

RETRANSMITTING APPARATUS FOR TERRESTRIAL DIGITAL BROADCASTING SIGNAL

TECHNICAL FIELD

5 [0001] The present invention relates to a retransmitting apparatus for a terrestrial digital broadcasting signal, specifically, to a retransmitting apparatus receiving an OFDM (Orthogonal Frequency Division Multiplexing) segment of a partially-received unit in a terrestrial digital television broadcasting or an OFDM segment in a terrestrial digital voice broadcasting, and retransmitting the received
10 signal.

RELATED ART

[0002] Currently, the OFDM transferring method which is referred to as ISDB-T (Integrated Services Digital Broadcasting-Terrestrial) is actually used as
15 a transferring method for the terrestrial digital broadcasting signal.

[0003] In the terrestrial digital television broadcasting, by utilizing the transferring method, the terrestrial digital broadcasting signal is broadcasted as divided to 13 segments. While a television (broadcast receiver) provided at home receives the 13 segments collectively, a portable/mobile receiver such as a
20 portable phone and a PDA (Personal Digital Assistant) receives only one segment of the 13 segments, so-called, partially- receives.

[0004] A service for such a portable/mobile receiving is executed by using the OFDM segment with a transfer signal parameter, whose transfer resistance characteristic is strong. For example, as illustrated in Fig. 5, the segments of
25 the terrestrial digital television broadcasting are configured with 13 segments which are numbered as 0 to 12, and one central segment (segment of number 0) of the segments is utilized as a partially-received unit.

[0005] The retransmitting apparatus is necessary, which retransmits a signal transmitted by the OFDM segment, to configure a network so that the OFDM
30 segment used for the service for the portable/mobile receiving can be received at every location such as a building shade out of doors, a place inside a building, and an underground mall.

[0006] As retransmitting techniques for the terrestrial digital broadcasting, a

technique using the single frequency network (SFN) is known which transmits a signal of the same content with the same frequency from a plurality of transmitting stations or relay stations by using one frequency (e.g. refer to Patent Document 1 (Japanese Patent Laid-Open No. 10-75262), Patent Document 2 (Japanese Patent Laid-Open No. 10-75263), Patent Document 3 (Japanese Patent Publication No. 2768353), Patent Document 4 (Japanese Patent Publication No. 2768354)). A technique using a double-frequency network (DFN) is also known which transmits a signal as alternatively switching a frequency used in each relay station by using two frequencies (e.g. refer to Non-Patent Document 1 (Aiichirou Totake, etc. "Study for terrestrial digital broadcasting by OFDM-double-frequency broadcasting relay (DFN)", 1995 television academy annual conference theses, pp. 277-278)).

[0007] In addition, as a retransmitting technique for the terrestrial digital broadcasting, the technique is also known which uses a network transmitting only the partially-received unit. Such a network refers to a network extracting only the partially-received unit with a filter to retransmit (e.g. gap filling apparatus), and a network executing a phase-rotating control for the received partially-received units, and combining the partially-received units to retransmit (e.g. refer to Patent Document 5 (Japanese Patent Laid-Open No. 2006-109283)).

[0008] Fig. 9 is a block diagram illustrating a configuration of the retransmitting apparatus for the terrestrial digital broadcasting signal. Fig. 10 is a diagram illustrating a frequency allocation example of a receiving channel and a retransmitting channel in a retransmitting apparatus 11 for the terrestrial digital broadcasting signal illustrated in Fig. 9. The retransmitting apparatus 11 includes a receiving antenna 10, a plurality of receiving units 20-1 to N, a transmitting unit 30, a transmitting antenna 41, and a transmission leakage coaxial cable 42. The receiving unit 20-1 includes a receiving-converting circuit 21, a Fourier-transforming/equalizing circuit 22, a carrier selecting circuit 23, and a receiving-synchronization processing circuit 24. A configuration of the receiving unit 20-2 to N is the same as that of the receiving unit 20-1. The transmitting unit 30 includes a segment delay controlling circuit 31, a carrier symbol hard deciding circuit 32, a carrier symbol synthesizing circuit 33, a reverse-Fourier-transforming circuit 34, and transmitting-converting circuit 35.

[0009] The receiving units 20-1 to N receives the OFDM signals of the terrestrial digital broadcasting assigned to 13 ch (channel), 14 ch, 15 ch, 17 ch, and 18 ch, which are received by the receiving antenna 10, selects a signal of a desired channel of such channels respectively, and selects and outputs a carrier symbol of the segment 0 of the desired channel. The synchronization signal is outputted, which is regenerated for the selected signal of the desired channel. The synchronization signal will be described below.

[0010] The transmitting unit 30 synchronizes the selected segment, phase-converts carriers of the synchronized segment, combines the phase-converted carriers, and retransmits the combined signal with a frequency of 50 ch which is a retransmission channel.

[0011] Specifically, in the receiving unit 20-1, the receiving-converting circuit 21 extracts a signal of the desired channel of the inputted terrestrial digital broadcasting signals of a plurality of channels, the Fourier-transforming/equalizing circuit 22 Fourier-transforms the signal of the channel to equalize, and generates carrier symbol data after the equalizing, the carrier selecting circuit 23 selects the carrier symbol data of the segment 0 of the channel. The receiving-synchronization processing circuit 24 generates the synchronization signal based on the signal of the channel, which is extracted by the receiving-converting circuit 21.

[0012] In the transmitting unit 30, the segment delay controlling circuit 31 inputs the carrier symbol data of the segment 0 of each channel from each of the receiving units 20-1 to N respectively, synchronizes by delay-adjusting, and outputs all together in parallel. The carrier symbol hard deciding circuit 32 hard-decides the carrier symbol data inputted from the segment delay controlling circuit 31 to estimate a transmission signal point. The carrier symbol synthesizing circuit 33 phase-rotates the carrier symbol data inputted from the carrier symbol hard deciding circuit 32 so that the carrier symbol data adapts to the ISDB-T method transmission, and synthesizes (combines) the carrier symbol data of each segment. The reverse-Fourier-transforming circuit 34 reverse-Fourier-transforms the carrier symbol data inputted from the carrier symbol synthesizing circuit 33, and generates the OFDM signal in a time domain. The transmitting-converting circuit 35 converts the OFDM signal in a time domain,

which is inputted from the reverse-Fourier-transforming circuit 34, to a transmission signal which is used to retransmit with a frequency of 50 ch which is a retransmission channel.

5 [0013] The transmission signal generated by the transmitting unit 30 is transmitted through the transmitting antenna 41 and the transmission leakage coaxial cable 42.

[0015] However, in the retransmitting apparatus for the terrestrial digital broadcasting signal using the SFN, which are described in the above Patent Documents 1 to 4, when the terrestrial digital broadcasting signal is retransmitted,
10 even if a signal is retransmitted only for a portable/mobile receiver which is used for a building shade out of doors, a place inside a building, and an underground mall, even though it is enough to retransmit one segment, it is necessary to retransmit the whole of signal band width, 6 MHz, which includes 13 segments configuring one channel.

15 [0016] When the terrestrial digital television signals corresponding to eight channels are retransmitted with different channels such as in case of the DFN, it is necessary to secure the signal band width of $6 \text{ MHz} \times 8 \text{ channels} = 48 \text{ MHz}$. In such a case, it is very hard to retransmit the whole of signal band width, 6 MHz, per one channel in consideration of such a Japanese circumstance that
20 frequencies for the broadcasting are crowded.

[0017] In the retransmitting apparatus for the terrestrial digital broadcasting signal in a network transmitting only the partially-received unit, the retransmitting apparatus, which retransmits only the partially-received unit with the same channel, degrades the receiving characteristics of the fixed receiving
25 around a retransmitting point. The retransmitting apparatus, which retransmits only the partially-received units of a plurality of channels with the same channel, needs the retransmitting apparatus whose number is the same as that of the channels, and the frequency band of the signal to be retransmitted also becomes wider.

30 [0018] On the other hand, because only the partially-received units of a plurality of channels are retransmitted as being combined, as illustrated in Fig. 10, the retransmitting apparatus 11 for the terrestrial digital broadcasting signal described in the above Patent Document 5 (Japanese Patent Laid-Open No. 2006-

109283) can retransmit one-segment signals of a plurality of channels with one retransmitting apparatus.

[0019] The retransmitting apparatus 11 synthesizes the carrier symbol of the OFDM segment selected by the carrier selecting circuit 23 for each channel with the carrier symbol synthesizing circuit 33 to allocate on a frequency axis, and reverse-Fourier-transforms with the reverse-Fourier-transforming circuit 34 to generate the signal to be retransmitted.

[0020] However, the transfer signal parameters such as a transfer mode, a guard interval ratio, a symbol length need to correspond to each other in all the channels of the received terrestrial digital broadcasting signals so that the retransmitting apparatus 11 can retransmit. When the transfer signal parameters do not correspond to each other among the channels, a carrier interval or a symbol rate is different from each other, so that a modified waveform can not be collectively generated by reverse-Fourier-transforming, and the retransmission can not be realized. When a FFT clock frequency difference is included among the channels of the received terrestrial digital broadcasting signal, if the difference exceeds the range which can not be absorbed by a buffer, a failure is induced.

[0021] Thus, the present invention is invented to address the above problems, and the object of the present invention is to provide the retransmitting apparatus for the terrestrial digital broadcasting signal, which can absorb a difference, and realize the stable retransmission without degrading the receiving characteristics even if the transfer signal parameters are different among the channels.

DISCLOSURE OF THE INVENTION

[0022] To address the above problems, the retransmitting apparatus for the terrestrial digital broadcasting signal according to the present invention includes a plurality of receiving units which receives the terrestrial digital broadcasting signals of a plurality of channels, and selects one channel of the plurality of channels to generate a TS signal, a first multiplying-transferring unit which inputs each of the TS signals generated by the plurality of receiving units, multiplexes each of the TS signals, and generates and transfers a multiplexed stream signal, a second multiplying-transferring unit which inputs the

multiplexed stream signal transferred by the first multiplying-transferring unit to separate to each of the original TS signals, and a transmitting unit which independently assigns each of the TS signals separated by the second multiplying-transferring unit to each of segments configuring a signal to be retransmitted respectively, determines a multiplexing frame pattern with the transfer signal parameter obtained by unifying the assigned TS signals, re-multiplexes by using the multiplexing frame pattern to combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.

5 [0023] The retransmitting apparatus for the terrestrial digital broadcasting signal according to the present invention includes the plurality of receiving units which receives the terrestrial digital broadcasting signals of a plurality of channels, and selects one channel of the plurality of channels to generate the TS signal, and the transmitting unit which inputs each of the TS signals generated by the plurality of receiving units, independently assigns each of the original TS
10 signals to each of segments configuring the signal to be retransmitted respectively, determines the multiplexing frame pattern with the transfer signal parameter obtained by unifying the assigned TS signals, re-multiplexes by using the multiplexing frame pattern to combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.

20 [0024] The retransmitting apparatus for the terrestrial digital broadcasting signal according to the present invention includes the plurality of second multiplying-transferring units, and the plurality of transmitting units which correspond to the plurality of second multiplying-transferring units respectively, the first multiplying-transferring unit transfers the generated multiplexed stream
25 signal to the plurality of second multiplying-transferring units, and each of the plurality of second multiplying-transferring units outputs each of the separated original TS signals to the corresponding transmitting unit.

[0025] In the retransmitting apparatus for the terrestrial digital broadcasting signal according to the present invention, the first multiplying-transferring unit
30 IP-capsules the generated multiplexed stream signal to transmit an IP packet to the second multiplying-transferring unit through an IP network, and the second multiplying-transferring unit receives the IP packet from the first multiplying-transferring unit, and IP-decapsules the IP packet to separate to each of the

original TS signals.

[0026] The terrestrial digital broadcasting signals of a plurality of channels, which are received by the receiving unit, includes the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal.

5 [0027] The transmitting unit inputs each of the TS signals and also another TS signal for transmitting a broadcasting differing from the broadcastings by such TS signals, independently assigns each of the TS signals and another TS signal to each segment configuring the signal to be retransmitted respectively, determines the multiplexing frame pattern with the transfer signal parameter
10 obtained by unifying the assigned TS signals, re-multiplexes by using the multiplexing frame pattern to combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.

[0028] The plurality of receiving units generate the transfer signal parameters from the terrestrial digital broadcasting signal of one selected channel
15 respectively, and the transmitting unit independently assigns each TS signal to each segment configuring the signal to be retransmitted, determines the multiplexing frame pattern with the transfer signal parameter whose transfer rate is maximum of the transfer signal parameters generated by the plurality of receiving units, which is the transfer signal parameter obtained by unifying the
20 assigned TS signals, re-multiplexes by using the multiplexing frame pattern to combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.

[0029] As described above, according to the present invention, the retransmitting apparatus for the terrestrial digital broadcasting signal can be
25 realized, which can absorb a difference even when the transfer signal parameters are different among the channels, and stably retransmit without degrading the receiving characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

30 [0075] Fig. 1 is a block diagram illustrating a configuration of a retransmitting apparatus (embodiment 1) for a terrestrial digital broadcasting signal according to an embodiment of the present invention;

Fig. 2 is a block diagram illustrating a configuration of a retransmitting

apparatus (embodiment 2) for the terrestrial digital broadcasting signal according to the embodiment of the present invention;

Fig. 3 is a block diagram illustrating a configuration of a retransmitting apparatus (embodiment 3) for the terrestrial digital broadcasting signal according to the embodiment of the present invention;

Fig. 4 is a block diagram illustrating a configuration of a retransmitting apparatus (embodiment 4) for the terrestrial digital broadcasting signal according to the embodiment of the present invention;

Fig. 5 is a diagram describing a segment configuration of a terrestrial digital television broadcasting signal;

Fig. 6 is a diagram illustrating a frequency allocation example of a receiving channel and a retransmitting channel of the terrestrial digital television broadcasting signal;

Fig. 7 is a diagram describing a segment configuration of a terrestrial digital voice broadcasting signal;

Fig. 8 is a diagram illustrating a frequency allocation example of the receiving channel and the retransmitting channel of the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal;

Fig. 9 is a block diagram illustrating a configuration of a conventional retransmitting apparatus for the terrestrial digital broadcasting signal; and

Fig. 10 is a diagram illustrating a frequency allocation example of the receiving channel and the retransmitting channel for the terrestrial digital television broadcasting signal in Fig. 9.

BEST MODE FOR CARRYING OUT THE INVENTION

[0030] The best embodiments for implementing the present invention will be described in detail below by using the drawings. The best embodiments for implementing the present invention will be realized with the following embodiments 1 to 5. The retransmitting apparatus for the terrestrial digital broadcasting signal illustrated in the embodiments 1 to 4 receives the OFDM signal of the terrestrial digital television broadcasting assigned to a plurality of channels according to the ISDB-T method, and combines only one segment, which is a partially-received unit of each channel, to transmit as a signal to be

retransmitted. The retransmitting apparatus for the terrestrial digital broadcasting signal illustrated in the embodiments 5 receives the OFDM signal of the terrestrial digital television broadcasting signal and the OFDM signal of the terrestrial digital voice broadcasting signal, and combines only one segment, which is a partially-received unit of each channel, to transmit as the signal to be retransmitted.

[0031] An example of the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 1 is such a case that a receiving unit receiving the terrestrial digital television broadcasting signal and a transmitting unit generating and retransmitting the signal to be retransmitted are not close to each other. An example of the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 2 is such a case that the receiving unit and the transmitting unit are close to each other, an example of the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 3 is such a case that the signal to be retransmitted is retransmitted to the plurality of transmitting units to a plurality of points, an example of the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 4 is such a case that the receiving unit and the transmitting unit are not close to each other, a signal received by the receiving unit is transmitted to the transmitting unit through an IP network and the signal to be retransmitted is retransmitted. An example of the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 5 is such a case that the partially-received unit of the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal are combined to be retransmitted by the retransmitting apparatus of the embodiments 1 to 4.

[0032] Here, three transfer modes are defined for the terrestrial digital broadcasting signal of the ISDB-T method as described in ARIB STD-B31 "a transfer method of the terrestrial digital television broadcasting" which is the standards issued by the association of radio industries and businesses. The number of carriers of the OFDM signal is 1405 in the transfer mode 1, the number of carriers of the OFDM signal is 2809 in the transfer mode 2, and the number of carriers of the OFDM signal is 5617 in the transfer mode 3.

[0033] As illustrated in Fig. 5, in the terrestrial digital television

broadcasting signal of the ISDB-T method, one channel is configured with a frequency band width 6 MHz including 13 OFDM blocks (OFDM segment, hereinafter referred to as "segment"). A segment number is attached to each segment, which is used to identify the 13 segments, and the 0-th segment is a partially-received unit, and is used to transfer a signal for the portable/mobile service.

[0034] The broadcaster broadcasts by using the OFDM signals of the ISDB-T method, which are configured with the 13 segments in one assigned channel of frequency band width 6MHz. There exist a plurality of broadcasters in the following examples 1 to 4, as illustrated in Fig. 6, five channels (13ch, 14ch, 15ch, 17ch, 18ch) are assigned to such broadcasters, and the broadcasting is executed in each channel.

[0035] That is, the retransmitting apparatus for the terrestrial digital broadcasting signal illustrated in the following embodiments 1 to 4 receive the OFDM signals of the terrestrial digital television broadcastings, which are assigned to the plurality of channels, selects and separates the segments, whose number is 0, from each of the OFDM signals, combines each of the separated segments, whose number is 0, again and transmits the combined signals as the signal to be retransmitted by using a frequency band of an unused channel, e.g. 50 ch.

[Embodiment 1]

[0036] First, the embodiment 1 will be described. An example of the embodiment 1 is such a case that such a case that a receiving unit receiving the terrestrial digital broadcasting signal and a transmitting unit generating and retransmitting a signal to be retransmitted are not close to each other. Fig. 1 is a block diagram illustrating a configuration of a retransmitting apparatus (embodiment 1) for the terrestrial digital broadcasting signal according to the embodiment of the present invention. A retransmitting apparatus 1 includes a receiving antenna 100, a plurality of receiving units 200-1 to N, TS multiplexing-transferring units 300-1 and 2, a transmitting unit 400, a transmitting antenna 501, and a transmission leakage coaxial cable 502.

[0037] The terrestrial digital television broadcasting signals of a plurality of channels, which are received through the receiving antenna 100, are distributed

to be inputted to the receiving units 200-1 to N respectively. Meanwhile, while it is assumed that the embodiment 1 include one set of the receiving antenna 100, the space diversity may be configured by using a plurality of receiving antennas to improve the receiving characteristics.

5 **[0038]** The receiving unit 200-1 includes a receiving-converting circuit 201, a Fourier-transforming/equalizing circuit 202, a demodulating circuit 203, and a receiving-synchronization processing circuit 204. Configurations of the receiving units 200-2 to N are also the same as that of the receiving unit 200-1.

10 **[0039]** The receiving-converting circuit 201 of the receiving unit 200-1 selects the terrestrial digital television broadcasting signal of a desired (previously designated) channel from the inputted terrestrial digital television broadcasting signals of a plurality of channels. For example, the receiving-converting circuit 201 selects a signal of the 13 ch as a digital broadcasting channel #1. The receiving units 200-2 to N also similarly select signals of
15 desired channels. The receiving-converting circuit 201 extracts a RF signal of the selected channel to output an I, Q complex equalized base band signal. In such a case, the RF signals of the 13 segments corresponding to one channel may be also extracted, and the RF signal of only one segment whose segment number is 0 may be also extracted.

20 **[0040]** The Fourier-transforming/equalizing circuit 202 inputs an equalized base band signal from the receiving-converting circuit 201, Fourier-transforms the equalized base band signal, and obtains un-equalized carrier symbol data of all carriers of the OFDM signals. Next, the Fourier-transforming/equalizing circuit 202 equalizes all the carriers, and outputs the equalized carrier symbol
25 data.

30 **[0041]** The demodulating circuit 203 inputs the equalized carrier symbol data from the Fourier-transforming/equalizing circuit 202, demodulates the carrier symbol data, and outputs a TS signal transferred by the segment whose segment number is 0. In such a case, all the TS signals may be outputted, which are transferred by the 13 segments corresponding to one channel.

30 **[0042]** The receiving-synchronization processing circuit 204 inputs the equalized base band signal from the receiving-converting circuit 201, regenerates a synchronization signal based on the equalized base band signal, collects a

transfer signal parameter, and maintains the synchronization signal and the transfer signal parameter. Next, the receiving-synchronization processing circuit 204 outputs information on the regenerated synchronization signal to the Fourier-transforming/equalizing circuit 202 and the demodulating circuit 203 in the receiving unit 200-1, and if necessary, outputs information to the TS multiplexing-transferring unit 300-1. In addition, the receiving-synchronization processing circuit 204 outputs information on the synchronization signal and the transfer signal parameter through the TS multiplexing-transferring units 300-1 and 2 to the transmitting unit 400.

10 [0043] Meanwhile, while the transmitting unit 400 inputs information on the synchronization signal and the transfer signal parameter from the receiving unit 200-1 to use, the transmitting unit 400 may input from any receiving unit of the receiving units 200-2 to N to use.

[0044] Here, the synchronization signal refers to each of signals of a local oscillating frequency, a sampling clock, a frame synchronization, and a symbol synchronization, and such signals are regenerated by the receiving-synchronization processing circuit 204. The transfer signal parameter refers to each of parameters of a transfer mode, a guard interval ratio, a symbol length, and TMCC (Transmission and Multiplexing Configuration Control) information, and such parameters are collected by the receiving-synchronization processing circuit 204.

[0045] A TS multiplexing circuit 301 included in the TS multiplexing-transferring unit 300-1 inputs the TS signals from the receiving units 200-1 to N respectively, multiplexes such TS signals to one multiplexed stream signal, sets a transfer rate of the multiplexed stream signal to 32.5 Mbps conforming to the broadcasting TS, and transfer to the TS multiplexing-transferring units 300-2. The transfer rate is set to 32.5 Mbps because the transfer rate can correspond to the transfer signal parameter of every TS signal. Meanwhile, such a multiplexing operation may be executed by using a clock of the synchronization signal inputted from the receiving-synchronization processing circuit 204 of the receiving unit 200-1, or may be executed by using an internal clock.

30 [0046] In such a case, when the inputted TS signals are the TS signals of the 13 segments corresponding to one channel, the TS multiplexing circuit 301

extracts the TS signal transferred by only the segment whose segment number is 0 with the packet-filtering operation, and multiplexes the extracted TS signal. When the TS signal is multiplexed, PCR (Program Clock Reference) included in each TS signal is corrected based on a difference between input time and output
5 time of a signal in the TS multiplexing circuit 301. Meanwhile, not only the TS signal but also information on the transfer parameter such as the TMCC information and the receiving channel information which are inputted from the receiving-synchronization processing circuit 204 of the receiving unit 200-1 may be multiplexed.

10 [0047] A TS separating circuit 302 included in the TS multiplexing-transferring unit 300-2 inputs the multiplexed stream signal from the TS multiplexing circuit 301, separate the plurality of original TS signals from the multiplexed stream signal, and outputs each of the separated TS signals to the transmitting unit 400. When the inputted multiplexed stream includes
15 information on the transfer parameter such as the TMCC information, which is multiplexed by the TS multiplexing circuit 301, the TS separating circuit 302 similarly separates the TMCC information, etc. from the multiplexed stream signal, and outputs the separated TMCC information, etc. to a TMCC controlling circuit 406 of the transmitting unit 400. In the transmitting unit 400, the
20 inputted TMCC information, etc. are used to control a re-multiplexing circuit 401, an OFDM-framing circuit 402, a reverse-Fourier-transforming circuit 403 and a transmitting-converting circuit 404, which will be described below.

[0048] The transmitting unit 400 includes the re-multiplexing circuit 401, the OFDM-framing circuit 402, the reverse-Fourier-transforming circuit 403, the
25 transmitting-converting circuit 404, an amplifying circuit 405, and a TMCC controlling circuit 406.

[0049] The re-multiplexing circuit 401 of the transmitting unit 400 inputs each TS signal from the TS separating circuit 302, inputs a TS signal (MPEG-2 TS signal) which is independently generated by an un-illustrated generating unit
30 inside the retransmitting apparatus 1, and for such TS signals, executes operations such as deletion/insertion of NULL-TS, correction of PCR, replacement of TOT (Time Offset Table), change of NIT (Network Information Table). In addition, the re-multiplexing circuit 401 inputs information on the

transfer parameter such as the transfer mode and the guard interval ratio from the TMCC controlling circuit 406, and sets the multiplexing frame pattern based on the inputted transfer parameter. Next, the re-multiplexing circuit 401 multiplexes depending on the set multiplexing frame pattern, and converts to the multiplexed TS signal to output.

5 [0050] The re-multiplexing circuit 401 designates the segment assignment for each TS signal to output the assignment information. Meanwhile, for the segments which are not assigned, the assignment information is outputted so that the NULL-TS signal is appropriately inserted. When a retransmission frequency is not described in frequency information (terrestrial distribution system descriptor) described in the NIT of PSI/SI information of MPEG-2 System, the re-multiplexing circuit 401 adds a value of the retransmission frequency according to the segment number to be transmitted. That is, when the transmission frequency is previously determined, a value of the transmission frequency is described at a transmitting side, however, when the transmission frequency is not previously determined, the re-multiplexing circuit 401 replaces to a previously provided packet of the NIT.

15 [0051] Here, the multiplexing frame pattern defines a rule in the case of the multiplexing operation, and for clocks inside the transmitting unit 400 in the retransmitting apparatus 1, the clock is used whose frequency is completely synchronized with the retransmitting apparatus 1. The transfer mode and the guard interval ratio are set so that the TS signal can be transferred, whose transfer rate is the highest of each TS signal inputted by the re-multiplexing circuit 401 and the own TS signal, based on the transfer signal parameter of each channel, which is inputted from the TMCC controlling circuit 406. Or, the transfer mode and the guard interval ratio are set so that the rate can be secured, which is equal to or higher than the highest transfer rate. Meanwhile, the re-multiplexing circuit 401 may input information on the transfer signal parameter which is previously set from the TMCC controlling circuit 406, and may set the multiplexing frame pattern based on the transfer signal parameter.

25 [0052] The OFDM-framing circuit 402 inputs the multiplexed TS signal and the assignment information from the re-multiplexing circuit 401, assigns the TS signal to the segment depending on the assignment information, adds an error

correcting code so as to adapt to the transmission in the ISDB-T method, executes a variety of interleaving operations, adds a pilot carrier, control data, etc., and generates and outputs the carrier symbol data of the OFDM. Here, an allocation and a modification pattern of the pilot carrier depend on methods such as the terrestrial digital television broadcasting method, a method for combining partially-received units of the ISDB-T, the terrestrial digital voice broadcasting method, etc. That is, the OFDM-framing circuit 402 processes OFDM-framing for each segment. A frame format by the OFDM-framing depends on the multiplexing frame pattern set by the re-multiplexing circuit 401.

5 [0053] The reverse-Fourier-transforming circuit 403 inputs the carrier symbol data from the OFDM-framing circuit 402, reverse-Fourier-transforms the data for each symbol, and generates a time-waveform digital signal corresponding to one symbol of the OFDM. Next, the reverse-Fourier-transforming circuit 403 duplicates a guard interval signal from the time-waveform digital signal corresponding to one symbol to insert, repeats the operation for each symbol, and outputs the OFDM signal of a time domain, which is obtained as described above.

15 [0054] The transmitting-converting circuit 404 inputs the OFDM signal of a time domain from the reverse-Fourier-transforming circuit 403, converts a frequency depending on an output frequency of each segment in the previously-set retransmitting channel, combines on the frequency allocation, and thereby, generates the signal to be retransmitted, which is a RF signal obtained by binding the one-segments. The signal to be retransmitted is amplified by the amplifying circuit 405, and is transmitted through the transmitting antenna 501 and the transmission leakage coaxial cable 502. Meanwhile, while the transmitting antenna 501 and the transmission leakage coaxial cable 502 are included in Fig. 1, only any one may be included to configure.

25 [0055] The TMCC controlling circuit 406 inputs information on the synchronization signal and the transfer signal parameter through the TS multiplexing-transferring units 300-1 and 2 from the receiving units 200-1 to N, and outputs such information to the re-multiplexing circuit 401, the OFDM-framing circuit 402, the reverse-Fourier-transforming circuit 403, and the transmitting-converting circuit 404.

[0056] As described above, according to the retransmitting apparatus 1 for the terrestrial digital broadcasting signal illustrated in Fig. 1, the re-multiplexing circuit 401 multiplexes each TS signal by using a clock frequency inside the transmitting unit 400. Thereby, a difference among the clock frequencies of each TS signal of a plurality of channels can be absorbed. In addition, the re-multiplexing circuit 401 sets the multiplexing frame pattern based on the transfer signal parameter inputted from the TMCC controlling circuit 406, and multiplexes each TS signal depending on the multiplexing frame pattern. Thereby, a difference among the transfer signal parameters of each TS signal of a plurality of channels can be absorbed. As described above, because the differences of the clock frequencies and the transfer signal parameters of each TS signal can be absorbed, when the signal to be retransmitted is generated by combining the separated segments whose segment number is 0, the stable retransmission can be realized without degrading the receiving characteristics. That is, a network can be configured with less frequency resource so that the portable/mobile service can be also received in an area such as a building shade out of doors.

[0057] According to the retransmitting apparatus 1 for the terrestrial digital broadcasting signal illustrated in Fig. 1, the TS multiplexing circuit 301 of the TS multiplexing-transferring unit 300-1 provided in the receiving unit 200 side multiplexes the plurality of TS signals to generate one multiplexed stream, and transfers the signals to the TS separating circuit 302 of the TS multiplexing-transferring unit 300-2 provided in the transmitting unit 400 side. Thereby, even when the receiving unit 200 and the transmitting unit 400 are not close to each other and are away from each other, the stable retransmission can be realized.

[0058] Furthermore, according to the retransmitting apparatus 1 for the terrestrial digital broadcasting signal illustrated in Fig. 1, the re-multiplexing circuit 401 inputs each TS signal from the TS separating circuit 302, and also, inputs the independently-generated TS signal to re-multiplex such TS signals. Thereby, because the re-multiplexing circuit 401 can input a new content as the own TS signal, the new content can be added to a part of the signal to be retransmitted.

[Embodiment 2]

[0059] Next, an embodiment 2 will be described. An example of the embodiment 2 is such a case that the receiving unit 200 and the transmitting unit 400 are close to each other. Fig. 2 is a block diagram illustrating a configuration of the retransmitting apparatus (embodiment 2) for the terrestrial digital broadcasting signal according to the embodiment of the present invention. A retransmitting apparatus 2 includes the receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting unit 400, the transmitting antenna 501, and the transmission leakage coaxial cable 502. As comparing the retransmitting apparatus 1 of the embodiment 1 illustrated in Fig. 1 with the retransmitting apparatus 2 of the embodiment 2 illustrated in Fig. 2, while both apparatus are the same in that both apparatus include the receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting unit 400, the transmitting antenna 501, and the transmission leakage coaxial cable 502, both apparatus are not the same in that the retransmitting apparatus 2 does not include the TS multiplexing-transferring units 300-1 and 2. This is because in the embodiment 2, the receiving unit 200 and the transmitting unit 400 are close to each other, so that it is not necessary to multiplex each TS signal and generate one multiplexed stream. That is, the re-multiplexing circuit 401 of the transmitting unit 400 inputs the TS signals from the receiving units 200-1 to N respectively, which are close to the re-multiplexing circuit 401. Meanwhile, the receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting unit 400, the transmitting antenna 501, and the transmission leakage coaxial cable 502 are described above, so that the description will be omitted.

[0060] As described above, according to the retransmitting apparatus 2 for the terrestrial digital broadcasting signal illustrated in Fig. 2, as well as the advantageous effects by the retransmitting apparatus 1 of the embodiment 1, differences of the clock frequency and the transfer signal parameter of each TS signal can be absorbed, and the stable retransmission can be realized without degrading the receiving characteristics. That is, a network can be configured with less frequency resource so that the portable/mobile service can be also received in an area such as a building shade out of doors. The re-multiplexing circuit 401 can input a new content as the own TS signal, so that the new content

can be added to a part of the signal to be retransmitted.

[Embodiment 3]

[0061] Next, an embodiment 3 will be described. An example of the embodiment 3 is such a case that the signal is retransmitted by a plurality of transmitting apparatus 400-1 to M to a plurality of points. Fig. 3 is a block diagram illustrating a configuration of the retransmitting apparatus (embodiment 3) for the terrestrial digital broadcasting signal according to the embodiment of the present invention. A retransmitting apparatus 3 includes the receiving antenna 100, the plurality of receiving units 200-1 to N, the TS multiplexing-transferring unit 310-1, the plurality of TS multiplexing-transferring units 310-2 to M, the plurality of transmitting units 400-1 to M, the transmitting antenna 501, and the transmission leakage coaxial cable 502. As comparing the retransmitting apparatus 1 of the embodiment 1 illustrated in Fig. 1 with the retransmitting apparatus 3 of the embodiment 3 illustrated in Fig. 3, while both apparatus are the same in that both apparatus include the receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting antenna 501, and the transmission leakage coaxial cable 502, both apparatus are not the same in that the retransmitting apparatus 3 includes the TS multiplexing-transferring units 310-1 whose configuration is not the same as that of the TS multiplexing-transferring unit 300-1 of the retransmitting apparatus 1, the plurality of TS multiplexing-transferring units 310-2-1 to M, and the plurality of transmitting units 400-1 to M. This is because the embodiment 3 is configured to transmit the signal to be retransmitted to a plurality of points.

[0062] Specifically, the TS multiplexing-transferring units 310-1 includes the TS multiplexing circuit 301 illustrated in Fig. 1 and also a TS distributing circuit 303. The TS distributing circuit 303 distributes the multiplexed stream signal multiplexed by the TS multiplexing circuit 301, and outputs the signals to the TS multiplexing-transferring units 310-2-1 to M respectively.

[0063] The TS multiplexing-transferring units 310-2-1 include the TS separating circuit 302 as well as a configuration of the TS multiplexing-transferring units 300-2 illustrated in Fig. 1. Configurations of the TS multiplexing-transferring units 310-2-2 to M are also the same as that of the TS multiplexing-transferring units 310-2-1. As well as the configuration of the

transmitting unit 400 illustrated in Fig. 1, the transmitting units 400-1 includes the re-multiplexing circuit 401, the OFDM-framing circuit 402, the reverse-Fourier-transforming circuit 403, the transmitting-converting circuit 404, the amplifying circuit 405, and the TMCC controlling circuit 406. Configuration of the transmitting units 400-2 to M are also the same as that of the transmitting units 400-1. The receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting antenna 501, and the transmission leakage coaxial cable 502 are described above, so that the description will be omitted.

[0064] As described above, according to the retransmitting apparatus 3 for the terrestrial digital broadcasting signal illustrated in Fig. 3, the same advantageous effects as that of the retransmitting apparatus of the embodiment 1 are obtained. The signal to be retransmitted can be transmitted from the plurality of transmitting units 400 to a plurality of points respectively.

[Embodiment 4]

[0065] Next, an embodiment 4 will be described. An example of the embodiment 4 is such a case that the receiving unit 200 and the transmitting unit 400 are not close to each other, a signal received by the remotely-located receiving unit 200 is transferred through the IP network to the transmitting unit 400, and the signal to be retransmitted is transmitted. Fig. 4 is a block diagram illustrating a configuration of the retransmitting apparatus (embodiment 4) for the terrestrial digital broadcasting signal according to the embodiment of the present invention. A retransmitting apparatus 4 includes the receiving antenna 100, the plurality of receiving units 200-1 to N, the TS multiplexing-transferring units 320-1 and 2, the transmitting units 400-1, the transmitting antenna 501, and the transmission leakage coaxial cable 502. The TS multiplexing-transferring units 320-1 and the TS multiplexing-transferring units 320-2 are connected with an IP network 330. As comparing the retransmitting apparatus 1 of the embodiment 1 illustrated in Fig. 1 with the retransmitting apparatus 4 of the embodiment 4 illustrated in Fig. 4, while both apparatus are the same in that both apparatus include the receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting unit 400, the transmitting antenna 501, and the transmission leakage coaxial cable 502, both apparatus are not the same in that the retransmitting apparatus 4 includes the TS multiplexing-transferring units

320-1 and 2 whose configuration is not the same as that of the TS multiplexing-transferring units 300-1 and 2 of the retransmitting apparatus 1. This is because the embodiment 4 is configured to transfer a signal received by the remotely-located receiving unit 200 through the IP network 330 to the transmitting unit 400, and transmit the signal to be retransmitted.

[0066] Specifically, the TS multiplexing-transferring units 320-1 includes the TS multiplexing circuit 301 illustrated in Fig. 1 and also an IP-capsuling circuit 311. The IP-capsuling circuit 311 capsules the multiplexed stream signal multiplexed by the TS multiplexing circuit 301, generates an IP packet, and transmits the signals through the IP network 330 to the TS multiplexing-transferring units 320-2.

[0067] The TS multiplexing-transferring units 320-2 includes the TS separating circuit 302 illustrated in Fig. 1 and also an IP decapsuling circuit 312. The IP-decapsuling circuit 312 receives the IP packet through the IP network 330 from the IP-capsuling circuit 311, decapsules the IP packet, and generates the original multiplexed stream signal to output it to the TS separating circuit 302. The receiving antenna 100, the plurality of receiving units 200-1 to N, the transmitting unit 400, the transmitting antenna 501, and the transmission leakage coaxial cable 502 are described above, so that the description will be omitted. While the IP-capsuling circuit 311 and the IP-decapsuling circuit 312 include a buffer for controlling the transmitting and receiving respectively, the description for the buffer will be also omitted.

[0068] As described above, according to the retransmitting apparatus 4 for the terrestrial digital broadcasting signal illustrated in Fig. 4, the same advantageous effects as that of the retransmitting apparatus of the embodiment 1 are obtained.

[Embodiment 5]

[0069] In the embodiments 1 to 4, such an example is described that the partially-received unit of the terrestrial digital television broadcasting signal is selected and separated, and the separated partially-received unit is combined and retransmitted. Such an embodiment 5 will be described below that the partially-received unit of the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal are combined and retransmitted.

[0070] Here, as illustrated in Fig. 7, in the terrestrial digital voice broadcasting signal in the ISDB-T method, one channel is configured with eight segments, one segment or three segments corresponds to the independent TS signal. A broadcaster of the terrestrial digital voice broadcasting executes a plurality of digital voice broadcastings with one channel. For example, as illustrated in Fig. 8, six to eight broadcastings are executed in the 7 ch by utilizing the eight segments.

[0071] A configuration of the retransmitting apparatus of an embodiment 5 is the same as that of the retransmitting apparatus 1 to 4 described in the embodiments 1 to 4. The receiving units 200-1 to N input the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal through the antenna 100. The receiving-converting circuit 201 of the receiving units 200-1 to N selects the terrestrial digital television broadcasting signal or the terrestrial digital voice broadcasting signal of a desired (previously designated) channel from the inputted terrestrial digital television broadcasting signal and the inputted terrestrial digital voice broadcasting signal, extracts a RF signal of the selected channel, and outputs the I, Q complex equalized base band signal.

[0072] The re-multiplexing circuit 401 of the transmitting unit 400 inputs information on the transfer parameter such as the transfer mode and the guard interval ratio from the TMCC controlling circuit 406, sets the multiplexing frame pattern based on the inputted transfer parameter so that the transfer rate is the highest. In the example illustrated in Fig. 8, the multiplexing frame pattern is set to the transfer mode 3 and the guard interval ratio 1/16. This is because the transfer parameter is the transfer mode 3 and the guard interval ratio 1/8 in the terrestrial digital television broadcasting signal, and the transfer parameter is the transfer mode 3 and the guard interval ratio 1/16 in the terrestrial digital voice broadcasting signal, so that both guard interval ratios are different from each other, thus, the multiplexing frame pattern is set so that the transfer rate becomes the highest depending on the transfer parameter of the terrestrial digital voice broadcasting signal.

[0073] The reverse-Fourier-transforming circuit 403 duplicates the guard interval signal based on the transfer mode and the guard interval ratio which are used by the re-multiplexing circuit 401. That is, the reverse-Fourier-

transforming circuit 403 inputs information on the transfer parameter such as the transfer mode and the guard interval ratio from the TMCC controlling circuit 406, specifies the transfer mode and the guard interval ratio so that the transfer rate becomes the highest, and duplicates the guard interval signal. In the example

5 illustrated in Fig. 8, the transfer mode 3 and the guard interval ratio 1/16 are used.

[0074] As described above, according to the retransmitting apparatus for the terrestrial digital broadcasting signal of the embodiment 5, the same

advantageous effects as that of the retransmitting apparatus 1 to 4 of the embodiment 1 to 4 are obtained. The transfer parameters are unified so that the

10 transfer rate becomes the highest, so that a difference between the transfer parameters can be absorbed, and all of the partially-received unit of the terrestrial digital television broadcasting signal and the terrestrial digital voice broadcasting signal which are different from each other can be combined to be retransmitted.

CLAIMS

1. A retransmitting apparatus for a terrestrial digital broadcasting signal, comprising:

- 5 a plurality of receiving units receiving terrestrial digital broadcasting signals of a plurality of channels, and selects one channel of the plurality of channels to generate a TS signal;
- a first multiplexing-transmitting unit inputting each TS signal generated by the plurality of receiving units, multiplexing each TS signal, and generating a multiplexed stream signal to transfer;
- 10 a second multiplexing-transmitting unit inputting the multiplexed stream signal transferred by the first multiplexing-transmitting unit, and separating to each original TS signal; and

a transmitting unit independently assigning each TS signal separated by the second multiplexing-transmitting unit to each segment configuring a signal to be retransmitted respectively, determining a multiplexing frame pattern with a transfer signal parameter obtained by unifying the assigned TS signals, re-multiplexing by using the multiplexing frame pattern to combine all the TS signals, and transmitting the combined signals as the signal to be retransmitted.

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2. A retransmitting apparatus for a terrestrial digital broadcasting signal, comprising:

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- a plurality of receiving units receiving terrestrial digital broadcasting signals of a plurality of channels, and selects one channel of the plurality of channels to generate a TS signal; and
- a transmitting unit inputting each TS signal generated by the plurality of receiving units, independently assigning each TS signal to each segment configuring a signal to be retransmitted respectively, determining a multiplexing frame pattern with a transfer signal parameter obtained by unifying the assigned TS signals, re-multiplexing by using the multiplexing frame pattern to combine all the TS signals, and transmitting the combined signals as the signal to be retransmitted.
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3. The retransmitting apparatus for the terrestrial digital broadcasting signal according to claim 1, comprising:

the plurality of second multiplexing-transmitting units; and

the plurality of transmitting units corresponding to the plurality of second multiplexing-transmitting units respectively,

wherein the first multiplexing-transmitting unit transfers the generated multiplexed stream signal to the plurality of second multiplexing-transmitting

5 units, and

each of the second multiplexing-transmitting units outputs each of the separated original TS signals to the corresponding transmitting unit.

4. The retransmitting apparatus for the terrestrial digital broadcasting signal according to claim 1,

10 wherein the first multiplexing-transmitting unit IP-capsules the generated multiplexed stream signal, and transmits an IP packet through an IP network to the second multiplexing-transmitting unit, and

the second multiplexing-transmitting unit receives the IP packet from the first multiplexing-transmitting unit, and IP-decapsules the IP packet to separate
15 to each original TS signal.

5. The retransmitting apparatus for the terrestrial digital broadcasting signal according to any one of claims 1 to 4,

wherein the terrestrial digital broadcasting signal of the plurality of channels, the terrestrial digital broadcasting signal being received by the
20 receiving unit, includes a terrestrial digital television broadcasting signal and a terrestrial digital voice broadcasting signal.

6. The retransmitting apparatus for the terrestrial digital broadcasting signal according to any one of claims 1 to 4,

wherein the transmitting unit inputs each of the TS signals, and also
25 another TS signal for transmitting a broadcasting differing from the broadcasting by such TS signals, independently assigns each of the TS signals and another TS signal to each segment configuring the signal to be retransmitted respectively, determines the multiplexing frame pattern with the transfer signal parameter obtained by unifying the assigned TS signals, re-multiplexes by using the
30 multiplexing frame pattern to combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.

7. The retransmitting apparatus for the terrestrial digital broadcasting signal according to any one of claims 1 to 4,

wherein the plurality of receiving units generate the transfer signal parameter from the terrestrial digital broadcasting signal of one selected channel respectively, and

- 5 the transmitting unit independently assigns each of the TS signals to each segment configuring the signal to be retransmitted respectively, determines the multiplexing frame pattern with the transfer signal parameter, a transfer rate of which is maximum of the transfer signal parameters generated by the plurality of receiving units, the transfer signal parameter being obtained by unifying the assigned TS signals, re-multiplexes by using the multiplexing frame pattern to
- 10 combine all the TS signals, and transmits the combined signals as the signal to be retransmitted.