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(54) **METHOD OF TRANSMITTING BROADCASTING SIGNAL WITH BANDWIDTH SCALABILITY
USING MULTIPLES OF BASIC BANDWIDTH AND APPARATUS FOR THE SAME**

(57) Disclosed herein are a method for transmitting and receiving a broadcast signal in which bandwidth scalability using multiples of a basic bandwidth is applied and an apparatus for the same. The method for transmitting a broadcast signal includes generating a multiplexed signal by multiplexing a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which differs from the first broadcast service; modulating the multiplexed signal in order for the first broadcast service and the second broadcast service to share a compound band, the bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth, thereby generating a signal to be transmitted; and transmitting the generated signal using the compound band.

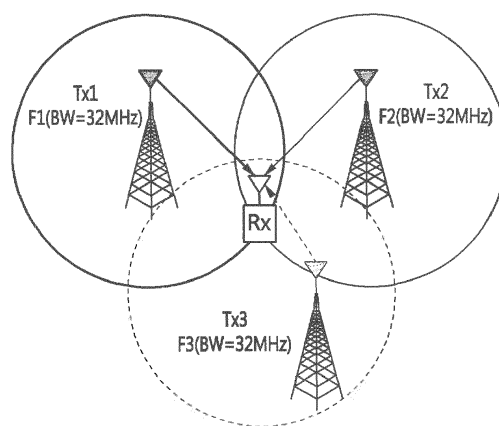


FIG. 1

Description

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The present invention relates generally to technology for transmitting terrestrial TV broadcast signals to which bandwidth scalability is applied, and more particularly to technology for transmitting and receiving broadcast signals, which uses wideband, which is wider than the existing 6, 7 or 8 MHz bandwidth and is advantageous from the aspect of securing frequencies, compared to technology using the entire UHF broadcast band as a single band.

2. Description of the Related Art

[0002] "WiB", which is wideband technology for using the entire Ultra-High Frequency (UHF) band from 470 to 694 MHz, allocated to Digital Terrestrial Television (DTT), as a single full band of 224 MHz (BW= 224 MHz), has been introduced.

[0003] For example, five broadcasters may divide the frequency band from 470 to 694 MHz into sub-bands having a 6, 7 or 8 MHz bandwidth and transmit their broadcast signals using different frequencies, but WiB is configured such that the broadcast signals of all five broadcasters may be transmitted using a single wide band (BW = 224 MHz).

[0004] In the case of existing DTT, a bandwidth of 6, 7 or 8 MHz is applied, and as a result, about a data rate of 40 Mbps may be obtained in a Multi-Frequency Network (MFN), and a data rate of about 33 Mbps may be obtained in a Single-Frequency Network (SFN).

[0005] For example, when an 8 MHz bandwidth is used for the existing broadcast service, broadcasters may transmit their broadcast signals in different frequency ranges. That is, when an MFN is configured such that frequency ranges used for neighboring broadcast coverage areas do not overlap by appropriately allocating frequency ranges, interference between the signals of different broadcasters may be prevented.

[0006] Conversely, WiB is configured such that all broadcast coverage areas use the same center frequency (i.e., f_0) and the same 224 MHz bandwidth. That is, because the same center frequency, f_0 , is used for all broadcast coverage areas, signal interference is caused between neighboring broadcast coverage areas. In order to cancel such broadcast signal interference, WiB uses a modulated signal that is robust to noise by applying QPSK modulation and a channel code rate of $1/2$ ($CR = 1/2$). Here, in spite of the application of low-order QAM, WiB may acquire the same data rate as the existing method in the entire UHF broadcast frequency band from 470 to 694 MHz because it uses a wide band of 224 MHz bandwidth.

[0007] When five broadcasters use the UHF broadcast

frequency band from 470 to 694 MHz, the case in which a data rate of about 200 Mbps is obtained (using a single transmitter) by applying a 224 MHz bandwidth, QPSK, and $CR = 1/2$ based on WiB requires about 50 times (17dB) lower transmission power than the case in which a data rate of 200 Mbps ($= 5 \times 40$ Mbps) is obtained (using five transmitters) by applying an 8 MHz bandwidth, 256QAM, and $CR = 2/3$ based on a DVB-T2 system. Here, when a broadcast signal is transmitted based on WiB, because only 10% of the transmission power of the case where the broadcast signal is transmitted based on DVB-T2 is used, 90% of transmission power may be saved. Here, the reason why WiB requires relatively low transmission power is that the distance between signal constellation points is large, and thus it is possible to apply lower transmission power than when DVB-T2 is used.

[0008] As described above, because WiB uses the entire UHF broadcast frequency band as a single band, it is very simple to allocate frequencies. For example, in the case in which a broadcast signal is transmitted at a center frequency of f_1 using the existing 8 MHz bandwidth, if six neighboring broadcast coverage areas are present and they provide different content, the six neighboring broadcast coverage areas must use different center frequencies ($f_2, \dots, f_7$) in order to prevent signal interference. That is, when the existing 6, 7 or 8 MHz bandwidth is applied, frequency allocation for channels is necessary.

[0009] Conversely, in the case of WiB, all broadcast coverage areas use a 224 MHz bandwidth and the same center frequency, f_0 . Therefore, when WiB is applied, there is no need to allocate frequencies because all broadcast coverage areas use the same 224 MHz bandwidth and the same center frequency, f_0 .

[0010] Also, WiB may reduce broadcast network installation costs. For example, when five broadcasters use the existing 6, 7 or 8 MHz bandwidth in the UHF broadcast frequency band from 470 to 694 MHz, it is necessary to install five respective transmitters for the five broadcasters. However, when the UHF broadcast frequency band of 224 MHz is used as a single band, because the five broadcasters may share a single transmitter, broadcast network installation costs may be significantly reduced.

[0011] Furthermore, WiB may reduce broadcast network management costs. When the existing 6, 7 or 8 MHz bandwidth is used, 256QAM and a channel code rate of $CR = 2/3$ must be applied in order to obtain a data rate of about 40 Mbps for each broadcaster, which requires high transmission power. Here, when each broadcaster provides a data rate of 40 Mbps, five broadcasters provide a data rate of 200 Mbps over the entire broadcast frequency band. However, when WiB is applied, because a 224 MHz bandwidth is used, a data rate of about 224 Mbps may be obtained if 1 bit/Hz is realized. Here, when QPSK modulation and a channel code rate of $CR = 1/2$ are applied, it is possible to realize 1 bit/Hz. In this case, because WiB enables a broadcast signal to be transmit-

ted using about 10% of the transmission power that is required when an 8 MHz bandwidth, 256QAM, and CR = 2/3 are used, 90% of transmission power may be saved.

[0012] However, WiB is problematic in that signal interference between multiple broadcast networks may occur when the multiple broadcast networks provide multiple broadcast services. In an area in which signals transmitted by different transmitters overlap, a broadcast signal from a different transmitter is applied as noise in the same frequency band due to signal interference, which may degrade broadcast signal reception performance. Therefore, cancelling signal interference between neighboring broadcast networks is a critical issue afflicting broadcast based on WiB.

[0013] Generally, when the signals of three transmitters in neighboring broadcast coverage areas overlap, if there is neither Additive White Gaussian Noise (AWGN) nor fading channel estimation error, the WiB signal spectrum is represented as overlapping three signals transmitted from respective transmitters. Here, when an attempt is made to receive a signal transmitted by a specific transmitter, among signals Tx1, Tx2 and Tx3 transmitted by the three transmitters, the signals transmitted by the two remaining transmitters are applied as noise in the same frequency band. Therefore, in order to receive the signal of a specific transmitter under the condition in which double the amount of noise is present, channel compensation must be performed through normal channel estimation, and error remaining in the channel code must be compensated for, whereby a signal may be received normally.

[0014] In order to solve the problem of signal interference between neighboring broadcast coverage areas, WiB uses a method in which a rooftop antenna with high directivity is installed at a height of about 10 m and only a desired signal is received, and an unwanted signal is eliminated using the difference of directions in which the signals of respective transmitters are transmitted. The use of a directional antenna may be effective when a directional antenna such as a Yagi antenna is used for fixed reception.

[0015] However, when mobile reception is necessary, it is difficult to use a Yagi antenna. Also, because the direction in which a signal is transmitted continually changes, it is difficult to apply the method of using a directional antenna.

[0016] Therefore, there is required a new broadcast signal transmission method that may take the advantages of wideband and effectively cancel broadcast signal interference between neighboring broadcast coverage areas.

SUMMARY OF THE INVENTION

[0017] An object of the present invention is to take the advantages of wideband, such as the reduction of broadcast network installation costs, the reduction of management costs, and the simplification of broadcast frequency

allocation and to effectively eliminate broadcast signal interference between neighboring broadcast coverage areas even when mobile reception is required.

[0018] Another object of the present invention is to provide broadcast signal transmission technology that is more efficiently applied in the transition from existing broadcast systems to next-generation broadcast systems based on wide bandwidth.

[0019] A further object of the present invention is to improve spectral efficiency by removing unnecessary guard bands.

[0020] In order to accomplish the above objects, a method for transmitting a broadcast signal according to the present invention includes multiplexing a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service, and thereby generating a multiplexed signal; modulating the multiplexed signal in order for the first broadcast service and the second broadcast service to share a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth, and thereby generating a signal to be transmitted; and transmitting the generated signal using the compound band.

[0021] Here, the method may further include transmitting one or more of information about the multiple corresponding to the compound band, information about a number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters.

[0022] Here, a guard band may not be inserted on at least one of opposite sides of a spectrum of the basic bandwidth, but may be used on opposite sides of the compound band.

[0023] Here, a modulation order corresponding to the bandwidth of the compound band may be lower than a modulation order corresponding to the basic bandwidth.

[0024] Here, the first broadcast service and the second broadcast service may have a same transmission power and a same broadcast transmission site.

[0025] Here, the first broadcast service and the second broadcast service may share a single transmitter.

[0026] Also, a method for receiving a broadcast signal according to an embodiment of the present invention includes receiving a broadcast signal; extracting a compound band signal from the broadcast signal, the compound band signal being received through a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth; generating a demodulated signal by demodulating the compound band signal; and demultiplexing the demodulated signal into a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service.

[0027] Here, the method may further include extracting an additional compound band signal, corresponding to an additional compound band, which has the same band-

width as the compound band but is different from the compound band, from the broadcast signal; and extracting a third broadcast service signal for a third broadcast service, which is different from the first broadcast service and the second broadcast service, from the additional compound band signal.

[0028] Also, an apparatus for transmitting a broadcast signal according to an embodiment of the present invention includes a multiplexer unit for generating a multiplexed signal by multiplexing a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service; a modulation unit for modulating the multiplexed signal in order for the first broadcast service and the second broadcast service to share a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth, and thereby generating a signal to be transmitted; and an antenna for transmitting the generated signal using the compound band.

[0029] Here, the apparatus may further include a signaling information generation unit for transmitting one or more of information about the multiple corresponding to the compound band, information about a number of broadcasters that share the compound band, and information about frequency ranges used by the respective

broadcasters.

[0030] Here, a guard band may not be inserted on at least one of opposite sides of a spectrum of the basic bandwidth, but may be used on opposite sides of the compound band.

[0031] Here, a modulation order corresponding to the bandwidth of the compound band may be lower than a modulation order corresponding to the basic bandwidth.

[0032] Here, the first broadcast service and the second broadcast service may have a same transmission power and a same broadcast transmission site.

[0033] Here, the first broadcast service and the second broadcast service may share a single transmitter.

[0034] Also, an apparatus for receiving a broadcast signal according to an embodiment of the present invention includes an antenna for receiving a broadcast signal; a demodulation unit for generating a demodulated signal by demodulating a compound band signal, which is extracted from the broadcast signal after being received through a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth; and

a demultiplexer unit for demultiplexing the demodulated signal into a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The above and other objects, features and advantages of the present invention will be more clearly

understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 and FIG. 2 are views that show the concept of a method for transmitting a broadcast signal according to an embodiment of the present invention; FIG. 3 is a view that shows an example in which four broadcasters transmit broadcast signals using four 8 MHz-bandwidth transmitters;

FIG. 4 is a view that shows an example of an apparatus for transmitting a broadcast signal according to an embodiment of the present invention;

FIG. 5 is a view that shows another example of an apparatus for transmitting a broadcast signal according to an embodiment of the present invention;

FIG. 6 is a view that shows an example of an apparatus for receiving a broadcast signal according to an embodiment of the present invention;

FIG. 7 is a view that shows frequency allocation based on a compound bandwidth according to an embodiment of the present invention;

FIG. 8 and FIG. 9 are views that show the spectral efficiency of a method for transmitting a broadcast signal according to an embodiment of the present invention;

FIG. 10 is a flowchart that shows a method for transmitting a broadcast signal according to an embodiment of the present invention;

FIG. 11 is a flowchart that shows a method for receiving a broadcast signal according to an embodiment of the present invention;

FIG. 12 is a view that shows an example in which a method for transmitting a broadcast signal according to an embodiment of the present invention is applied in Seoul, Korea; and

FIG. 13 is a view that shows an example in which a method for transmitting a broadcast signal according to an embodiment of the present invention is applied in a national broadcast service in Korea.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] The present invention will be described in detail below with reference to the accompanying drawings. Repeated descriptions and descriptions of known functions and configurations which have been deemed to make the gist of the present invention unnecessarily obscure will be omitted below. The embodiments of the present invention are intended to fully describe the present invention to a person having ordinary knowledge in the art to which the present invention pertains. Accordingly, the shapes, sizes, etc. of components in the drawings may be exaggerated in order to make the description clearer.

[0037] Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0038] The present invention relates to technology for providing bandwidth scalability using a compound band-

width that is a multiple of a basic bandwidth but is smaller than the 224 MHz full bandwidth. Here, the basic bandwidth is a 6, 7 or 8 MHz bandwidth, which is currently being used in several countries.

[0039] For example, when four broadcasters provide national broadcast services in a country where a 6 MHz bandwidth is used for a terrestrial broadcast service and when the four broadcasters have the same broadcast coverage (the area reached by output transmission signals) and the same transmission site, the four broadcasters may use a single 24 MHz bandwidth ($= 4 \times 6$ MHz). In this case, because the four broadcasters may share a single transmitter, broadcast network installation costs may be reduced to 1/4 compared to when four transmitters are used. However, when the broadcasters have different broadcast coverage areas or different transmission sites, it may be difficult to aggregate their bandwidths and use a single wide bandwidth.

[0040] The present invention provides technology that may take the advantages of WiB technology and solve the problem of signal interference between neighboring broadcast networks. Furthermore, when the existing broadcast system is replaced with a next-generation broadcast system based on a wide bandwidth, the present invention may facilitate frequency allocation for the next-generation broadcast system because it uses multiples of a 6, 7 or 8 MHz bandwidth that is currently being used.

[0041] FIG. 1 and FIG. 2 are views that show the concept of a method for transmitting a broadcast signal according to an embodiment of the present invention.

[0042] Referring to FIG. 1, in a country where 8 MHz is used as a basic bandwidth, 32 MHz, corresponding to a multiple of 8 MHz ($32 \text{ MHz} = 8 \text{ MHz} \times 4$), may be used. In this case, unlike the case in which a UHF broadcast channel of 224 MHz is used as a single full band, neighboring broadcast coverage areas may use different frequency ranges, whereby interference between the broadcast signals of the neighboring broadcast coverage areas may be prevented.

[0043] FIG. 2 shows that a single compound bandwidth is constituted by aggregating four basic bandwidths, each of which is 8 MHz.

[0044] In FIG. 1 and FIG. 2, a compound bandwidth that is four times the basic bandwidth is illustrated. However, this is merely an example, and the technical idea of the present invention is not limited to a compound band having four times the basic bandwidth.

[0045] FIG. 3 is view that shows an example in which four broadcasters transmit broadcast signals using four 8 MHz-bandwidth transmitters.

[0046] Referring to FIG. 3, four broadcasters 311, 313, 315 and 317 transmit broadcast signals using four transmitters 321, 323, 325 and 327 with an 8 MHz basic bandwidth and four transmission antennas 331, 333, 335 and 337.

[0047] In the example shown in FIG. 3, all of the four broadcasters use the 8 MHz basic bandwidth, but they

are required to use different frequency ranges in order to prevent interference therebetween. Therefore, the broadcasters have their own transmitters.

[0048] FIG. 4 is a view that shows an example of an apparatus for transmitting a broadcast signal according to an embodiment of the present invention.

[0049] Referring to FIG. 4, an apparatus for transmitting a broadcast signal according to an embodiment of the present invention includes a transmitter 420 and an antenna 430.

[0050] Here, the transmitter 420 includes a multiplexer unit 421 and a modulation unit 423.

[0051] In the example shown in FIG. 4, when four broadcasters 411, 413, 415 and 417 share a compound band of 32 MHz ($= 8 \text{ MHz} \times 4$), the four broadcasters 411, 413, 415 and 417 may share a single transmitter and transmit broadcast signals using the single transmitter.

[0052] The multiplexer unit 421 generates a multiplexed signal by multiplexing the broadcast signals corresponding to the broadcast services provided by the broadcasters 411, 413, 415 and 417.

[0053] The modulation unit 423 modulates the multiplexed signal in order to enable the broadcast services provided by the broadcasters 411, 413, 415 and 417 to share a compound band, the bandwidth of which is a multiple of the basic bandwidth but is smaller than the entire bandwidth, and thereby generates the signal to be transmitted.

[0054] The antenna 430 transmits the generated signal using the compound band.

[0055] Here, the apparatus for transmitting a broadcast signal may further include a signaling information generation unit 419. Here, the signaling information generation unit 419 may transmit one or more of information about a multiple corresponding to the compound band, information about the number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters. Here, the information about frequency ranges used by the respective broadcasters may be information about the frequency ranges allocated to the respective broadcasters within the compound band.

[0056] Here, a guard band may not be inserted on at least one side of a spectrum of the basic bandwidth, and guard bands may be used on opposite sides of a compound band.

[0057] Here, a modulation order applied to the compound bandwidth may be lower than a modulation order applied to the basic bandwidth. Therefore, when the compound bandwidth is used, lower transmission power is used, and transmission power may be reduced.

[0058] Here, the broadcasters 411, 413, 415 and 417 may have the same transmission power and the same transmission site. Here, the broadcasters 411, 413, 415 and 417 may share a single transmitter.

[0059] FIG. 5 is a view that shows another example of an apparatus for transmitting a broadcast signal accord-

ing to an embodiment of the present invention.

[0060] Referring to FIG. 5, the apparatus for transmitting a broadcast signal according to an embodiment of the present invention includes a transmitter 520 and an antenna 530.

[0061] Here, the transmitter 520 includes a multiplexer unit 521 and a modulation unit 523.

[0062] In the example shown in FIG. 5, when two broadcasters 511 and 513 share a compound band having a 32 MHz bandwidth, the two broadcasters 511 and 513 may share a single transmitter and transmit broadcast signals using the single transmitter.

[0063] Here, the apparatus for transmitting a broadcast signal may further include a signaling information generation unit 519. Here, the signaling information generation unit 519 may transmit one or more of information about a multiple corresponding to the compound band, information about the number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters.

[0064] As illustrated in FIG. 5, when two broadcasters use a 32 MHz bandwidth, frequency ranges, each of which has a 16 MHz bandwidth, may be allocated to the two broadcasters. Here, if 256QAM is used when the bandwidth is 8 MHz, it is possible to realize the same data rate using 16QAM when the bandwidth is 16 MHz. Accordingly, when a compound band is used, broadcasters may share a transmitter and apply robust modulation having a low order, whereby transmission power may be reduced.

[0065] FIG. 6 is a view that shows an example of an apparatus for receiving a broadcast signal according to an embodiment of the present invention.

[0066] Referring to FIG. 6, the apparatus for receiving a broadcast signal according to an embodiment of the present invention includes an antenna 630 and a receiver 620. Here, the receiver 620 includes a demodulation unit 621 and a demultiplexer unit 623.

[0067] The antenna 630 receives a broadcast signal.

[0068] Although not illustrated in FIG. 6, the receiver 620 may include a spectrum extraction unit for extracting signals in a certain frequency band (for example, a compound band) from the broadcast signals.

[0069] The demodulation unit 621 generates a demodulated signal by demodulating the compound band signal extracted from the broadcast signal. Here, the compound band signal may be received using a compound bandwidth. Here, the compound bandwidth is a multiple of the basic bandwidth, and is smaller than the entire bandwidth.

[0070] The demultiplexer unit 623 demultiplexes the demodulated signal into broadcast signals for the broadcasters 611, 613, 615 and 617.

[0071] Here, the demodulation unit 621 or the demultiplexer unit 623 may operate using one or more of information about a multiple corresponding to the compound band, information about the number of broadcasters that share the compound band, and information about fre-

quency ranges used by the respective broadcasters, which are transmitted from the transmitter.

[0072] Here, the receiver 620 may extract an additional compound band signal, corresponding to an additional compound band, which has the same bandwidth as the compound band but does not overlap the compound band, from the broadcast signal, and may extract another broadcast service signal for a broadcaster, other than the broadcasters 611, 613, 615 and 617, from the additional compound band signal.

[0073] FIG. 7 is a view that shows frequency allocation based on a compound bandwidth according to an embodiment of the present invention.

[0074] Referring to FIG. 7, when a 32 MHz compound bandwidth is used, different frequencies are allocated to neighboring broadcast coverage areas in order to prevent signal interference between the neighboring broadcast coverage areas.

[0075] When a certain broadcast coverage area is contiguous to six broadcast coverage areas, seven different frequency ranges (compound bands) must be present within the broadcast frequency band from 470 to 694 MHz, the bandwidth of which is 224 MHz. Accordingly, 32 MHz ($= 224 \text{ MHz} / 7$) is set as the compound bandwidth, whereby an MFN using 32 MHz may be configured.

[0076] In the case of a DVB-T2 system using an 8 MHz bandwidth, 256QAM, and a channel code rate of $CR = 2/3$, because the spectral efficiency is 5.31 bit/Hz, the data rate is about 42.5 ($= 5.31 \times 8$) Mbps. Here, when the bandwidth is extended to 32 MHz, even though QPSK and $CR = 2/3$ are used, the spectral efficiency is 1.33 bit/Hz, and thus the data rate is about 42.5 Mbps ($= 1.33 \times 32$).

[0077] Based on a DVB-T2 system, the Quasi Error Free (QEF) Carrier-to-Noise Ratio (CNR) of QPSK and $CR = 2/3$ is about 4.9 dB in a Rayleigh channel. The QEF CNR of 256QAM and $CR = 2/3$ is about 20.1 dB in a Rayleigh channel. Therefore, if the data rates are the same as each other, when QPSK modulation is used, about 15.2 QEF CNR gain may be obtained, compared to when 256QAM is used. In this case, in comparison with the case in which an 8 MHz bandwidth, 256QAM, and $CR = 2/3$ are used, only 12% transmission power is required for the same data rate, and as a result, 88% of the transmission power may be saved.

[0078] If 16QAM and $CR = 2/3$ are used, the QEF CNR is about 10.8 dB in a Rayleigh channel. Therefore, when a 16QAM signal is applied, about 9.3 dB of QEF CNR gain may be obtained, compared to when a 256QAM signal is applied. In this case, in comparison with the case in which an 8MHz bandwidth, 256QAM, and $CR = 2/3$ are used, only about 23% transmission power is required for the same data rate, and as a result, 77% of the transmission power may be saved. When 16QAM is used, the QEF CNR gain is reduced to 1/2, compared to when QPSK is used, but data rate may be doubled.

[0079] When a compound bandwidth according to an embodiment of the present invention is applied, the fol-

lowing advantages may be acquired.

- Reduction of transmission power

[0080] When a single broadcaster acquires a data rate of about 42.5 Mbps by applying a 32 MHz bandwidth, rather than an 8 MHz bandwidth, not 256 QAM but QPSK may be used, whereby transmission power may be significantly reduced. As described above, when the same channel code rate is used, QPSK modulation may acquire a QEF CNR gain of 15.2 dB, compared to 256QAM. Therefore, for the same broadcast coverage area, transmission power may be significantly reduced.

- Reduction of broadcast network construction costs and reduction of management costs

[0081] When two broadcasters intend to acquire a data rate of about 85 Mbps ($= 2 \times 42.5$ Mbps) using a 32 MHz bandwidth, they may use 16QAM, instead of QPSK modulation. Here, because the two broadcasters share a single transmitter, the broadcast network installation costs may be halved. Also, when the case in which a 32 MHz bandwidth and a 16QAM signal are used is compared with the case in which an 8 MHz bandwidth and a 256QAM signal are used, because the QEF CNR gain is about 9.3 dB, it is possible to cover the same broadcast coverage area with lower transmission power. Therefore, broadcast network management costs may be reduced.

- Provision of flexibility in transition of broadcast systems

[0082] The use of a compound bandwidth is more advantageous for securing frequency bands than the use of a 224 MHz bandwidth when a broadcast system is replaced with a new one. When a 224 MHz bandwidth is used, because the frequency band overlaps the frequency bands of the existing broadcast network, it is difficult to avoid interference between an existing broadcast network using a 6, 7 or 8 MHz bandwidth and a broadcast network using a 224 MHz full bandwidth. However, when a compound bandwidth is used, because it is possible to use a frequency range that does not overlap the frequency ranges used in a broadcast network using a 6, 7 or 8 MHz bandwidth, it is more advantageous than WiB when the current broadcast system is replaced with a new one.

- Improvement of spectral efficiency

[0083] An OFDM transmission system inserts guard bands, which are empty space that is not used to transmit data, on the opposite sides of a frequency spectrum in order to avoid interference from neighboring broadcast bands. As the number of guard bands increases, the frequency range that is not used to transmit data is increased, and the spectral efficiency decreases. The existing system using a 6, 7 or 8 MHz bandwidth inserts guard bands for OFDM in every spectrum of the basic

bandwidth. Conversely, a broadcast system using a wide bandwidth may minimize the number of guard bands, whereby spectral efficiency may be improved.

[0084] FIG. 8 and FIG. 9 are views that show the spectral efficiency of a method for transmitting a broadcast signal according to an embodiment of the present invention.

[0085] Referring to FIG. 8 and FIG. 9, when an 8 MHz basic bandwidth is used, four times as many guard bands are used, compared to when a 32 MHz compound bandwidth is used.

[0086] Therefore, the case shown in FIG. 9 has higher spectral efficiency than the case shown in FIG. 8.

[0087] FIG. 10 is a flowchart that shows a method for transmitting a broadcast signal according to an embodiment of the present invention.

[0088] Referring to FIG. 10, in the method for transmitting a broadcast signal according to an embodiment of the present invention, a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which differs from the first broadcast service, are multiplexed, whereby a multiplexed signal is generated at step S1010.

[0089] Also, in the method for transmitting a broadcast signal according to an embodiment of the present invention, a signal to be transmitted is generated at step S1020 by modulating the multiplexed signal such that the first broadcast service and the second broadcast service share a compound band, the bandwidth of which is a multiple of a basic bandwidth but is smaller than the entire bandwidth.

[0090] Also, in the method for transmitting a broadcast signal according to an embodiment of the present invention, the generated signal is transmitted using the compound band at step S1030.

[0091] Here, the method for transmitting a broadcast signal according to an embodiment of the present invention may further include transmitting one or more of information about a multiple corresponding to the compound band, information about the number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters.

[0092] Here, a guard band is not inserted on at least one side of a spectrum of the basic bandwidth, but guard bands may be used on opposite sides of the compound band.

[0093] Here, a modulation order corresponding to the bandwidth of the compound band may be lower than a modulation order corresponding to the basic bandwidth.

[0094] Here, the first broadcast service and the second broadcast service may have the same transmission power and the same broadcast transmission site.

[0095] Here, the first broadcast service and the second broadcast service may share a single transmitter.

[0096] FIG. 11 is a flowchart that shows a method for receiving a broadcast signal according to an embodiment of the present invention.

[0097] Referring to FIG. 11, in the method for receiving

a broadcast signal according to an embodiment of the present invention, a broadcast signal is received at step S1110.

[0098] Also, in the method for receiving a broadcast signal according to an embodiment of the present invention, a compound band signal, which is received through a compound band, the bandwidth of which is a multiple of a basic bandwidth but is smaller than the entire bandwidth, is extracted from the broadcast signal at step S1120.

[0099] Also, in the method for receiving a broadcast signal according to an embodiment of the present invention, a demodulated signal is generated at step S1130 by demodulating the compound band signal.

[0100] Also, in the method for receiving a broadcast signal according to an embodiment of the present invention, the demodulated signal is demultiplexed into a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which differs from the first broadcast service, at step S1140.

[0101] Here, the method for receiving a broadcast signal according to an embodiment of the present invention may further include extracting an additional compound band signal, corresponding to an additional compound band, which has the same bandwidth as the compound band but does not overlap the compound band, from the broadcast signal; and extracting a third broadcast service signal for a third broadcast service, which differs from the first and second broadcast services, from the additional compound band signal.

[0102] According to the method for transmitting a broadcast signal using a compound bandwidth according to an embodiment of the present invention, the application of multiples of 6, 7 or 8 MHz, which is a spectral bandwidth for terrestrial broadcasting in several countries, may be advantageous for frequency allocation. This is because the current frequency band for terrestrial broadcasting is allocated based on a 6, 7 or 8 MHz bandwidth. If a new spectral bandwidth of A MHz (where A is any positive integer) is used, a frequency band must be newly allocated based on A MHz, which would be expensive and time-consuming. Therefore, it is effective to set 6, 7 or 8 MHz, which is already used, as a basic bandwidth and to apply a multiple of the basic bandwidth. Broadcasters form a single compound band by aggregating consecutively arranged frequency ranges, each of which has the basic bandwidth, whereby they may share a single transmitter.

[0103] FIG. 12 is a view that shows an example in which a method for transmitting a broadcast signal according to an embodiment of the present invention is applied in Seoul, Korea.

[0104] Referring to FIG. 12, transmitters are installed on Gwanak Mountain, Yongmoon Mountain, and Gyeyang Mountain in order to provide a local broadcast service in Seoul.

[0105] Here, broadcasters providing broadcast serv-

es in Seoul include four national broadcasters, namely KBS1, KBS2, EBS and MBC, and two local broadcasters, namely SBS and OBS.

[0106] Here, the transmitters of five broadcasters, including KBS1, KBS2, EBS, MBC and SBS, may be installed on Gwanak Mountain, and 2.5 kilowatt transmission power may be output therefrom. Here, the transmitters of six broadcasters, including KBS1, KBS2, EBS, MBC, SBS and OBS, may be installed on Yongmoon Mountain, and 1 kilowatt transmission power may be output therefrom. Here, the transmitters of five broadcasters, including KBS1, KBS2, MBC, SBS and OBS, may be installed on Gyeyang Mountain, and 0.5 kilowatt transmission power may be output therefrom.

[0107] In this case, when all four national broadcasters KBS1, KBS2, EBS and MBC are made to have the same conditions by installing a transmitting station of EBS on Gyeyang Mountain, the four national broadcasters KBS1, KBS2, EBS and MBC may have the same transmission power and the same broadcast transmission site. Here, the national broadcasters KBS1, KBS2, EBS and MBC may use a single band of 24 MHz ($= 4 \times 6$ MHz) by aggregating their bands having 6 MHz bandwidth. When the single band is shared, because the four national broadcasters KBS1, KBS2, EBS and MBC may share a single transmitter, the expense of installing and managing a broadcast network may be reduced to 1/4 thereof.

[0108] The two local broadcasters SBS and OBS have different broadcast coverage areas. Specifically, the broadcast coverage area of SBS is Seoul, and that of OBS is Incheon and Gyeonggi province. Further, because the two local broadcasters SBS and OBS have different broadcast transmission sites and different transmission power, it is difficult to apply a single band of 12 MHz ($= 2 \times 6$ MHz). Therefore, it may be more advantageous to use the 6 MHz basic bandwidth without change.

[0109] FIG. 13 is a view that shows an example in which a method for transmitting a broadcast signal according to an embodiment of the present invention is applied in the national broadcast service in Korea.

[0110] Referring to FIG. 13, the method for transmitting a broadcast signal using a compound bandwidth according to an embodiment of the present invention is applied, and the entire area of Korea is partitioned so as to use four compound bands F_1 , F_2 , F_3 and F_4 .

[0111] Here, the four national broadcasters KBS1, KBS2, EBS and MBC may use a single compound bandwidth of 24 MHz. Here, in order to prevent signal interference between neighboring broadcast coverage areas, compound bands having different frequency ranges F_1 , F_2 , F_3 and F_4 are used for the neighboring broadcast coverage areas.

[0112] As illustrated in FIG. 13, when frequencies are allocated to compound bands, each of which has a 24 MHz bandwidth, so as to prevent interference, only four compound bands are required for frequency allocation

for national broadcasters in the entire area of Korea.

[0113] Here, in addition to the four compound bands having a 24 MHz bandwidth, which are used by the four national broadcasters KBS1, KBS2, EBS and MBC, five bands, f_1 , f_2 , f_3 , f_4 and f_5 , each of which has a 6 MHz basic bandwidth, may be required for local broadcasters OBS, SBS, G1, CJB, TJB, JTV, TBC, KBC, UBC and KNN, which are present in respective broadcast coverage areas. That is, when frequency reuse is applied for the ten local broadcasters OBS, SBS, GI, CJB, TJB, JTV, TBC, KBC, UBC and KNN, so as to prevent signal interference, only five bands having a 6 MHz bandwidth may cover the entire area of Korea.

[0114] Here, in the UHF band from 470 to 694 MHz (BW = 224 MHz) allocated for terrestrial broadcasting in Korea, the bandwidth of the unused frequency band is 98 MHz (= 224 MHz - (4×24 MHz + 5×6 MHz)).

[0115] The unused frequency band of 98 MHz may be appropriately divided and additionally allocated to the four compound bands having a 24 MHz bandwidth and/or five bands having a 6 MHz bandwidth. Also, using the additionally allocated frequency bands, the data rate may be increased, or a modulation order may be decreased, whereby transmission power may be reduced.

[0116] According to the present invention, the advantages of wideband, such as the reduction of broadcast network installation costs, the reduction of management costs, and the simplification of broadcast frequency allocation, may be obtained, and broadcast signal interference between neighboring broadcast coverage areas may be effectively eliminated even when mobile reception is necessary.

[0117] Also, the present invention may provide broadcast signal transmission technology that is more efficiently applied in the transition from the existing broadcast system to a next-generation broadcast system based on a wide bandwidth.

[0118] Also, the present invention may improve spectral efficiency by removing unnecessary guard bands.

[0119] As described above, the apparatus and method for transmitting and receiving a broadcast signal according to the present invention are not limitedly applied to the configurations and operations of the above-described embodiments, but all or some of the embodiments may be selectively combined and configured, so that the embodiments may be modified in various ways.

Claims

1. A method for transmitting a broadcast signal, comprising:

multiplexing a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service, and thereby generating a multiplexed signal;

modulating the multiplexed signal in order for the first broadcast service and the second broadcast service to share a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth, and thereby generating a signal to be transmitted; and

transmitting the generated signal using the compound band.

2. The method of claim 1, further comprising: transmitting one or more of information about the multiple corresponding to the compound band, information about a number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters.

3. The method of claim 1 or 2, wherein a guard band is not inserted on at least one of opposite sides of a spectrum of the basic bandwidth, but is used on opposite sides of the compound band.

4. The method of claim 1, 2, or 3 wherein a modulation order corresponding to the bandwidth of the compound band is lower than a modulation order corresponding to the basic bandwidth.

5. The method of one of claims 1 to 4, wherein the first broadcast service and the second broadcast service have a same transmission power and a same broadcast transmission site.

6. The method of claim 5, wherein the first broadcast service and the second broadcast service share a single transmitter.

7. A method for receiving a broadcast signal, comprising:

receiving a broadcast signal;
extracting a compound band signal from the broadcast signal, the compound band signal being received through a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth;
generating a demodulated signal by demodulating the compound band signal; and
demultiplexing the demodulated signal into a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service.

8. The method of claim 7, further comprising:

extracting an additional compound band signal, corresponding to an additional compound band, which has the same bandwidth as the compound

band but is different from the compound band, from the broadcast signal; and
 extracting a third broadcast service signal for a third broadcast service, which is different from the first broadcast service and the second broadcast service, from the additional compound band signal.

9. An apparatus for transmitting a broadcast signal, comprising:
 a multiplexer unit for generating a multiplexed signal by multiplexing a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service;
 a modulation unit for modulating the multiplexed signal in order for the first broadcast service and the second broadcast service to share a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth, and thereby generating a signal to be transmitted; and
 an antenna for transmitting the generated signal using the compound band.
10. The apparatus of claim 9, further comprising:
 a signaling information generation unit for transmitting one or more of information about the multiple corresponding to the compound band, information about a number of broadcasters that share the compound band, and information about frequency ranges used by the respective broadcasters.
11. The apparatus of claim 9 or 10, wherein a guard band is not inserted on at least one of opposite sides of a spectrum of the basic bandwidth, but is used on opposite sides of the compound band.
12. The apparatus of claim 9, 10 or 11 wherein a modulation order corresponding to the bandwidth of the compound band is lower than a modulation order corresponding to the basic bandwidth.
13. The apparatus of one of claims 9 to 12, wherein the first broadcast service and the second broadcast service have a same transmission power and a same broadcast transmission site.
14. The apparatus of claim 13, wherein the first broadcast service and the second broadcast service share a single transmitter.
15. An apparatus for receiving a broadcast signal, comprising:

an antenna for receiving a broadcast signal;

a demodulation unit for generating a demodulated signal by demodulating a compound band signal, which is extracted from the broadcast signal after being received through a compound band, a bandwidth of which is a multiple of a basic bandwidth but is smaller than an entire bandwidth; and
 a demultiplexer unit for demultiplexing the demodulated signal into a first broadcast service signal for a first broadcast service and a second broadcast service signal for a second broadcast service, which is different from the first broadcast service.

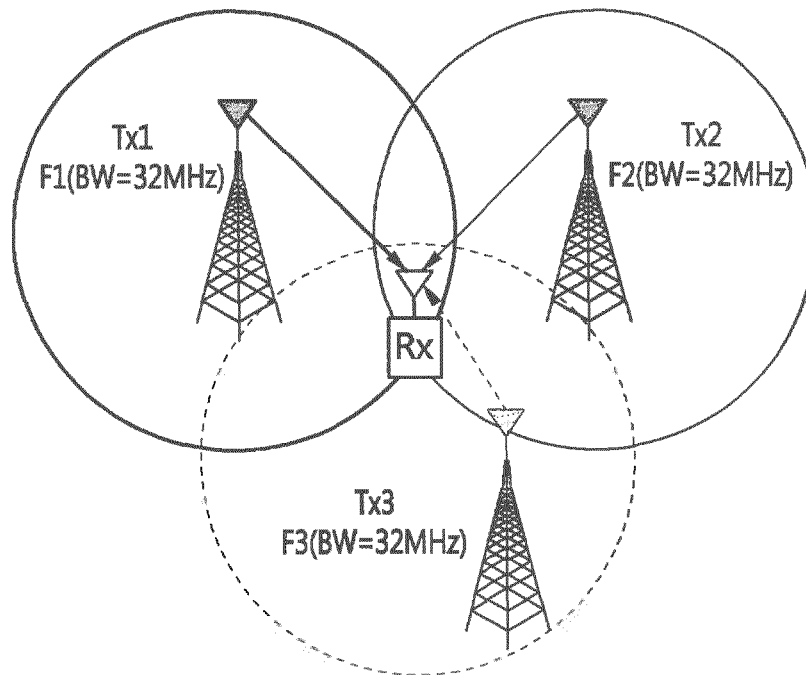


FIG. 1

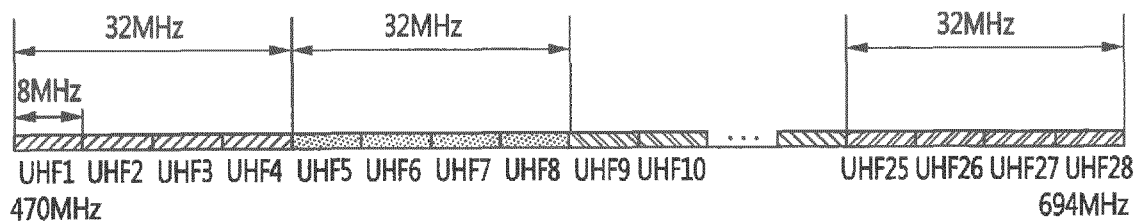


FIG. 2

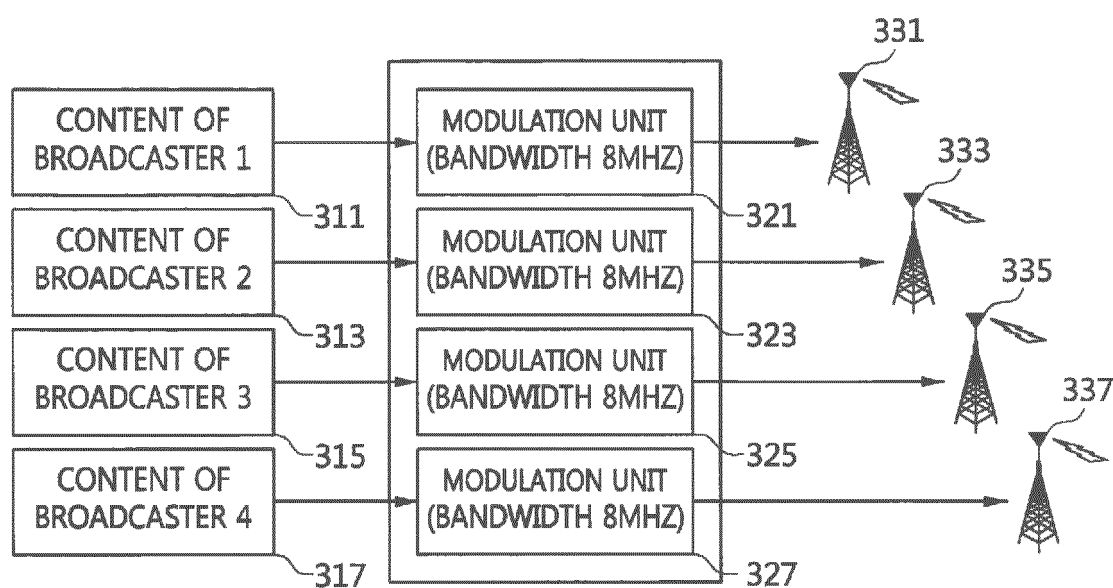


FIG. 3

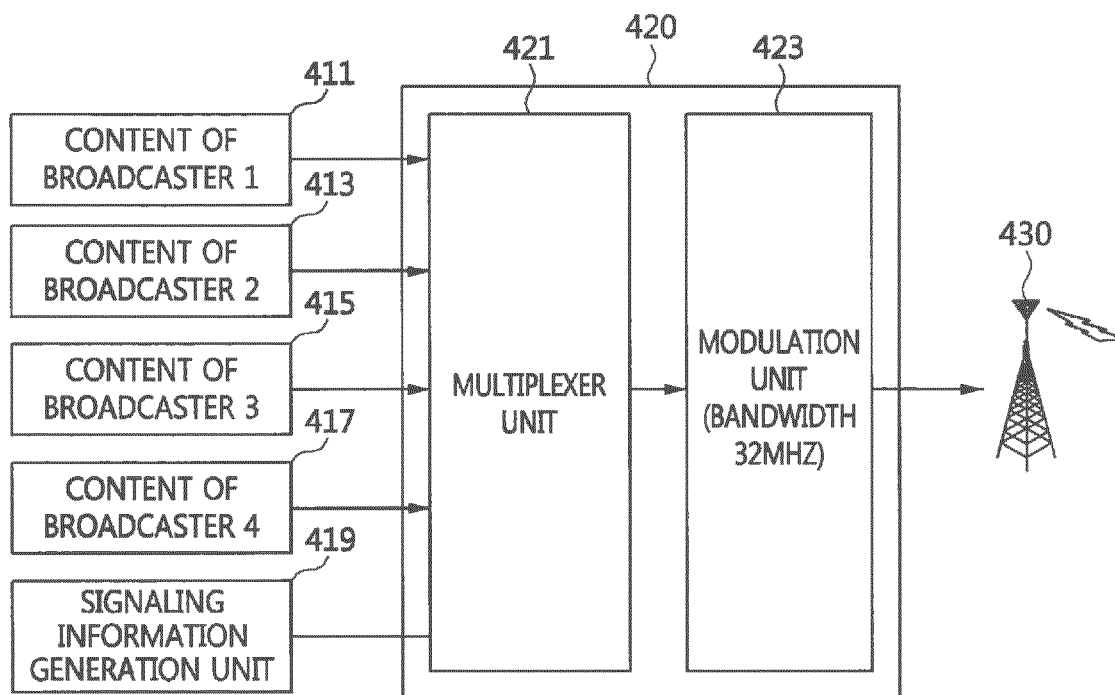


FIG. 4

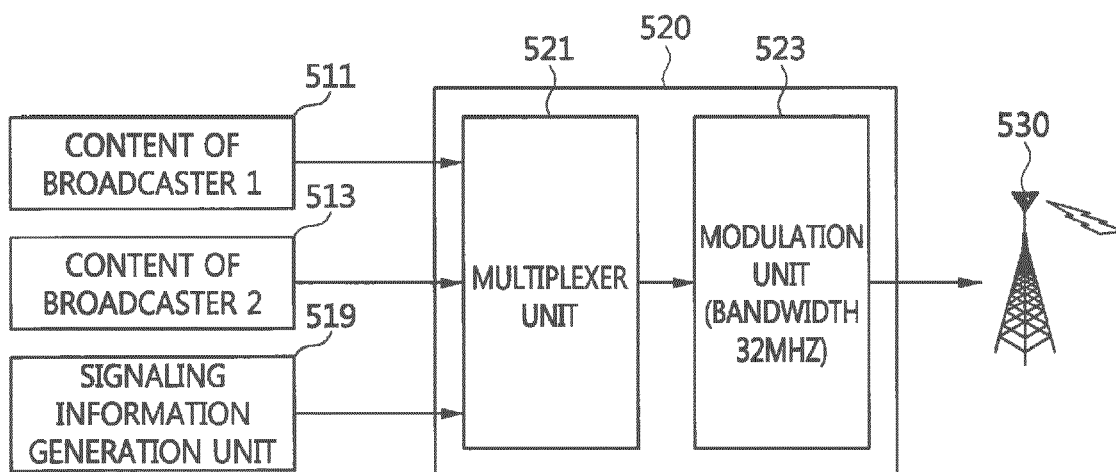


FIG. 5

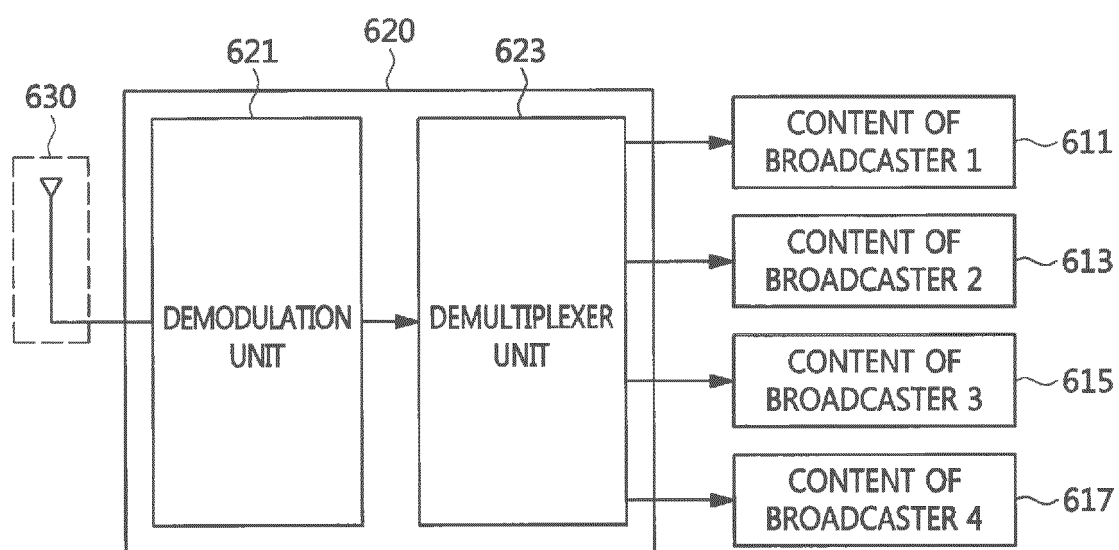


FIG. 6

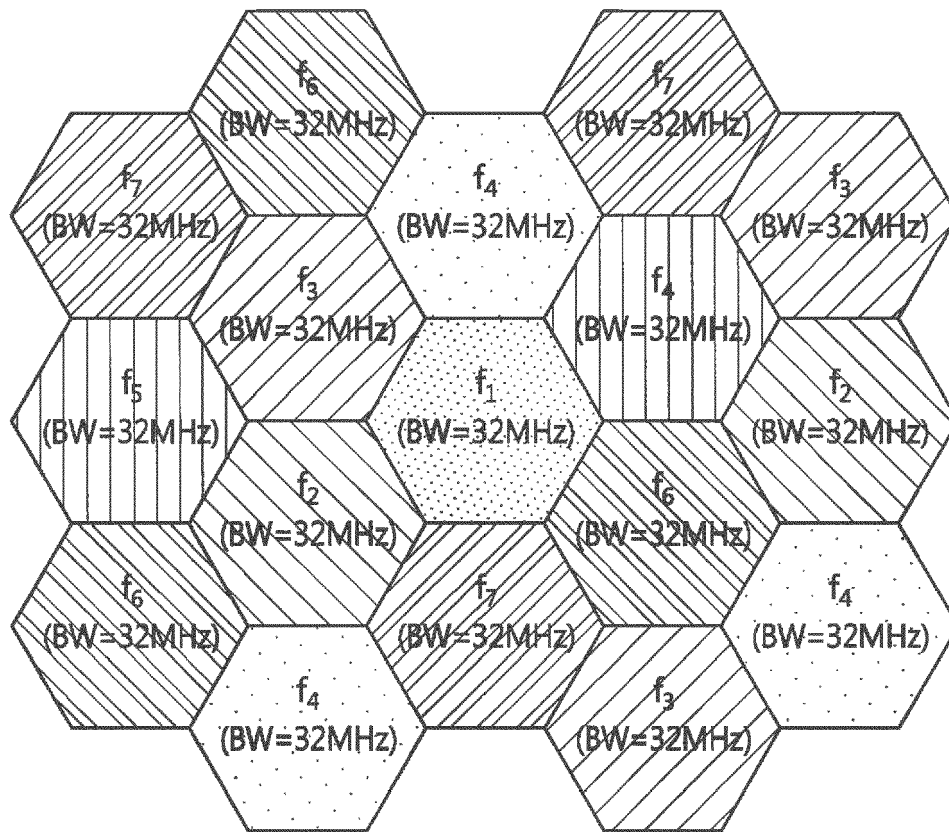


FIG. 7

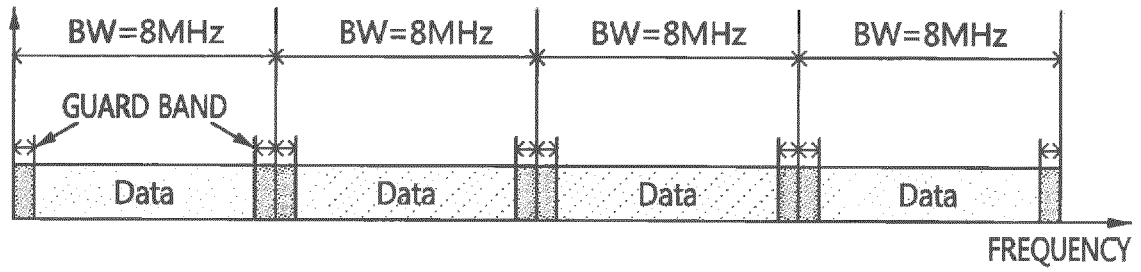


FIG. 8

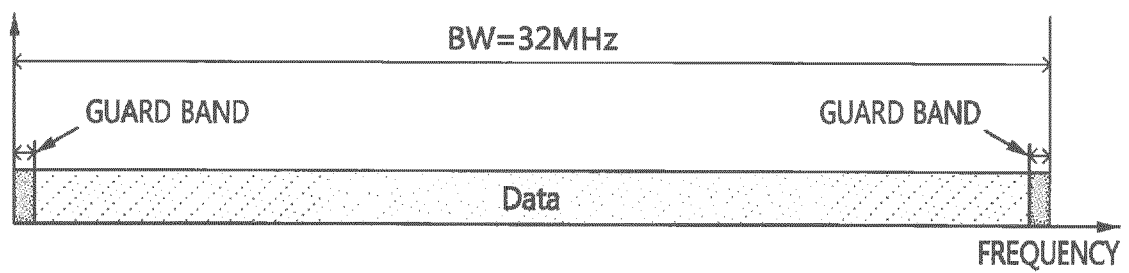


FIG. 9

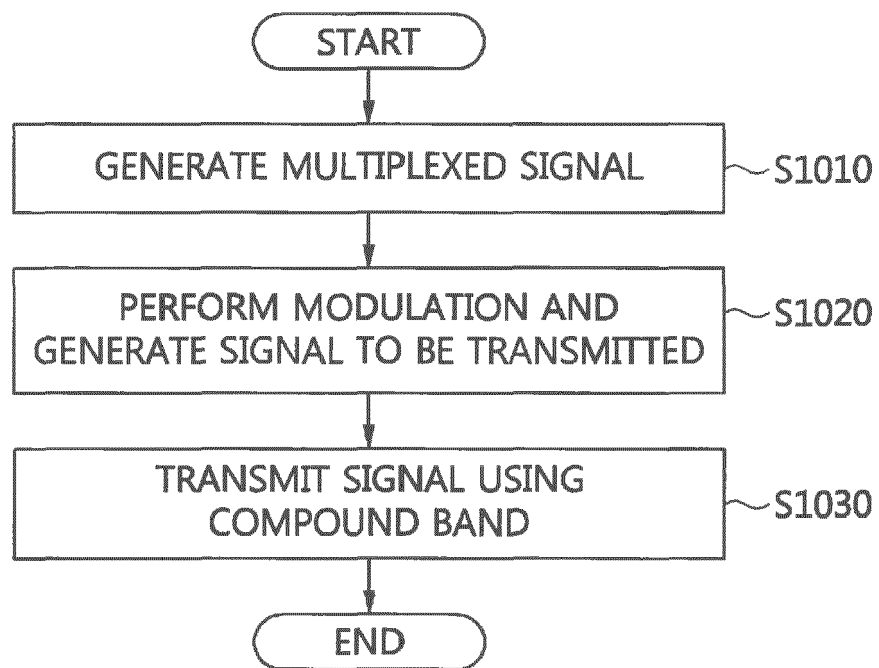


FIG. 10

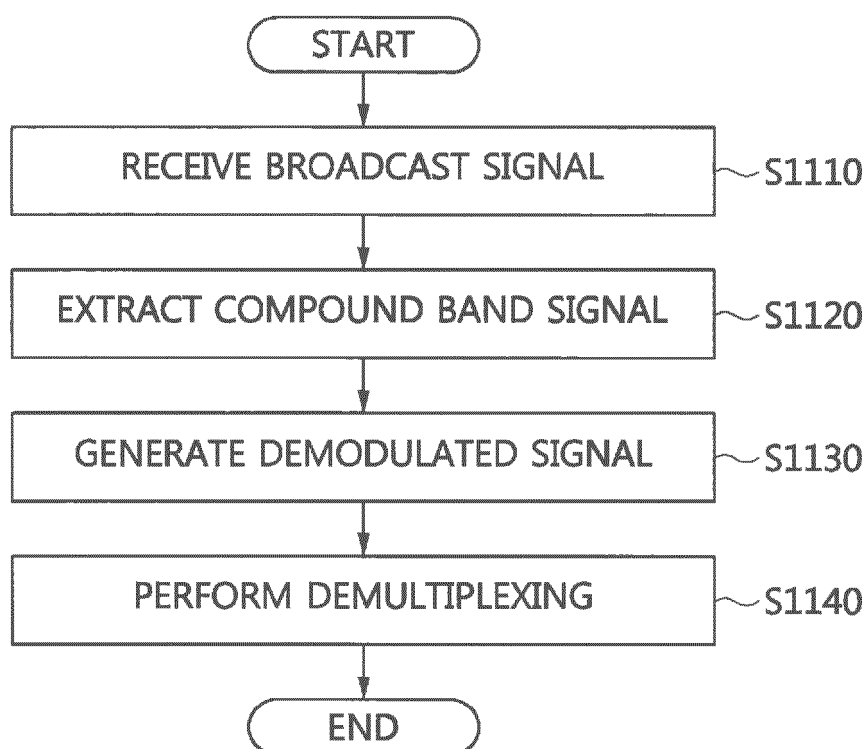


FIG. 11



FIG. 12

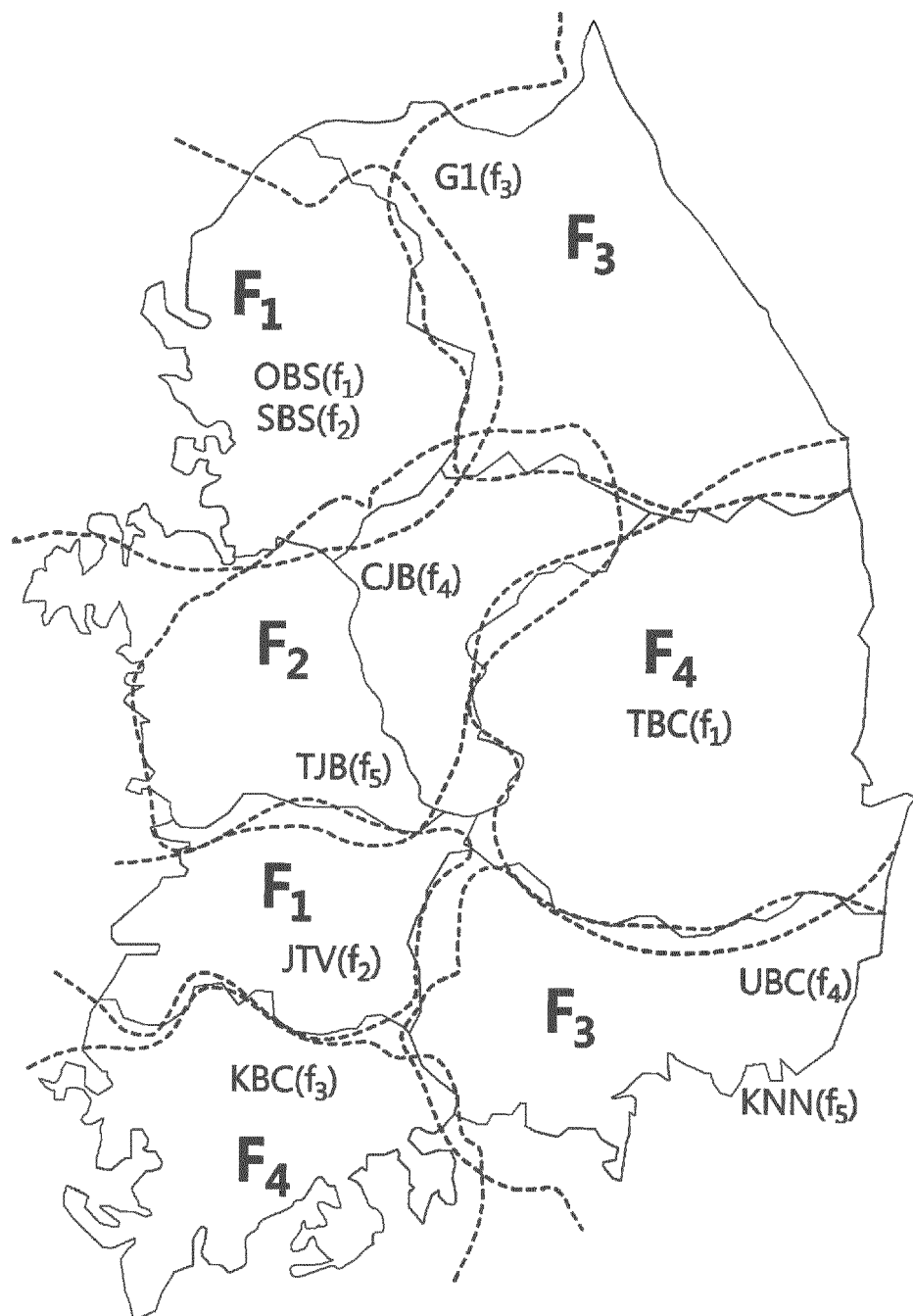


FIG. 13



EUROPEAN SEARCH REPORT

Application Number
EP 18 17 0992

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Place of search The Hague		Date of completion of the search 20 September 2018	Examiner Van Hoorick, Jan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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