicing method, the receiving system configures ensemble θ. The ensemble θ configured as described above, includes an SMT on the associated virtual channels (including channel θ) and IP streams on the corresponding virtual channels. Therefore, the receiving system uses the SMT included in the MH ensemble θ in order to acquire various information on channel θ (e.g., Virtual Channel θ Table Entry) and stream access information on channel θ (e.g., Virtual Channel θ Access Info). The receiving system uses the stream access information on channel θ to receive only the associated IP streams, thereby providing channel θ services to the user.

[0101] The digital broadcast receiving system according to the present invention adopts the fast information channel (FIC) for a faster access to a service that is currently being broadcasted. More specifically, the FIC handler **215** of FIG. **1** parses the FIC body, which corresponds to an FIC transmission structure, and outputs the parsed result to the physical adaptation control signal handler **216**. FIG. **14** illustrates an exemplary FIC body format according to an embodiment of the present invention. According to the embodiment of the present invention, the FIC format consists of an FIC body header and an FIC body payload.

[0102] Meanwhile, according to the embodiment of the present invention, data are transmitted through the FIC body header and the FIC body payload in FIC segment units. Each FIC segment has the size of 37 bytes, and each FIC segment consists of a 2-byte FIC segment header and a 35-byte FIC segment payload. More specifically, an FIC body configured of an FIC body header and an FIC body payload, is segmented in units of 35 bytes, which are then carried in FIC segment payload within at least one of FIC segment, so as to be transmitted. In the description of the present invention, an example of inserting one FIC segment in one data group, which is then transmitted, will be given. In this case, the receiving system receives a slot corresponding to each data group by using a time-slicing method.

[0103] The signaling decoder **190** included in the receiving system shown in FIG. **1** collects each FIC segment inserted in each data group. Then, the signaling decoder **190** uses the collected FIC segments to created a single FIC body. Thereafter, the signaling decoder **190** performs a decoding process on the FIC body payload of the created FIC body, so that the decoded FIC body payload corresponds to an encoded result of a signaling encoder (not shown) included in the transmitting system. Subsequently, the decoded FIC body payload is outputted to the FIC handler **215**. The FIC handler **215** parses the FIC data included in the FIC body payload, and then outputs the parsed FIC data to the physical adaptation control signal handler **216**. The physical adaptation control signal handler **216** uses the inputted FIC data to perform processes associated with MH ensembles, virtual channels, SMTs, and so on.

[0104] According to an embodiment of the present invention, when an FIC body is segmented, and when the size of the last segmented portion is smaller than 35 data bytes, it is assumed that the lacking number of data bytes in the FIC segment payload is completed with by adding the same number of stuffing bytes therein, so that the size of the last FIC segment can be equal to 35 data bytes. However, it is apparent that the above-described data byte values (i.e., 37 bytes for the FIC segment, 2 bytes for the FIC segment header, and 35 bytes for the FIC segment payload) are merely exemplary, and will, therefore, not limit the scope of the present invention.

[0105] FIG. **15** illustrates an exemplary bit stream syntax structure with respect to an FIC segment according to an embodiment of the present invention. Herein, the FIC segment signifies a unit used for transmitting the FIC data. The FIC segment consists of an FIC segment header and an FIC segment payload. Referring to FIG. **15**, the FIC segment payload corresponds to the portion starting from the 'for' loop statement. Meanwhile, the FIC segment header may include a FIC_type field, an error_indicator field, an FIC_seg_number field, and an FIC_last_seg_number field. A detailed description of each field will now be given.

[0106] The FIC_type field is a 2-bit field indicating the type of the corresponding FIC. The error_indicator field is a 1-bit field, which indicates whether or not an error has occurred within the FIC segment during data transmission. If an error has occurred, the value of the error_indicator field is set to '1'. More specifically, when an error that has failed to be recovered still remains during the configuration process of the FIC segment, the error_indicator field value is set to '1'. The error_indicator field enables the receiving system to recognize the presence of an error within the FIC data. The FIC_seg_number field is a 4-bit field. Herein, when a single FIC body is divided into a plurality of FIC segments and transmitted, the FIC_seg_number field indicates the number of the corresponding FIC segment. Finally, the FIC_last_seg_number field is also a 4-bit field. The FIC_last_seg_number field indicates the number of the last FIC segment within the corresponding FIC body.

[0107] FIG. **16** illustrates an exemplary bit stream syntax structure with respect to a payload of an FIC segment according to the present invention, when an FIC type field value is equal to '0'. According to the embodiment of the present invention, the payload of the FIC segment is divided into 3 different regions. A first region of the FIC segment payload exists only when the FIC_seg_number field value is equal to '0'. Herein, the first region may include a current_next_indicator field, an ESG_version field, and a transport_stream_id field. However, depending upon the embodiment of the present invention, it may be assumed that each of the 3 fields exists regardless of the FIC_seg_number field.

[0108] The current_next_indicator field is a 1-bit field. The current_next_indicator field acts as an indicator identifying whether the corresponding FIC data carry MH ensemble configuration information of an MH frame including the current FIC segment, or whether the corresponding FIC data carry MH ensemble configuration information of a next MH frame. The ESG_version field is a 5-bit field indicating ESG version information. Herein, by providing version information on the service guide providing channel of the corresponding ESG, the ESG_version field enables the receiving system to notify whether or not the corresponding ESG has been updated. Finally, the transport_stream_id field is a 16-bit field acting as a unique identifier of a broadcast stream through which the corresponding FIC segment is being transmitted.

[0109] A second region of the FIC segment payload corresponds to an ensemble loop region, which includes an ensemble_id field, an SI_version field, and a num_channel field. More specifically, the ensemble_id field is an 8-bit field indicating identifiers of an MH ensemble through which MH services are transmitted. Herein, the ensemble_id field binds the MH services and the MH ensemble. The SI_version field is a 4-bit field indicating version information of SI data included in the corresponding ensemble, which is being transmitted within the RS frame. Finally, the num_channel field is an 8-bit field indicating the number of virtual channel being transmitted via the corresponding ensemble.

[0110] A third region of the FIC segment payload a channel loop region, which includes a channel_type field, a channel_activity field, a CA_indicator field, a stand_alone_service_indicator field, a major_channel_num field, and a minor_channel_num field. The channel_type field is a 5-bit field indicating a service type of the corresponding virtual channel. For example, the channel_type field may indicates an audio/video channel, an audio/video and data channel, an audio-only channel, a data-only channel, a file download channel, an ESG delivery channel, a notification channel, and so on. The channel_activity field is a 2-bit field indicating activity information of the corresponding virtual channel. More specifically, the channel_activity field may indicate whether the current virtual channel is providing the current service.

[0111] The CA_indicator field is a 1-bit field indicating whether or not a conditional access (CA) is applied to the current virtual channel. The stand_alone_service_indicator field is also a 1-bit field, which indicates whether the service of the corresponding virtual channel corresponds to a stand alone service. The major_channel_num field is an 8-bit field indicating a major_channel_number of the corresponding virtual channel. Finally, the minor_channel_num field is also an 8-bit field indicating a minor_channel_number of the corresponding virtual channel.

[0112] FIG. **17** illustrates an exemplary bit stream syntax structure of a service map table (hereinafter referred to as "SMT") according to the present invention. According to the embodiment of the present invention, the SMT is configured in an MPEG-2 private section format. However, this will not limit the scope and spirit of the present invention. The SMT according to the embodiment of the present invention includes description information for each virtual channel within a single MH ensemble. And, additional information may further be included in each descriptor area. Herein, the SMT according to the embodiment of the present invention includes at least one field and is transmitted from the transmitting system to the receiving system.

[0113] As described in FIG. **3**, the SMT section may be transmitted by being included in the MH TP within the RS frame. In this case, each of the RS frame decoders **170** and **180**, shown in FIG. **1**, decodes the inputted RS frame, respectively. Then, each of the decoded RS frames is outputted to the respective RS frame handler **211** and **212**. Thereafter, each RS frame handler **211** and **212** identifies the inputted RS frame by row units, so as to create an MH TP, thereby outputting the created MH TP to the MH TP handler **213**. When it is determined that the corresponding MH TP includes an SMT section based upon the header in each of the inputted MH TP, the MH TP handler **213** parses the corresponding SMT section, so as to output the SI data within the parsed SMT section to the physical adaptation control signal handler **216**. However, this is limited to when the SMT is not encapsulated to IP datagrams.

[0114] Meanwhile, when the SMT is encapsulated to IP datagrams, and when it is determined that the corresponding MH TP includes an SMT section based upon the header in each of the inputted MH TP, the MH TP handler **213** outputs the SMT section to the IP network stack **220**. Accordingly, the IP network stack **220** performs IP and UDP processes on the inputted SMT section and, then, outputs the processed SMT section to the SI handler **240**. The SI handler **240** parses the inputted SMT section and controls the system so that the parsed SI data can be stored in the storage unit **290**. The following corresponds to example of the fields that may be transmitted through the SMT.

[0115] The table_id field corresponds to an 8-bit unsigned integer number, which indicates the type of table section being defined in the service map table (SMT). The ensemble_id field is an 8-bit unsigned integer field, which corresponds to an ID value associated to the corresponding MH ensemble. Herein, the ensemble_id field may be assigned with a value ranging from range '0x00' to '0x3F'. It is preferable that the value of the ensemble_id field is derived from the parade_id of the TPC data, which is carried from the baseband processor of MH physical layer subsystem. When the corresponding MH ensemble is transmitted through (or carried over) the primary RS frame, a value of '0' may be used for the most significant bit (MSB), and the remaining 7 bits are used as the parade_id value of the associated MH parade (i.e., for the least significant 7 bits). Alternatively, when the corresponding MH ensemble is transmitted through (or carried over) the secondary RS frame, a value of '1' may be used for the most significant bit (MSB).

[0116] The num_channels field is an 8-bit field, which specifies the number of virtual channels in the corresponding

SMT section. Meanwhile, the SMT according to the embodiment of the present invention provides information on a plurality of virtual channels using the 'for' loop statement. The major_channel_num field corresponds to an 8-bit field, which represents the major_channel_number associated with the corresponding virtual channel. Herein, the major_channel_num field may be assigned with a value ranging from '0x00' to '0xFF'. The minor_channel_num field corresponds to an 8-bit field, which represents the minor_channel_number associated with the corresponding virtual channel. Herein, the minor_channel_num field may be assigned with a value ranging from '0x00' to '0xFF'.

[0117] The short_channel_name field indicates the short name of the virtual channel. The service id field is a 16-bit unsigned integer number (or value), which identifies the virtual channel service. The service_type field is a 6-bit enumerated type field, which identifies the type of service carried in the corresponding virtual channel as defined in Table 2 below.

TABLE 2

0x00	[Reserved]
0x01	MH_digital_television - The virtual channel carries television programming (audio, video and optional associated data) conforming to ATSC standards.
0x02	MH_audio - The virtual channel carries audio programming (audio service and optional associated data) conforming to ATSC standards.
0x03	MH_data_only_service - The virtual channel carries a data service conforming to ATSC standards, but no video or audio component.
0x04-0xFF	[Reserved for future ATSC use]

[0118] The virtual_channel_activity field is a 2-bit enumerated field identifying the activity status of the corresponding virtual channel. When the most significant bit (MSB) of the virtual_channel_activity field is '1', the virtual channel is active, and when the most significant bit (MSB) of the virtual_channel_activity field is '0', the virtual channel is inactive. Also, when the least significant bit (LSB) of the virtual_channel_activity field is '1', the virtual channel is hidden (when set to 1), and when the least significant bit (LSB) of the virtual_channel_activity field is '0', the virtual channel is not hidden. The num_components field is a 5-bit field, which specifies the number of IP stream components in the corresponding virtual channel. The IP_version_flag field corresponds to a 1-bit indicator. More specifically, when the value of the IP_version_flag field is set to '1', this indicates that a source_IP_address field, a virtual_channel_target_IP_address field, and a component_target_IP_address field are IPv6 addresses. Alternatively, when the value of the IP_version_flag field is set to '0', this indicates that the source_IP_address field, the virtual_channel_target_IP_address field, and the component_target_IP_address field are IPv4 addresses.

[0119] The source_IP_address_flag field is a 1-bit Boolean flag, which indicates, when set, that a source IP address of the corresponding virtual channel exist for a specific multicast source. The virtual_channel_target_IP_address_flag field is a 1-bit Boolean flag, which indicates, when set, that the corresponding IP stream component is delivered through IP datagrams with target_IP_addresses different from the virtual_channel_target_IP_address. Therefore, when the flag is set, the receiving system (or receiver) uses the component_target_IP_address as the target_IP_address in order to access the corresponding IP stream component. Accordingly, the receiving system (or receiver) may ignore the virtual_channel_target_IP_address field included in the num_channels loop.

[0120] The source_IP_address field corresponds to a 32-bit or 128-bit field. Herein, the source_IP_address field will be significant (or present), when the value of the source_IP_address_flag field is set to '1'. However, when the value of the source_IP_address_flag field is set to '0', the source_IP_address field will become insignificant (or absent). More specifically, when the source_IP_address_flag field value is set to '1', and when the IP_version_flag field value is set to '0', the source_IP_address field indicates a 32-bit IPv4 address, which shows the source of the corresponding virtual channel. Alternatively, when the IP_version_flag field value is set to '1', the source_IP_address field indicates a 128-bit IPv6 address, which shows the source of the corresponding virtual channel.

[0121] The virtual_channel_target_IP_address field also corresponds to a 32-bit or 128-bit field. Herein, the virtual_channel_target_IP_address field will be significant (or present), when the value of the virtual_channel_target_IP_address_flag field is set to '1'. However, when the value of the virtual_channel_target_IP_address_flag field is set to '0', the virtual_channel_target_IP_address field will become insignificant (or absent). More specifically, when the virtual_channel_target_IP_address_flag field value is set to '1', and when the IP_version_flag field value is set to '0', the virtual_channel_target_IP_address field indicates a 32-bit target IPv4 address associated to the corresponding virtual channel. Alternatively, when the virtual_channel_target_IP_address_flag field value is set to '1', and when the IP_version_flag field value is set to '1', the virtual_channel_target_IP_address field indicates a 64-bit target IPv6 address associated to the corresponding virtual channel. If the virtual_channel_target_IP_address field is insignificant (or absent), the component_target_IP_address field within the num_channels loop should become significant (or present). And, in order to enable the receiving system to access the IP stream component, the component_target_IP_address field should be used.

[0122] Meanwhile, the SMT according to the embodiment of the present invention uses a 'for' loop statement in order to provide information on a plurality of components. Herein, the RTP_payload_type field, which is assigned with 7 bits, identifies the encoding format of the component based upon Table 3 shown below. When the IP stream component is not encapsulated to RTP, the RTP_payload_type field shall be ignored (or deprecated). Table 3 below shows an example of an RTP payload type.

TABLE 3

RTP payload type	Meaning
35	AVC video
36	MH audio
37-72	[Reserved for future ATSC use]

[0123] The component_target_IP_address_flag field is a 1-bit Boolean flag, which indicates, when set, that the corresponding IP stream component is delivered through IP datagrams with target_IP_addresses different from the virtual_channel_target_IP_address. Furthermore, when the component_target_IP_address_flag is set, the receiving system (or receiver) uses the component_target_IP_address field as the target_IP_address to access the corresponding IP stream component. Accordingly, the receiving system (or receiver) will ignore the virtual_channel_target_IP_address field included in the num_channels loop. The component_target_IP_address field corresponds to a 32-bit or 128-bit field. Herein, when the value of the IP_version_flag field is set to '0', the component_target_IP_address field indicates a 32-bit target IPv4 address associated to the corresponding IP stream component. And, when the value of the IP_version_flag field is set to '1', the component_target_IP_address field indicates a 128-bit target IPv6 address associated to the corresponding IP stream component.

[0124] The port_num_count field is a 6-bit field, which indicates the number of UDP ports associated with the corresponding IP stream component. A target_UDP_port_number value starts from the target_UDP_port_num field value and increases (or is incremented) by 1. For the RTP stream, the target_UDP_port_number should start from the target_UDP_port_num field value and shall increase (or be incremented) by 2. This is to incorporate RTCP streams associated with the RTP streams.

[0125] The target_UDP_port_num field is a 16-bit unsigned integer field, which represents the target_UDP_port_number for the corresponding IP stream component. When used for RTP streams, the value of the target_UDP_port_num field shall correspond to an even number. And, the next higher value shall represent the target_UDP_port_number of the associated RTCP stream. The component_level_descriptor( ) represents zero or more descriptors providing additional information on the corresponding IP stream component. The virtual_channel_level_descriptor( ) represents zero or more descriptors providing additional information for the corresponding virtual channel. The ensemble_level_descriptor( ) represents zero or more descriptors providing additional information for the MH ensemble, which is described by the corresponding SMT.

[0126] FIG. **18** illustrates an exemplary bit stream syntax structure of an MH audio descriptor according to the present invention. When at least one audio service is present as a component of the current event, the MH_audio_descriptor( ) shall be used as a component_level_descriptor of the SMT. The MH_audio_descriptor( ) may be capable of informing the system of the audio language type and stereo mode status. If there is no audio service associated with the current event, then it is preferable that the MH_audio_descriptor( ) is considered to be insignificant (or absent) for the current event. Each field shown in the bit stream syntax of FIG. **18** will now be described in detail.

[0127] The descriptor_tag field is an 8-bit unsigned integer having a TBD value, which indicates that the corresponding descriptor is the MH_audio_descriptor( ) The descriptor_length field is also an 8-bit unsigned integer, which indicates the length (in bytes) of the portion immediately following the descriptor_length field up to the end of the MH_audio_descriptor( ) The channel configuration field corresponds to an 8-bit field indicating the number and configuration of audio channels. The values ranging from '1' to '6' respectively indicate the number and configuration of audio channels as given for "Default bit stream index number" in Table 42 of ISO/IEC 13818-7:2006. All other values indicate that the number and configuration of audio channels are undefined.

[0128] The sample_rate_code field is a 3-bit field, which indicates the sample rate of the encoded audio data. Herein, the indication may correspond to one specific sample rate, or may correspond to a set of values that include the sample rate of the encoded audio data as defined in Table A3.3 of ATSC A/52B. The bit_rate_code field corresponds to a 6-bit field. Herein, among the 6 bits, the lower 5 bits indicate a nominal bit rate. More specifically, when the most significant bit (MSB) is '0', the corresponding bit rate is exact. On the other hand, when the most significant bit (MSB) is '1', the bit rate corresponds to an upper limit as defined in Table A3.4 of ATSC A/53B. The ISO__639_language_code field is a 24-bit (i.e., 3-byte) field indicating the language used for the audio stream component, in conformance with ISO 639.2/B [x]. When a specific language is not present in the corresponding audio stream component, the value of each byte will be set to '0x00'.

[0129] FIG. **19** illustrates an exemplary bit stream syntax structure of an MH RTP payload type descriptor according to the present invention. The MH RTP_payload_type_descriptor( ) specifies the RTP payload type. Yet, the MH_RTP_payload_type_descriptor( ) exists only when the dynamic value of the RTP_payload_type field within the num_components loop of the SMT is in the range of '96' to '127'. The MH_RTP_payload_type_descriptor( ) is used as a component_level_descriptor of the SMT. The MH_RTP_payload_type descriptor translates (or matches) a dynamic RTP_payload_type field value into (or with) a MIME type. Accordingly, the receiving system (or receiver) may collect (or gather) the encoding format of the IP stream component, which is encapsulated in RTP. The fields included in the MH_RTP_payload_type_descriptor( ) will now be described in detail.

[0130] The descriptor_tag field corresponds to an 8-bit unsigned integer having the value TBD, which identifies the current descriptor as the MH_RTP_payload_type_descriptor( ) The descriptor_length field also corresponds to an 8-bit unsigned integer, which indicates the length (in bytes) of the portion immediately following the descriptor_length field up to the end of the MH_RTP_payload_type_descriptor( ). The RTP_payload_type field corresponds to a 7-bit field, which identifies the encoding format of the IP stream component. Herein, the dynamic value of the RTP_payload_type field is in the range of '96' to '127'. The MIME_type_length field specifies the length (in bytes) of the MIME_type field. The MIME_type field indicates the MIME type corresponding to the encoding format of the IP stream component, which is described by the MH_RTP_payload_type_descriptor( ).

[0131] FIG. **20** illustrates an exemplary bit stream syntax structure of an MH current event descriptor according to the present invention. The MH_current_event_descriptor( ) shall be used as the virtual_channel_level_descriptor( ) within the SMT. Herein, the MH_current_event_descriptor( ) provides basic information on the current event (e.g., the start time, duration, and title of the current event, etc.), which is transmitted via the respective virtual channel. The fields included in the MH_current_event_descriptor( ) will now be described in detail.

[0132] The descriptor_tag field corresponds to an 8-bit unsigned integer having the value TBD, which identifies the current descriptor as the MH_current_event_descriptor( ). The descriptor_length field also corresponds to an 8-bit unsigned integer, which indicates the length (in bytes) of the portion immediately following the descriptor_length field up to the end of the MH_current_event_descriptor( ). The current_event_start_time field corresponds to a 32-bit unsigned integer quantity. The current_event_start_time field represents the start time of the current event and, more specifically, as the number of GPS seconds since 00:00:00 UTC, Jan. 6, 1980. The current_event_duration field corresponds to a 24-bit field. Herein, the current_event_duration field indicates the duration of the current event in hours, minutes, and seconds (for example, wherein the format is in 6 digits, 4-bit BCD=24 bits). The title_length field specifies the length (in bytes) of the title_text field. Herein, the value ‘0’ indicates that there are no titles existing for the corresponding event. The title_text field indicates the title of the corresponding event in event title in the format of a multiple string structure as defined in ATSC A/65C [x].

[0133] FIG. **21** illustrates an exemplary bit stream syntax structure of an MH next event descriptor according to the present invention. The optional MH_next_event_descriptor( ) shall be used as the virtual_channel_level_descriptor( ) within the SMT. Herein, the MH_next_event_descriptor( ) provides basic information on the next event (e.g., the start time, duration, and title of the next event, etc.), which is transmitted via the respective virtual channel. The fields included in the MH_next_event_descriptor( ) will now be described in detail.

[0134] The descriptor_tag field corresponds to an 8-bit unsigned integer having the value TBD, which identifies the current descriptor as the MH_next_event_descriptor( ). The descriptor_length field also corresponds to an 8-bit unsigned integer, which indicates the length (in bytes) of the portion immediately following the descriptor_length field up to the end of the MH_next_event_descriptor( ). The next_event_start_time field corresponds to a 32-bit unsigned integer quantity. The next_event_start_time field represents the start time of the next event and, more specifically, as the number of GPS seconds since 00:00:00 UTC, Jan. 6, 1980. The next_event_duration field corresponds to a 24-bit field. Herein, the next_event_duration field indicates the duration of the next event in hours, minutes, and seconds (for example, wherein the format is in 6 digits, 4-bit BCD=24 bits). The title_length field specifies the length (in bytes) of the title_text field. Herein, the value ‘0’ indicates that there are no titles existing for the corresponding event. The title_text field indicates the title of the corresponding event in event title in the format of a multiple string structure as defined in ATSC A/65C [x].

[0135] FIG. **22** illustrates an exemplary bit stream syntax structure of an MH system time descriptor according to the present invention. The MH_system_time_descriptor( ) shall be used as the ensemble_level_descriptor( ) within the SMT. Herein, the MH_system_time_descriptor( ) provides information on current time and date. The MH_system_time_descriptor( ) also provides information on the time zone in which the transmitting system (or transmitter) transmitting the corresponding broadcast stream is located, while taking into consideration the mobile/portable characterstics of the MH service data. The fields included in the MH_system_time_descriptor( ) will now be described in detail.

[0136] The descriptor_tag field corresponds to an 8-bit unsigned integer having the value TBD, which identifies the current descriptor as the MH_system_time_descriptor( ). The descriptor_length field also corresponds to an 8-bit unsigned integer, which indicates the length (in bytes) of the portion immediately following the descriptor_length field up to the end of the MH_system_time_descriptor( ). The system_time field corresponds to a 32-bit unsigned integer quantity. The system_time field represents the current system time and, more specifically, as the number of GPS seconds since 00:00:00 UTC, Jan. 6, 1980. The GPS_UTC_offset field corresponds to an 8-bit unsigned integer, which defines the current offset in whole seconds between GPS and UTC time standards. In order to convert GPS time to UTC time, the GPS_UTC_offset is subtracted from GPS time. Whenever the International Bureau of Weights and Measures decides that the current offset is too far in error, an additional leap second may be added (or subtracted). Accordingly, the GPS_UTC_offset field value will reflect the change.

[0137] The time_zone_offset_polarity field is a 1-bit field, which indicates whether the time of the time zone, in which the broadcast station is located, exceeds (or leads or is faster) or falls behind (or lags or is slower) than the UTC time. When the value of the time_zone_offset_polarity field is equal to ‘0’, this indicates that the time on the current time zone exceeds the UTC time. Therefore, the time_zone_offset_polarity field value is added to the UTC time value. Conversely, when the value of the time_zone_offset_polarity field is equal to ‘1’, this indicates that the time on the current time zone falls behind the UTC time. Therefore, the time_zone_offset_polarity field value is subtracted from the UTC time value.

[0138] The time_zone_offset field is a 31-bit unsigned integer quantity. More specifically, the time_zone_offset field represents, in GPS seconds, the time offset of the time zone in which the broadcast station is located, when compared to the UTC time. The daylight_savings field corresponds to a 16-bit field providing information on the Summer Time (i.e., the Daylight Savings Time). The time_zone field corresponds to a (5×8)-bit field indicating the time zone, in which the transmitting system (or transmitter) transmitting the corresponding broadcast stream is located.

[0139] FIG. **23** illustrates segmentation and encapsulation processes of a service map table (SMT) according to the present invention. According to the present invention, the SMT is encapsulated to UDP, while including a target IP address and a target UDP port number within the IP datagram. More specifically, the SMT is first segmented into a predetermined number of sections, then encapsulated to a UDP header, and finally encapsulated to an IP header. In addition, the SMT section provides signaling information on all virtual channel included in the MH ensemble including the corresponding SMT section. At least one SMT section describing the MH ensemble is included in each RS frame included in the corresponding MH ensemble. Finally, each SMT section is identified by an ensemble_id included in each section. According to the embodiment of the present invention, by informing the receiving system of the target IP address and target UDP port number, the corresponding data (i.e., target IP address and target UDP port number) may be parsed without having the receiving system to request for other additional information.

[0140] FIG. **24** illustrates a flow chart for accessing a virtual channel using FIC and SMT according to the present invention. More specifically, a physical channel is tuned (S**501**). And, when it is determined that an MH signal exists in the tuned physical channel (S**502**), the corresponding MH signal is demodulated (S**503**). Additionally, FIC segments are grouped from the demodulated MH signal in sub-frame units (S**504** and S**505**). According to the embodiment of the present invention, an FIC segment is inserted in a data group, so as to be transmitted. More specifically, the FIC segment corresponding to each data group described service information on the MH ensemble to which the corresponding data group belongs.

[0141] When the FIC segments are grouped in sub-frame units and, then, deinterleaved, all service information on the physical channel through which the corresponding FIC segment is transmitted may be acquired. Therefore, after the tuning process, the receiving system may acquire channel information on the corresponding physical channel during a sub-frame period. Once the FIC segments are grouped, in S**504** and S**505**, a broadcast stream through which the corresponding FIC segment is being transmitted is identified (S**506**). For example, the broadcast stream may be identified by parsing the transport_stream_id field of the FIC body, which is configured by grouping the FIC segments. Furthermore, an ensemble identifier, a major channel number, a minor channel number, channel type information, and so on, are extracted from the FIC body (S**507**). And, by using the extracted ensemble information, only the slots corresponding to the designated ensemble are acquired by using the time-slicing method, so as to configure an ensemble (S**508**).

[0142] Subsequently, the RS frame corresponding to the designated ensemble is decoded (S**509**), and an IP socket is opened for SMT reception (S**510**). According to the example given in the embodiment of the present invention, the SMT is encapsulated to UDP, while including a target IP address and a target UDP port number within the IP datagram. More specifically, the SMT is first segmented into a predetermined number of sections, then encapsulated to a UDP header, and finally encapsulated to an IP header. According to the embodiment of the present invention, by informing the receiving system of the target IP address and target UDP port number, the receiving system parses the SMT sections and the descriptors of each SMT section without requesting for other additional information (S**511**).

[0143] The SMT section provides signaling information on all virtual channel included in the MH ensemble including the corresponding SMT section. At least one SMT section describing the MH ensemble is included in each RS frame included in the corresponding MH ensemble. Also, each SMT section is identified by an ensemble_id included in each section. Furthermore each SMT provides IP access information on each virtual channel subordinate to the corresponding MH ensemble including each SMT. Finally, the SMT provides IP stream component level information required for the servicing of the corresponding virtual channel. Therefore, by using the information parsed from the SMT, the IP stream component belonging to the virtual channel requested for reception may be accessed (S**513**). Accordingly, the service associated with the corresponding virtual channel is provided to the user (S**514**).

[0144] Hereinafter, a digital broadcast receiving system according to an embodiment of the present invention will be described in detail, based upon the description of the present invention with reference to FIG. **1** to FIG. **24**. Therefore, the description of FIG. **1** to FIG. **24** may be partially or entirely applied to the digital broadcast receiving system according to the embodiment of the present invention. Evidently, the scope of the appended claims and their equivalents will not depart from the description of the present invention.

[0145] FIG. **25** is a block diagram showing the configuration of the digital broadcast receiver according to one embodiment of the present invention. Hereinafter, the functions of constituent elements of the digital broadcast receiver according to one embodiment of the present invention will be described with reference to FIG. **25**. For reference, FIG. **25** schematically shows the baseband processor **100**, management processor **200** and presentation processor **300** shown in FIG. **1**, and those skilled in the art will readily appreciate the present invention throughout the entire description of this specification. Also, the scope of the present invention is not limited to contents described in the drawings and should be in principle interpreted based on contents described in the appended claims.

[0146] As shown in FIG. **25**, the digital broadcast receiver according to one embodiment of the present invention, denoted by reference numeral **2500**, includes a tuner **2501**, baseband processor **2502**, RS frame memory **2503**, A/V decoder **2504**, A/V output unit (display/speaker) **2505**, FIC memory **2506**, SMT/EMT memory **2507**, host **2508**, channel/service map DB **2509**, and so forth.

[0147] For reference, the blocks shown in FIG. **25** are designable into modules, each of which signifies one unit that processes a specific function or operation. Also, each module can be implemented with hardware or software or may be implemented with a combination of hardware and software.

[0148] The host **2508** acts to control the constituent elements of the digital broadcast receiver **2500** and decode or process desired data. The tuner **2501** detects data applied at a frequency set by the host **2508**. The data detected by the tuner **2501** is transmitted to the baseband processor **2502**, which acts to demodulate the transmitted data. Output data from the baseband processor **2502** may be, for example, RS frame data, FIC data, etc.

[0149] On the other hand, the RS frame data is detected at a regular time interval based on criteria set by the host **2508**, and stored in the RS frame memory **2503**. Also, the FIC data is detected as needed in response to a request from the host **2508**, and stored in the FIC memory **2506**. For reference, a time interval at which the FIC data is detected corresponds to about ⅕ the time interval required to detect the RS frame data.

[0150] Meanwhile, the A/V decoder **2504** processes audio and video streams and outputs the resulting A/V data through the A/V output unit **2505**. The channel/service map DB **2509** stores information about a service map accessible by the digital broadcast receiver **2500**, and the host **2508** can process desired information using the channel/service map DB **2509**.

[0151] Also, the tuner **2501** of the digital broadcast receiver **2500** according to one embodiment of the present invention receives a broadcast signal into which mobile service data and main service data are multiplexed. Of course, a module taking charge of this function may be named a reception unit.

[0152] On the other hand, the host **2508** controls the tuner **2501**, baseband processor **2502**, RS frame memory **2503**, FIC memory **2506**, SMT/EMT memory **2507**, channel/service map DB **2509**, etc. to extract transmission parameter channel (TPC) signaling information and fast information channel (FIC) signaling information from a data group in the received mobile service data. Of course, a module taking charge of this function may be named an extractor.

[0153] Also, the host **2508** controls the tuner **2501**, baseband processor **2502**, RS frame memory **2503**, FIC memory **2506**, SMT/EMT memory **2507**, channel/service map DB **2509**, etc. to acquire a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble, using the extracted FIC signaling information. Of course, a module taking charge of this function may be named an acquirer.

[0154] For reference, the program table means a table defining information about all ensembles transmitted at a specific physical frequency, different from the SMT as described above. The program table may be named an ensemble map table (EMT). Of course, the scope of the present invention is not limited to the name of the EMT that is only an example of the name of the program table.

[0155] The EMT newly proposed in the present invention defines the mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble. In a more detailed example, the EMT includes information defining the number of all ensembles transmitted at a physical frequency, information identifying each of the ensembles, information defining the number of at least one virtual channel corresponding to each of the ensembles, IP address information required for channel tuning to the at least one virtual channel corresponding to the ensembles, and other information. For example, the IP address information may include IP_version_flag, source_IP_address_flag, virtual_channel_target_IP_address_flag, source_IP_address, virtual_channel_target_IP_address, etc, as shown in FIG. **26**.

[0156] The EMT newly proposed in the present invention will be described in more detail later in a description given with reference to FIG. **26**.

[0157] The host **2508** detects IP address information required for tuning to at least one virtual channel corresponding to each of one or more ensembles transmitted at a specific physical frequency, using the program table (which may be named "EMT") stored in the SMT/EMT memory **2507**. Of course, a module taking charge of this function may be named a detector.

[0158] When an input signal of channel tuning to a virtual channel that is different from a current virtual channel is received (in other words, when a channel tuning input signal is received over a virtual channel other than the current virtual channel), the host **2508** controls channel tuning to the other virtual channel, using the IP address information detected through the EMT. Of course, this is implemented only when both the current virtual channel and the other virtual channel correspond to ensembles transmitted at the same physical frequency, respectively. In some cases, it may be taken into consideration that the EMT does not define information associated with all ensembles corresponding to only one physical frequency, but defines information associated with all ensembles corresponding to at least two physical frequencies. Of course, a module taking charge of this function may be named a controller.

[0159] Thus, in the present invention, it is possible to considerably reduce the channel change time as all ensembles transmitted at a specific physical frequency, virtual channels corresponding to each ensemble, IP address information required for channel tuning, etc. are defined, as compared to the case in which parsing of an SMT is executed in every channel change.

[0160] FIG. **26** is a diagram illustrating an EMT according to one embodiment of the present invention. Hereinafter, the EMT according to the illustrated embodiment of the present invention will be described in detail with reference to FIG. **26**. The following description will be given only in conjunction with main fields, without a description of fields readily understandable by a skilled person. Meanwhile, it may be briefly summarized that, in accordance with the present invention, there is an advantage in that it is unnecessary to separately check an SMT upon channel tuning because the EMT includes IP address information about virtual channels corresponding to each of all ensembles transmitted at a specific physical frequency.

[0161] For reference, the EMT is added with a field defining the number of ensembles transmitted at a specific physical frequency, and a field identifying an ensemble in a 'for loop' syntax associated with the field defining the number of ensembles, different from the SMT.

[0162] A 'table_id' field (8 bits) is an 8-bit field for distinction of a table type. Based on this field, it can be determined that the current table is an EMT. (For reference, table_id: An 8-bit unsigned integer number that indicates the type of table section being defined in Ensemble Map Table (EMT)).

[0163] A 'transport_stream_id' field distinguishes an EMT transmitted over the current physical transmission channel from EMTs transmitted over other physical transmission channels. (For reference, transport_stream_id: The 16-bit identifier that distinguishes this Ensemble Map Table from others that may be broadcast in different Physical Transmission Channels).

[0164] A 'current_next_indicator' field identifies whether the EMT is currently applicable or next applicable. (For reference, current_next_indicator: A one-bit indicator, which when set to '1' indicates that the Ensemble Map Table sent is currently applicable. When the bit is set to '0', it indicates that the table sent is not yet applicable and shall be the next table to become valid.).

[0165] A 'num_ensembles' field is a field indicating the number of ensembles carried by the current EMT. For example, this field may be designed as an 8-bit field. As shown in FIG. **26**, the 'num_ensembles' field has influence on a 'for loop' syntax positioned just therebeneath. Accordingly, the EMT of the present invention may provide information about a plurality of ensembles.

[0166] An 'ensemble_id' field (8 bits) is an ID value associated with a current MH ensemble. A value in a range of 0x00 to 0x3F may be assigned to the 'ensemble_id' field. The value of this field may be derived from a parade_id of TPC data. When the current MH ensemble is carried by a primary RS frame, the most significant bit (MSB) of the 'ensemble_id' field is set to '0', and the remaining 7 bits are set, using the value of the parade_id of an associated MH parade. On the other hand, when the current MH ensemble is carried by a secondary RS frame, the MSB of the 'ensemble_id' field is set to '1', and the remaining 7 bits are set, using the value of the parade_id of an associated MH parade. (For reference, this 8-bit unsigned integer field in the range 0x00 to 0x3F shall be the Ensemble ID associated with this MH Ensemble. The value of this field shall be derived from the parade_id carried from the baseband processor of MH physical layer subsystem, by using the parade_id of the associated MH Parade for the least significant 7 bits, and using '0' for the most significant bit when the MH Ensemble is carried over the Primary RS frame, and using '1' for the most significant bit when the MH Ensemble is carried over the Secondary RS frame.).

[0167] A 'num_channels' field (8 bits) specifies the number of virtual channels in a current EMT section. (For reference, this 8 bit field specifies the number of virtual channels in this EMT section.).

[0168] Meanwhile, the EMT according to the illustrated embodiment provides information about a plurality of virtual channels, using 'for loop'.

[0169] A ‘major_channel_num’ field (8 bits) represents a major channel number associated with the current virtual channel. A value in a range of 0x00 to 0xFF may be assigned to the ‘major_channel_num’ field. (For reference, this 8-bit unsigned integer field in the range 0x00 to 0xFF shall represent the major channel number associated with this virtual channel.).

[0170] A “minor_channel_num” field (8 bits) represents a minor channel number associated with the current virtual channel. A value in a range of 0x00 to 0xFF may be assigned to the ‘minor_channel_num’ field. (For reference, this 8-bit unsigned integer field in the range 0x00 to 0xFF shall represent the minor channel number associated with this virtual channel.).

[0171] Although not shown in FIG. **26**, a ‘short_channel_name’ field representing a short name of the current virtual channel may be added.

[0172] A ‘num_components’ field (5 bits) specifies the number of IP stream components in the current virtual channel. (For reference, this 5-bit field specifies the number of IP stream components in this virtual channel.).

[0173] An ‘IP_version_flag’ field (1 bit) indicates, when set to ‘1’, that ‘source_IP_address’, ‘virtual_channel_target_IP_address’ and ‘component_target_IP_address’ fields are IPv6 addresses, while indicating, when set to ‘0’, that the ‘source_IP_address’, ‘virtual_channel_target_IP_address’ and ‘component_target_IP_address’ fields are IPv4 addresses. (For reference, a 1-bit indicator, which when set to ‘1’ indicates that source_IP_address, virtual_channel_target_IP_address and component_target_IP_address fields if exist, are IPv6 addresses, and when set to ‘0’ indicates that source_IP_address, virtual_channel_target_IP_address and component_target_IP_address fields are IPv4 addresses.).

[0174] A ‘source_IP_address_flag’ field (1 bit) indicates, when set, that a source IP address of the current virtual channel is present for a specific multicast source. (For reference, a 1-bit Boolean flag that indicates, when set, a source IP address of this virtual channel is present for source specific multicast.).

[0175] A ‘virtual_channel_target_IP_address_flag’ field (1 bit) indicates, when set, that the current IP stream component is delivered through an IP datagram with a target IP address different from the virtual_channel_target_IP_address. When this flag is set, the receiver utilizes the component_target_IP_address as the target_IP_address to access the current IP stream component, while ignoring the ‘virtual_channel_target_IP_address’ field in the ‘num_channels’ loop. (For reference, a 1-bit Boolean flag that indicates, when set, this IP stream component is delivered through IP datagrams with target IP addresses different from virtual_channel_target_IP_address. When this flag is set, then the receiver shall utilize the component_target_IP_address as the target_IP_address to access this IP stream component and shall ignore the virtual_channel_target_IP_address field in the num_channels loop.).

[0176] The ‘source_IP_address’ field (32 or 128 bits) is required to be interpreted when the source_IP_address_flag is set to ‘1’. However, when the source_IP_address_flag is set to ‘0’, it is unnecessary to interpret the ‘source_IP_address’ field. When the source_IP_address_flag is set to ‘1’, and the ‘IP_version_flag’ field is set to ‘0’, the ‘source_IP_address’ field specifies a 32-bit IPv4 address indicating the source of the current virtual channel. On the other hand, when the ‘IP_version_flag’ field is set to ‘1’, the ‘source_IP_address’ field specifies a 32-bit IPv6 address indicating the source of the current virtual channel. (For reference, this field shall present if the source_IP_address_flag is set to ‘1’ and shall not present if the source_IP_address_flag is set to ‘0’. If present, when IP_version_flag field is set to ‘0’, this field specifies 32-bit IPv4 address indicating the source of this virtual channel. When IP_version_flag field is set to ‘1’, this field specifies 128-bit IPv6 address indicating the source of this virtual channel.).

[0177] The ‘virtual_channel_target_IP_address’ field (32 or 128 bits) is required to be interpreted when the virtual_channel_target_IP_address_flag is set to ‘1’. However, when the virtual_channel_target_IP_address_flag is set to ‘0’, it is unnecessary to interpret the ‘source_IP_address’ field. When the virtual_channel_target_IP_address_flag is set to ‘1’, and the IP_version_flag field is set to ‘0’, the ‘virtual_channel_target_IP_address’ field specifies a 32-bit target IPv4 address for the current virtual channel. On the other hand, when the virtual_channel_target_IP_address_flag is set to ‘1’, and the IP_version_flag field is set to ‘1’, the ‘virtual_channel_target_IP_address’ field specifies a 64-bit target IPv6 address for the current virtual channel. If this virtual_channel_target_IP_address cannot be interpreted, then the ‘component_target_IP_address’ field in the ‘num_channels’ loop is required to be interpreted. In this case, the receiver also has to utilize the component_target_IP_address to access a target IP stream component. (For reference, this field shall present if the virtual_channel_target_IP_address_flag is set to ‘1’ and shall not present if the virtual_channel_target_IP_address_flag is set to ‘0’. If present, when IP_version_flag field is set to ‘0’, this field specifies 32-bit target IPv4 address for this virtual channel. When IP_version_flag field is set to ‘1’, this field specifies 128-bit target IPv6 address for this virtual channel. If this virtual_channel_target_IP_address doesn’t present, then the component_target_IP_address field in the num_channels loop shall present and the receiver shall utilize the component_target_IP_address to access IP stream components.).

[0178] As described above, the EMT newly proposed in the present invention includes IP address information required for tuning to a virtual channel (including, for example, the IP_version_flag, source_IP_address_flag, virtual_channel_target_IP_address_flag, source_IP_address, and virtual_channel_target_IP_address). Thus, in accordance with the present invention, it is possible to rapidly achieve tuning to all virtual channels corresponding to ensembles defined in the EMT, using only the EMT, without using an SMT.

[0179] Meanwhile, the EMT according to the illustrated embodiment provides information about a plurality of components, using ‘for loop’.

[0180] A ‘component_type’ field (7 bits) identifies an encoding format of the component. The ‘component_type’ field may be designed to have a value defined in a below table, or to have other values. (For reference, this 7-bit field identifies the encoding format of the component. The value may be any of the values assigned by IANA for the payload_type of an AVP/RTP stream, or it may be any of the values assigned in below table, or it may be a “dynamic value” in the range 96-127. If it is a value in the range 96-127, an ATSC_MH_payload_type_descriptor( ) shall appear in the descriptor loop for this component to map the component_type to a MIME type. If the IP stream component is encapsulated in RTP, the value of this field shall match the value in the payload_type field in the RTP header).

TABLE 4

component type meaning	
35	AVC video
36	ATSC-M/H audio
37	FLUTE file delivery session
38-71	[Reserved for future ATSC use]

[0181] The 'component_target_IP_address_flag' field (1 bit) indicates whether or not the component_target_IP_address of the current component is effective. (For reference, a 1-bit Boolean flag that indicates, when set to '1', that the component_target_IP_address is present for this component)

[0182] The component_target_IP_address' field is effective when the field value of the component_target_IP_address_flag is '1', while being ineffective when the field value of the component_target_IP_address_flag is '0'. (For reference, this field shall be present if the component_target_IP_address_flag is set to '1' and shall not be present if the component_target_IP_address_flag set to '0'. When this field is present, the destination address of the IP packets carrying this component of the virtual channel shall match the address in this field. When this field is not present, the destination address of the IP packets carrying this component shall match the address in the virtual_channel_target_IP_address field).

[0183] A 'port_num_count' field (6 bits) indicates the number of a UDP port associated with the current IP stream component. (For reference, this field indicates the number of UDP ports associated with this IP stream component. The values of the destination UDP port numbers shall start from the target_UDP_port_num field and shall be incremented by one, except in the case of RTP streams, when the target UDP port numbers shall from the target_UPD_port_num field and shall be incremented by two, to allow for the RTCP streams associated with the RTP streams.).

[0184] A 'target_UDP_port_num' field (16 bits) represents a target UDP port number for the current IP stream component. For a RTP stream, the 'target_UDP_port_num' field has an even value. A next higher value of the 'target_UDP_port_num' field represents the destination UDP port number of an associated RTCP stream. (For reference, a 16-bit unsigned integer field, that represents the destination UDP port number for this IP stream component. For RTP streams, the value of target_UDP_port_num shall be even, and the next higher value shall represent the destination UDP port number of the associated RTCP stream.).

[0185] A component_level_descriptor( ) represents a descriptor providing additional information for the current IP component. (For reference, zero or more descriptors providing additional information for this IP stream component, may be included.).

[0186] A virtual_channel_level_descriptor( ) represents a descriptor providing additional information for the current virtual channel. (For reference, zero or more descriptors providing additional information for this virtual channel, may be included.).

[0187] An ensemble_level_descriptor( ) represents a descriptor providing additional information for an MH ensemble described by the current SMT. (For reference, zero or more descriptors providing additional information for the MH Ensemble which this SMT describes, may be included.).

[0188] Furthermore, the above-stated data group may include, for example, a plurality of known data sequences, and the transmission parameter channel (TPC) signaling information and the fast information channel (FIC) signaling information may be designed to be placed, for example, between a first known data sequence and a second known data sequence, among the known data sequences.

[0189] Therefore, a known data detector of the digital broadcast receiver according to one embodiment of the present invention may detect known data in the received broadcast signal, and an equalizer of the digital broadcast receiver according to this embodiment may channel-equalize mobile service data corresponding to the detected known data using the detected known data. For reference, the functions of the known data detector and equalizer were adequately described in the description of FIG. **1**.

[0190] Moreover, according to this embodiment, the equalizer can improve equalization performance by using a known data symbol sequence inputted from the known data detector.

[0191] FIG. **27** is a flowchart illustrating a control method of a digital broadcast receiver according to one embodiment of the present invention. With reference to FIG. **27**, a brief description will hereinafter be given of the control method of the digital broadcast receiver according to one embodiment of the present invention. For reference, FIGS. **27** and **28** relate to a method invention, which can be interpreted with the description of the above-stated object invention supplementarily applied thereto.

[0192] According to one embodiment of the present invention, the digital broadcast receiver performs channel tuning at a specific physical frequency (S**2701**). The digital broadcast receiver parses an EMT (S**2702**), and stores the parsed EMT (S**2703**). The digital broadcast receiver performs a control operation to achieve a channel change, using the EMT (S**2704**).

[0193] For reference, no further description will be given of a program table newly proposed in the present invention, namely, an EMT, because the EMT was sufficiently described in the above description part. Of course, the above-stated EMT may be equally applied to the method invention.

[0194] In this connection, the effects of the present invention will be again described in brief. When a channel change is executed using an SMT, it is necessary to parse the SMT upon every channel change. In one embodiment of the present invention, however, the channel change between virtual channels corresponding to ensembles at the same physical frequency can be achieved using a previously-received EMT, without parsing of an SMT or EMT in every channel change. Accordingly, it is possible to directly decode associated A/V data. As a result, the channel change time is considerably reduced.

[0195] FIG. **28** is a flowchart illustrating a control method of a digital broadcast receiver and digital broadcast transmitter according to one embodiment of the present invention. With reference to FIG. **28**, a detailed description will hereinafter be given of the control method of the digital broadcast receiver and digital broadcast transmitter according to one embodiment of the present invention.

[0196] In accordance with one embodiment of the present invention, the digital broadcast transmitter generates a broadcast signal including a program table (for example, an EMT shown in FIG. **26**) defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble

(**S2810**). Then, the digital broadcast transmitter transmits the generated broadcast signal to a digital broadcast receiver (**S2820**).

[0197] On the other hand, the digital broadcast receiver receives a broadcast signal into which mobile service data and main service data are multiplexed (**S2830**), extracts transmission parameter channel (TPC) signaling information and fast information channel (FIC) signaling information from a data group in the received mobile service data (**S2840**) and acquires a program table defining a mapping relation between each of all ensembles transmitted at a physical frequency and at least one virtual channel corresponding to the ensemble, using the extracted fast information channel signaling information (**S2850**). Then, the digital broadcast receiver detects IP address information required for channel tuning to at least one virtual channel corresponding to each of the ensembles, using the acquired program table (**S2860**).

[0198] When a channel tuning input signal is input over a virtual channel other than the current virtual channel (in other words, when an input signal of channel tuning to a virtual channel that is different from a current virtual channel is received), the digital broadcast receiver controls channel tuning to the other virtual channel, using the detected IP address information (**S2870**).

[0199] Furthermore, the above-stated data group may include, for example, a plurality of known data sequences, and the transmission parameter channel signaling information and the fast information channel signaling information may be designed to be placed, for example, between a first known data sequence and a second known data sequence, among the known data sequences.

[0200] As above described, according to one embodiment of the present invention, it is possible to provide a digital broadcast receiver which is robust against a channel variation and noise, and a control method thereof.

[0201] Further, according to another embodiment of the present invention, it is possible to provide a digital broadcasting system which is capable of considerably enhancing the channel change speed of a digital broadcast receiver. For example, it is possible to more enhance the channel change speed upon a channel change at a specific physical frequency as an EMT including information about all ensembles transmitted at the specific physical frequency is newly defined.

[0202] The present method invention can be implemented in the form of program commands executable by a variety of computer means, and recorded on a computer-readable recording medium. The computer-readable recording medium can include program commands, data files, data structures, etc. individually or in combination. The program commands recorded on the medium may be ones specially designed and configured for the present invention or ones known and available to those skilled in computer software. Examples of the computer-readable recording medium include magnetic media such as a hard disk, a floppy disk and a magnetic tape, optical media such as a compact disc read only memory (CD-ROM) and a digital versatile disc (DVD), magneto-optical media such as a floptical disk, and hardware devices specially configured to store and execute program commands, such as a ROM, a random access memory (RAM) and a flash memory. Examples of the program commands include high-level language codes that can be executed by a computer using an interpreter, etc., as well as machine language codes such as those produced by a compiler. The above-stated hardware devices can be configured to operate as one or more software modules to perform the operation of the present invention, and vice versa.

[0203] Although the present invention has been described in conjunction with the limited embodiments and drawings, the present invention is not limited thereto. Those skilled in the art will appreciate that various modifications, additions and substitutions are possible from this description.

[0204] Therefore, the scope of the present invention should not be limited to the description of the exemplary embodiments and should be determined by the appended claims and their equivalents.

[0205] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

1-8. (canceled)

9. A method of processing broadcast data in a broadcast transmitter, the method comprising:

performing, by a Reed-Solomon (RS) encoder, RS encoding and Cyclic Redundancy Check (CRC) encoding on mobile service data to build an RS frame belonging to an ensemble, wherein data of the RS frame are mapped into data groups and each of the data groups includes known data sequences and transmission parameter channel (TPC) data;

segmenting fast information channel (FIC) data into FIC segment payloads, wherein one of the FIC segment payloads includes information indicating whether service protection is applied to the mobile service data; and

transmitting a transmission frame including data of the data groups, main service data, and k1 sub-frames,

wherein each of the k1 sub-frames includes k2 slots that are time periods for multiplexing the mobile service data and the main service data,

wherein each of the data groups is transmitted during each of the k2 slots,

wherein k1 and k2 are integers greater than 1,

wherein each of the data groups further includes an FIC segment comprising an FIC segment header and one of the FIC segment payloads,

wherein the TPC data include information for indicating a total number of data groups to be transmitted during one of the k1 sub-frames of the transmission frame, and

wherein the ensemble comprises a service map table (SMT) including access information of the mobile service data.

10. The method of claim **9**, wherein:

the SMT is segmented into at least one SMT section;

the at least one SMT section comprises a section header and a section body; and

the section header includes a table identifier for indicating a type of the at least one SMT section, an ensemble identifier for identifying the ensemble and protocol version information for indicating a current protocol version of the at least one SMT section.

11. The method of claim **10**, wherein the SMT is differentiated by utilizing at least the table identifier, the ensemble identifier or the protocol version information.

12. The method of claim **9**, wherein Internet protocol (IP) datagrams carrying the SMT have a well-known IP address and a well-known user datagram protocol (UDP) port number.

13. The method of claim **9**, wherein the TPC data further include information for indicating a current sub-frame number within the transmission frame.

14. A broadcast transmitter comprising:

a Reed-Solomon (RS) encoder for performing RS encoding and Cyclic Redundancy Check (CRC) encoding on mobile service data to build an RS frame belonging to an ensemble, wherein data of the RS frame are mapped into data groups and each of the data groups includes known data sequences and transmission parameter channel (TPC) data; and

a transmitting unit for transmitting a transmission frame including data of the data groups, main service data, and k1 sub-frames,

wherein each of the k1 sub-frames includes k2 slots that are time periods for multiplexing the mobile service data and the main service data,

wherein each of the data groups is transmitted during each of the k2 slots,

wherein k1 and k2 are integers greater than 1,

wherein fast information channel (FIC) data are segmented into FIC segment payloads,

wherein one of the FIC segment payloads includes information indicating whether service protection is applied to the mobile service data,

wherein each of the data groups further includes an FIC segment comprising an FIC segment header and one of the FIC segment payloads,

wherein the TPC data include information for indicating a total number of data groups to be transmitted during one of the k1 sub-frames of the transmission frame, and

wherein the ensemble comprises a service map table (SMT) including access information of the mobile service data.

15. The broadcast transmitter of claim **14**, wherein:

the SMT is segmented into at least one SMT section;

the at least one SMT section comprises a section header and a section body; and

the section header includes a table identifier for indicating a type of the at least one SMT section, an ensemble identifier for identifying the ensemble and protocol version information for indicating a current protocol version of the at least one SMT section.

16. The broadcast transmitter of claim **15**, wherein the SMT is differentiated by utilizing at least the table identifier, the ensemble identifier or the protocol version information.

17. The broadcast transmitter of claim **14**, wherein Internet protocol (IP) datagrams carrying the SMT have a well-known IP address and a well-known user datagram protocol (UDP) port number.

18. The broadcast transmitter of claim **14**, wherein the TPC data further include information for indicating a current sub-frame number within the transmission frame.

* * * * *