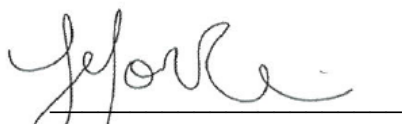


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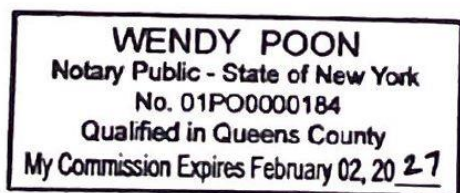


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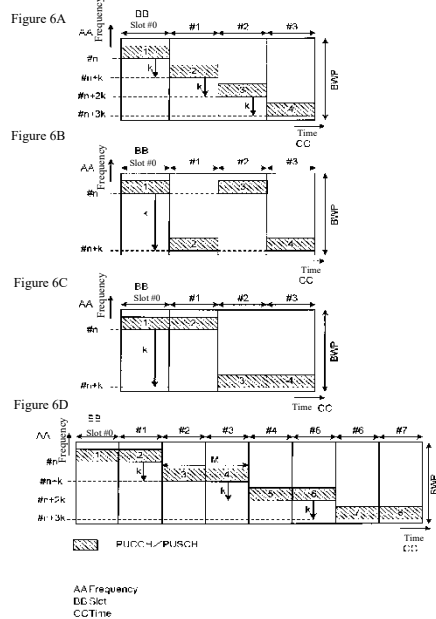
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(54) Title: USER TERMINAL AND WIRELESS COMMUNICATION METHOD

(54) TITLE OF THE INVENTION: User terminal and wireless communication method



(57) Abstract: To suitably control inter-slot frequency hopping of uplink channels/signals. The user terminal according to the present invention is characterized by comprising: a transmission unit that transmits an uplink data channel extending over a plurality of slots; and a control unit that controls frequency hopping of the uplink data channel between the plurality of slots.

(57) ABSTRACT: To properly control the inter-slot frequency hopping of an uplink channel/signal. The user terminal according to the present invention is characterized in that it is provided with a transmission unit that transmits an uplink data channel across a plurality of slots, and a control unit that controls frequency hopping of said uplink data channel between said plurality of slots

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Attached documentation:

International Search Report (Article 21 (3) of the Treaty)

SPECIFICATION

TITLE OF THE INVENTION: User terminal and wireless communication method

TECHNICAL FIELD

- (0001) The present invention relates to a user terminal and wireless communication method in a next generation mobile communication system.

BACKGROUND ART

- (0002) Long Term Evolution (LTE) was specified in the Universal Mobile Telecommunications System (UMTS) network for the purpose of achieving further high data rates and low latency, etc. (Non-patent literature 1). In order to further broaden the bandwidth and speed from LTE, successor systems of LTE (such as, LTE-A (LTE-Advanced), FRA (Future Radio Access), 4G, 5G, 5G+ (plus), NR (New RAT), and LTE Rel. 14, 15 onward, etc.) are also being studied.
- (0003) The existing LTE systems (such as LTE Rel. 8–13) use a 1 ms subframe (also known as a transmission time interval (TTI)) to perform downlink (DL) and/or uplink (UL) communications. This subframe is the transmission time unit of a single channel-coded data packet, and it may be a processing unit such as scheduling, link adaptation, or hybrid automatic repeat reQuest (HARQ).
- (0004) Also, in existing LTE systems (such as LTE Rel. 8–13), the user terminal transmits the uplink control information (UCI) using an uplink control channel (such as PUCCH: Physical Uplink Control Channel) or uplink data channel (such as PUSCH: Physical Uplink Shared Channel). The configuration (format) of this uplink control channel may also be called the PUCCH Format (PF), etc.

PRIOR ART LITERATURE**NON-PATENT LITERATURE**

- (0005) Non-patent literature 1: 3GPP TS 36.300 V8.12.0 “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 8)”, April 2010

OUTLINE OF THE INVENTION**PROBLEM TO BE SOLVED BY THE INVENTION**

- (0006) In future wireless communication systems (such as LTE Rel. 14, 15 onward, 5G, or NR, etc.), consideration is being given to the introduction of an uplink channel and/or an uplink signal (uplink channel/signal) that spans multiple slots (such as at least one of an uplink control channel (PUCCH), an uplink data channel (PUSCH), or a sounding reference signal (SRS), etc.). Consideration is also being given to the application of frequency hopping (inter-slot frequency hopping) that forces the hopping of the frequency resources to which said uplink channel/signal will be mapped between said plurality of slots.
- (0007) Here, the access BW may be also referred to as a carrier (Component Carrier (CC) or system band), a partial frequency band (Partial Band), or a Bandwidth part (BWP) in said carrier.
- (0008) In this way, in future wireless communication systems in which different access BW may be set up for multiple user terminals, it is desirable to appropriately control the pattern of uplink channel/signal inter-slot frequency hopping (such as the position and/or hopping timing (hopping boundary) of each frequency resource to be hopped).
- (0009) The present invention was constructed in light of this point, and one of the objectives of the present invention is to provide a user terminal and wireless

communication method that can appropriately control the inter-slot frequency hopping of the uplink channel/signal.

MEANS FOR SOLVING THE PROBLEM

- (0010) One aspect of the user terminal according to the present invention is characterized in that it is provided with a transmission unit that transmits an uplink data channel across a plurality of slots, and a control unit that controls frequency hopping of said uplink data channel between said plurality of slots.

EFFECT OF THE INVENTION

- (0011) According to the present invention, it will be possible to appropriately control the inter-slot frequency hopping of the uplink channel/signal.

BRIEF DESCRIPTION OF THE DRAWINGS

- (0012) (FIGURE 1) Figure 1A and Figure 1B are diagrams illustrating an example of a PUCCH in a future wireless communication system.

(FIGURE 2) Figure 2 is a diagram illustrating an example of a PUCCH format in a future wireless communication system.

(FIGURE 3) Figure 3A and Figure 3B are diagrams illustrating an example of the intra-slot frequency hopping of a PUCCH.

(FIGURE 4) Figure 4A and Figure 4B are diagrams illustrating an example of a long PUCCH that spans multiple slots.

(FIGURE 5) Figure 5A through Figure 5D are diagrams illustrating an example of inter-slot frequency hopping pertaining to the first aspect of the present invention.

(FIGURE 6) Figure 6A through Figure 6D are diagrams illustrating an example of the frequency offset when applying inter-slot frequency hopping pertaining to the first aspect of the present invention.

(FIGURE 7) Figure 7A and Figure 7B are diagrams illustrating a modified example of the frequency offset when applying inter-slot frequency hopping pertaining to the first aspect of the present invention.

(FIGURE 8) Figure 8A through Figure 8D are diagrams illustrating an example of the multiplexing of a plurality of user terminals when applying inter-slot frequency hopping pertaining to the first aspect of the present invention.

(FIGURE 9) Figure 9A through Figure 9C are diagrams illustrating an example of the determination of the frequency resources of PUCCH/PUSCH to which inter-slot frequency hopping pertaining to the second aspect of the present invention has been applied.

(FIGURE 10) Figure 10A and Figure 10B are diagrams illustrating a first example of the determination of the hopping boundary of inter-slot frequency hopping pertaining to the third aspect of the present invention.

(FIGURE 11) Figure 11A and Figure 11B are diagrams illustrating a second example of the determination of the hopping boundary of the inter-slot frequency hopping pertaining to the third aspect of the present invention.

(FIGURE 12) Figure 12A and Figure 12B are diagrams illustrating an example of the PUCCH resource set pertaining to the fourth aspect of the present invention.

(FIGURE 13) Figure 13 is a diagram illustrating an example of a DCI pertaining to the fifth aspect of the present invention.

(FIGURE 14) Figure 14A through Figure 14C are diagrams illustrating an example of a joint field in the DCI pertaining to the fifth aspect of the present invention.

(FIGURE 15) Figure 15 is a diagram illustrating an example of the schematic configuration of a wireless communication system pertaining to the present example of embodiment;

(FIGURE 16) Figure 16 is a diagram illustrating an example of the overall configuration of a wireless base station pertaining to the present example of embodiment.

(FIGURE 17) Figure 17 is a diagram illustrating an example of the functional configuration of a wireless base station pertaining to the present example of embodiment.

(FIGURE 18) Figure 18 is a diagram illustrating an example of the overall configuration of a user terminal pertaining to the present example of embodiment.

(FIGURE 19) Figure 19 is a diagram illustrating an example of the functional configuration of a user terminal pertaining to the present example of embodiment.

(FIGURE 20) Figure 20 is a diagram illustrating an example of the hardware configuration of a wireless base station and a user terminal pertaining to the present example of embodiment.

EXAMPLES OF EMBODIMENT OF THE INVENTION

- (0013) Existing LTE systems (LTE Rel. 13 or earlier) support multiple formats (such as LTE PUCCH format (LTE PF) 1–5, etc.) of uplink control channels (such as PUCCH) for the same period of time (such as 14 symbols in the normal Cyclic Prefix (CP)).

- (0014) For future wireless communication systems (such as from LTE Rel. 15 onward, 5G, or NR, etc.), consideration is being given to the transmission of the UCI using an uplink control channel (such as a PUCCH) with a plurality of formats having at least different durations (such as NR PUCCH format (NR PF), simply also referred to as the PUCCH format).
- (0015) Figure 1 is a diagram illustrating an example of a PUCCH in a future wireless communication system. Figure 1A shows a PUCCH (short PUCCH or a first uplink control channel) that is constructed of a relatively small number of symbols (duration), such as 1–2 symbols). Figure 1B shows a PUCCH (long PUCCH or second uplink control channel) that is constructed of a larger number of symbols (durations, such as 4–14 symbols) than the short PUCCH.
- (0016) As shown in Figure 1A, the short PUCCH may also be configured in a predetermined number of symbols (such as 1–2 symbols) (PUCCH duration) from the end of the slot. The location symbol of the short PUCCH is not limited to the end of the slot, and it may also be a predetermined number of symbols at the beginning or in the middle of the slot. The start position in the time direction of the short PUCCH in the slot may also be indicated by the index of the start symbol.
- (0017) Also, the short PUCCH may be configured in one or more frequency resources (such as one or more PRB). In Figure 1A, the short PUCCH is configured in a continuous PRB, but it may also be configured in a non-continuous PRB.
- (0018) The short PUCCH may also be time-division multiplexed and/or frequency-division multiplexed with the uplink data channel (hereinafter also referred to as PUSCH) within a slot. Further, the short PUCCH may be time-division multiplexed and/or frequency-division multiplexed with the downlink data channel (hereinafter also referred to as PDSCH) and/or downlink control channel (hereinafter also referred to as PDCCH) within a slot.

- (0019) It is acceptable for short PUCCH to use a multicarrier waveform (such as an OFDM (Orthogonal Frequency Division Multiplexing) waveform), or it may use a single carrier waveform (such as a DFT-s-OFDM (Discrete Fourier Transform-Spread-Orthogonal Frequency Division Multiplexing) waveform).
- (0020) The format of the short PUCCH may also be, for example, PUCCH format (PF) 0 or 2. The format of the short PUCCH may also vary depending on the number of bits of the UCI (such as less than or equal to 2 bits (up to 2 bits) or exceeding 2 bits (more than 2 bits)). For example, a PUCCH format 0 may be used for UCI of two bits or less, and a PUCCH format 2 may be used for UCI of more than two bits (see Figure 2).
- (0021) On the other hand, as shown in Figure 1B, the long PUCCH may be configured over a larger number of symbols (such as 4–14 symbols) (PUCCH duration) than the short PUCCH. In Figure 1B, the long PUCCH is not configured on the first predetermined number of symbols in the slot, but it may also be configured on said first predetermined number of symbols. The start position in the time direction of the long PUCCH in the slot may also be indicated by the index of the start symbol.
- (0022) As shown in Figure 1B, in order to obtain a power boosting effect, the long PUCCH may be configured with fewer frequency resources (such as one or two PRB) than the short PUCCH, or it may be configured with a number of frequency resources that is equal to that of a short PUCCH.
- (0023) The long PUCCH may also be frequency division multiplexed with PUSCH within a slot. The long PUCCH may also be time-divided multiplexed with the PDCCH within a slot. The long PUCCH may also be configured in the same slot as the short PUCCH. The long PUCCH may use a single carrier waveform (such as a DFT-s-OFDM waveform, or an OFDM waveform using a Constant Amplitude Zero Auto Correlation (CAZAC) series (such as a Computer-Generated Sequence (CGS) or a Zadoff-chu series) as the reference series for a transmission signal), or it may use a multicarrier waveform (such as an OFDM waveform).

- (0024) The format of the long PUCCH may also be, for example, PUCCH format (PF) 1, 3 or 4. The format of the long PUCCH may also vary depending on the number of bits of the UCI (such as less than or equal to 2 bits (up to 2 bits) or exceeding 2 bits (more than 2 bits)). For example, PUCCH format 1 may be used for UCI of 2 bits or less, and PUCCH format 3 or 4 may be used for UCI of more than 2 bits (see Figure 2).
- (0025) The long PUCCH format may also be controlled based on the number of bits N of the UCI. For example, a PUCCH format 3 may be used for UCI that exceed N bits (or greater than or equal to N bits), and a PUCCH format 4 may be used for UCI with N bits or less (or less than N bits) and greater than 2 bits (see Figure 2).
- (0026) Figure 2 merely shows an example, and it may also be $N=2$, or it may be $N>2$. Also, in Figure 2, different values of N may be used in the PUCCH format 3 and PUCCH format 4. For example, $N=2$ may be used in PUCCH format 3 and $N=100$ may be used in PUCCH format 4.
- (0027) The format of the long PUCCH may also vary depending on whether or not block-wise spreading (such as block-wise spreading of the time domain using an orthogonal diffusion code (OCC)) is applied. For example, if pre-DFT block-wise spreading is not applied, PUCCH format 3 may be used, and if pre-DFT block-wise spreading is applied, PUCCH format 4 may be used. In PUCH formats 1 and/or 4, block-wise spreading after DFT (such as block-wise spreading in the time domain with OCC) may also be applied.

- (0028) Also, as shown in Figure 1B, frequency hopping (intra-slot frequency hopping) in which hopping of the frequency resource is performed at a predetermined time within a slot may also be applied to a long PUCCH. Also, while not shown in the figure, the same intra-slot frequency hopping may also be applied to the short PUCCH and/or PUSCH that may be constructed of multiple symbols.
- (0029) Figure 3 is a diagram illustrating an example of the intra-slot frequency hopping of a PUCCH (such as a long PUCCH). While a long PUCCH is illustrated as an example of PUCCH in Figures 3A and 3B, other uplink channels/signals such as short PUCCH, PUSCH, and SRS are equally applicable.
- (0030) As shown in Figures 3A and 3B, in the future wireless communication system described above, a bandwidth that can be accessed (access BW (Bandwidth)) may be set (configured) for each user terminal. Here, the access BW may be also referred to as a carrier (Component Carrier (CC) or system band), a partial frequency band (Partial Band), or a Bandwidth part (BWP)) in said carrier.
- (0031) For example, in Figures 3A and 3B, the access BW of user terminal #1 is set to be broader than the access BW of user terminal #2. For access BW between different user terminals #1 and #2, the distance (offset) between frequency resources to which the PUCCH may be mapped may be different (Figure 3A) or the same (Figure 3B).
- (0032) Also, with the future wireless communication systems described above, consideration is also being given to enabling transmission of UCI using long PUCCH that span multiple slots. Figure 4 is a diagram illustrating an example of a long PUCCH that spans multiple slots. Although a long PUCCH is illustrated in Figure 4, other uplink channels/signals such as PUSCH or SRS, etc. are equally applicable.
- (0033) As shown in Figures 4A and 4B, if a long PUCCH spans multiple slots, the duration of the long PUCCH (PUCCH duration) and/or the start symbol in each slot may be the same. Although not shown in these figures, the PUCCH duration and/or start symbols in each slot may also be different.

- (0034) As shown in Figure 4A, in a long PUCCH that spans multiple slots, intra-slot frequency hopping may be applied to each slot. Alternatively, as shown in Figure 4B, in a long PUCCH that spans multiple slots, frequency hopping (inter-slot frequency hopping) may be applied in order to force hopping of the frequency resources that map the long PUCCH between said multiple slots.
- (0035) In a long PUCCH that spans multiple slots, intra-slot frequency hopping (Figure 4A) and inter-slot frequency hopping (Figure 4B) may not be applied simultaneously to the same user terminal.
- (0036) As described above, it is envisioned that the access BW will differ for each user terminal in future wireless communication systems (such as from LTE Rel. 15 onward, 5G, or NR, etc.) (such as Figure 2). For this reason, it is desirable to be able to flexibly control the pattern of inter-slot frequency hopping (such as the location and/or hopping timing of each frequency resource to be hopped) of the uplink channel/signal (such as at least one of the long PUCCH, short PUCCH, PUSCH, and SRS described above) for each user terminal.
- (0037) Therefore, the present inventors studied methods of flexibly controlling the pattern of uplink channel/signal inter-slot frequency hopping, resulting in the present invention.
- (0038) The present examples of embodiment will be described in detail below. In the following, as an example of an uplink channel/signal, PUCCH and/or PUSCH (PUCCH/PUSCH) are described, but the present example of embodiment can also be applied to other uplink channels and/or uplink signals, such as SRS. In addition, “PUCCH” shall be hereinafter collectively referred to as “long PUCCH” and/or “short PUCCH” below.
- (0039) (First aspect of the present invention)

In the first aspect of the present invention, when intra-slot frequency hopping is applied to a PUCCH/PUSCH that span a plurality of slots, a notification of information regarding the frequency resources to which said PUCCH/PUSCH may be mapped and about said frequency resources shall be described.

- (0040) If inter-slot frequency hopping is applied to PUCCH/PUSCH that span multiple slots, it is also acceptable to perform hopping of the frequency resource in which PUCCH/PUSCH will be mapped per predetermined number of slots. The number of slots (the number of hopping slots) M for hopping of the frequency resource of the PUCCH/PUSCH may be determined based on the number of slots allocated to said PUCCH/PUSCH, or it may be specified by the higher layer signaling and/or DCI.
- (0041) Figure 5 is a diagram illustrating an example of the inter-slot frequency hopping according to the first aspect of the present invention. Figures 5A through 5D show an example of the inter-slot frequency hopping that may be applied to PUCCH/PUSCH that span multiple slots. Figures 5A through 5D merely show examples, and the number of slots and/or hopping slots M for which PUCCH/PUSCH may be mapped are not limited to those shown in these figures. Also, in Figures 5A through 5D, the frequency resources of each hop may be constructed of a predetermined number of resource units (such as one or more PRB or RE).
- (0042) For example, in Figures 5A and 5B, the PUCCH/PUSCH frequency resources are hopped per single slot. As shown in Figure 5A, the PUCCH/PUSCH that spans multiple slots may be mapped to different frequency resources for each slot. Alternatively, as shown in Figure 5B, the PUCCH/PUSCH that spans multiple slots may be mapped to the same frequency resource for each predetermined number of slots (two slots in this example).
- (0043) In Figure 5A, the bandwidth of the frequency resources of each hop may be calculated based on the BWP and the number of slots of the PUCCH/PUSCH. Also, in Figure 5B, the bandwidth between the frequency resources for each hop may be calculated based on the BWP (such as multiplying the BWP by a predetermined factor).

- (0044) Also, in Figure 5C, hopping occurs only once for the frequency resources of the PUCCH/PUSCH that spans multiple slots. In Figure 5C, the number of hopping slots may be determined based on the number of slots/2 allocated to the PUCCH/PUSCH.
- (0045) Also, in Figure 5D, the frequency resources of the PUCCH/PUSCH may be hopped for each hopping slot number M that may be determined based on the number of slots allocated to the PUCCH/PUSCH. The number of hopping slots M may be determined using a table (such as Table 1 below) that associates the number of hopping slots M with the number of slots in the PUCCH/PUSCH.
- (0046) For example, because the number of slots allocated to the PUCCH/PUSCH of the user terminal in Figure 5D is 8, the user terminal may use the following Table 1 in order to determine the number of hopping slots M “2” corresponding to the number of slots “8” of the PUCCH/PUSCH.

(TABLE 1)

(Table 1)

M	Number of slots in the PUCCH/PUSCH
1	1 ~ 4
2	5 ~ 8
3	9 ~ 12
4	13 ~ 16
...	...

- (0047) In Figure 5D, the hopping boundary may also be calculated based on the value immediately after the $n \cdot M - 1$ slot (however, $n=1, 2, \dots, \text{cell}(N/M)$) if the slot index starts from 0. Here, M may also be determined by the number of slots allocated to PUCCH/PUSCH as described above. M may also be configured through higher layer signaling. N may be the number of slots allocated to PUCCH/PUSCH.
- (0048) In the first aspect of the present invention, when intra-slot frequency hopping is applied to a PUCCH/PUSCH that span a plurality of slots, a notification of information regarding the frequency resources to which said PUCCH/PUSCH may be mapped may be sent to the user terminal from the wireless base station.

- (0049) Here, the frequency resource information may also include information indicating the index of a particular frequency resource (such as the first (starting) frequency resource of the first hop) (such as an index of PRB and/or resource element (RE) (PRB/RE)), and information about other frequency resources (such as frequency resources after the second hop). The information about the other frequency resource may be, for example, information indicative of a predetermined frequency offset (frequency offset information) or information indicative of the index of the other frequency resource.
- (0050) Figure 6 is a diagram illustrating an example of the frequency offset when applying inter-slot frequency hopping according to the first aspect of the present invention. Figures 6A through 6D illustrate cases in which inter-slot frequency hopping is applied within a BWP that may be configured for the user terminal, but the bandwidth to which inter-slot frequency hopping is applied is not limited to the BWP, and it may be the access BW of the user terminal.
- (0051) Also, in Figures 6A through 6D, notification of the index #n (such as the minimum index) of a predetermined resource unit (such as PRB/RE) of the first hop frequency resource shall be submitted to the user terminal.
- (0052) For example, as shown in Figures 6A and 6B, when performing hopping of the frequency resource of PUCCH/PUSCH per slot, notification of the frequency offset information indicating the frequency offset k from the frequency resource of the previous hop (previous slot) may be submitted by the wireless base station to the user terminal.
- (0053) In Figure 6A, the user terminal may determine the index #n+k (such as the minimum PRB index or RE index) of the frequency resource of the next slot (such as the frequency resource of the second hop (slot #1)) based on the result of the addition of the index #n of the previous hop frequency resource (such as the frequency resource of the first hop (slot #0)) and the frequency offset k (k=integer).

- (0054) In Figure 6B, the user terminal may determine the index $\#n+k$ or $\#(n+k)-k$ (such as the minimum PRB or RE index) of the frequency resource of the subsequent hop (such as the frequency resource of the second, third, or fourth hop (slots #1, #2, #3)) based on the result of the addition or subtraction of the frequency resource of the previous hop (such as index $\#n$ of the frequency resource of the first hop (slot #0)) and the frequency offset k ($k=\text{integer}$).
- (0055) Also, as shown in Figure 6C, if hopping of the frequency resource of the PUCCH/PUSCH is performed only once, notification of the frequency offset information indicating the frequency offset k from the frequency resource of the first hop may be submitted by the wireless base station to the user terminal.
- (0056) In Figure 6C, the user terminal may determine the index of the second hop frequency resource $\#n+k$ (such as a minimum PRB index or RE index) based on the result of the addition of the index $\#n$ of the first hop frequency resource and the frequency offset k ($k=\text{integer}$).
- (0057) Also, as shown in Figure 6D, when performing hopping of the frequency resources of the PUCCH/PUSCH for each hopping slot number M , notification of the frequency offset information indicating the frequency offset k from the frequency resources of the previous hop may be submitted by the wireless base station to the user terminal.
- (0058) In Figure 6D, the user terminal may determine the index of the next hop frequency resource (such as PRB or RE minimum index $\#n+k$) based on the result of the addition of the index of the previous hop frequency resource (such as PRB or RE minimum index $\#n$) and the frequency offset k ($k=\text{integer}$).
- (0059) As described above, Figures 6A through 6D illustrate an example in which frequency offset information indicative of frequency offset k from a frequency resource of a previous hop is communicated from the wireless base station to a user terminal, but the frequency offset k is not limited to this example. Figure 7 is a diagram illustrating a modified example of the frequency offset when inter-slot frequency hopping is applied according to the first aspect of the present invention. It should be noted that while Figures 7A and 7B illustrate a modified

example of the frequency offset k using the pattern of inter-slot frequency hopping in Figure 6A as an example, it is also applicable to Figures 6B through 6D.

- (0060) In Figure 7A, notification of the frequency offset information indicating the frequency offset k_i of the i -th hop ($i=2-4$ in Figure 7A) from the index $\#m$ of the reference frequency resource (reference frequency resource) may be submitted from the wireless base station to the user terminal. Notification of the information indicating the index $\#m$ may be submitted to (configured in) the user terminal through higher layer signaling. In Figure 7A, the user terminal may determine the index $\#m+k_i$ of the frequency resource of the i -th hop (such as the minimum PRB index or RE index) based on the index $\#m$ of the reference frequency resource and the frequency offset k_i of the i -th hop ($k_i = \text{integer}$).
- (0061) In Figure 7B, notification of the frequency offset information indicating the frequency offset k_i of the i -th hop ($i=2-4$ in Figure 7B) from the index $\#I$ (such as the PRB or RE index) of one end (edge) of the user terminal access BW (BWP in this figure) may be submitted by the wireless base station to the user terminal. The index $\#I$ may be the index of the end of the access BW on the opposite side to the frequency resource of the first hop (such as a PRB index or a RE index).
- (0062) In Figure 7B, the user terminal may determine the index $\#I+k_i$ (such as the minimum PRB index or RE index) of the frequency resource of the i -th hop based on the index $\#I$ at one end of the access BWP and the frequency offset k_i ($k_i = \text{integer}$).
- (0063) Figure 8 is a diagram illustrating an example of the multiplexing of a plurality of user terminals when inter-slot frequency hopping is applied according to the first aspect of the present invention. Figure 8A shows that the frequency resource of the first hop of user terminal #2 is equal to the frequency resource of the second hop of user terminal #1. Also, in Figure 8A, based on the index of the frequency offset k and i -th frequency resources similar to that shown in Figure 6A, the frequency resources of the i -th hop of the user terminals #1 and #2, respectively ($i=2-4$ in Figure 8A) may be determined.

- (0064) In Figure 8A, because the frequency resource of the fourth hop of user terminal #2 will be smaller than one end of the BWP, the frequency resource of the fourth hop is determined to be the same as the frequency resource of the first hop of user terminal #1. The same is true for Figure 8D as well.
- (0065) In this way, if the index of the i -th hop frequency resource is not contained within an access BW (such as BWP) that was configured in the user terminal, the i -th frequency resource may be determined based on the surplus of the index and the resource units (such as PRB or RE) within the BWP.
- (0066) In the first aspect of the present invention, when inter-slot frequency hopping is applied to PUCCH/PUSCH, notification of the frequency resource information (such as information indicative of the frequency offset k shown in Figures 6A–6D, 7A, or 7B) may be submitted by the wireless base station to the user terminal in order to ensure that the user terminal can appropriately control the pattern of inter-slot frequency hopping based on the frequency resource information.
- (0067) (Second aspect of the present invention)
- The second aspect of the present invention differs from the first aspect in that, when intra-slot frequency hopping is applied to a PUCCH/PUSCH that span a plurality of slots, no explicit notification of information regarding the frequency resources to which said PUCCH/PUSCH may be mapped (frequency resource information) will be sent from the network (such as the wireless base station). In other words, in the second aspect of the present invention, the user terminal will determine the frequency resource to which the PUCCH/PUSCH may be mapped based on implicit information.
- (0068) More specifically, the user terminal may determine the frequency resource for mapping of the PUCCH/PUSCH to which the inter-slot frequency hopping may be mapped based on information about the frequency resource of the PUCCH/PUSCH to which the intra-slot frequency hopping is applied (intra-slot FH information).
- (0069) Here, the intra-slot FH information may include information indicating an index of a particular frequency resource of the PUCCH/PUSCH to which the

intra-slot frequency hopping may be applied (such as the index of the (first: starting) frequency resource of the first hop) (such as the index of the PRB and/or resource element (RE) (PRB/RE)), and information about other frequency resources (such as frequency resources from the second hop onward). The information about the other frequency resource may be, for example, information indicative of a predetermined frequency offset (frequency offset information) or information indicative of the index of the other frequency resource.

- (0070) The user terminal may also determine the frequency resource of the PUCCH/PUSCH to which inter-slot frequency hopping will be applied based on the frequency resource indicated by the intra-slot FH information. For example, the user terminal may apply the pattern of intra-slot frequency hopping indicated by the intra-slot FH information to the inter-slot frequency hopping as is. Alternatively, the pattern of intra-slot frequency hopping indicated by the intra-slot FH information may be multiplied by m (m = positive integer) for application to the inter-slot frequency hopping.
- (0071) Note that the intra-slot FH information may include information about the time resources of the PUCCH/PUSCH to which the intra-slot frequency hopping may be applied. The user terminal may determine the time resource of the PUCCH/PUSCH to which inter-slot frequency hopping is applied based on the time resource indicated by the intra-slot FH information.
- (0072) Figure 9 is a diagram illustrating one example of the determination of the frequency resources of PUCCH/PUSCH to which the inter-slot frequency hopping according to the second aspect of the present invention may be applied. Figures 9A through 9C describe the use of a frequency offset k from a previous hop frequency resource, this may also be applied as appropriate when a frequency offset k from a reference frequency resource (Figure 7A) or a frequency offset k from a user terminal access BW (such as BWP) is used.
- (0073) In Figure 9A, during the intra-slot frequency hopping, notification of the intra-slot FH information indicating the index $\#n$ and/or frequency offset k of the first hop frequency resource is submitted to the user terminal.

- (0074) In Figure 9B, the pattern of intra-slot frequency hopping shown in Figure 9A may also be applied to the inter-slot frequency hopping based on the intra-slot FH information. In Figure 9B, the number of hopping slots (hopping timing, hopping boundary) M may be determined based on the number of slots allocated to PUCCH/PUSCH, it may be configured through higher layer signaling, or it may also be predetermined.
- (0075) In Figure 9C, based on the intra-slot FH information, a multiple of m (m = positive integer) of the pattern of the intra-slot frequency hopping shown in Figure 9A may be applied to the inter-slot frequency hopping. Here, m may be specified through higher layer signaling and/or physical layer signaling (such as DCI), or it may be derived by the user terminal itself according to a predetermined rule. For example, m may be determined based on a user terminal group and/or user terminal category (such as enhanced Mobile Broad Band (eMBB), enhanced Machine Type Communication (eMTC), or Ultra Reliable and Low Latency Communications (URLLC), etc.).
- (0076) Although the above-noted example assumes that the intra-slot FH information is communicated to the user terminal from a wireless base station, the pattern of intra-slot frequency hopping (such as at least one parameter from among the frequency resources, frequency offsets, time resources, and hopping timing, etc.) may be derived based on at least one of the access BW (UE BWP), cell bandwidth (cell BW), UL BWP, or DL BWP of the user terminal.
- (0077) Also, Figures 9B and 9C described an example in which the frequency resource of a PUCCH/PUSCH to which inter-slot frequency hopping may be applied was determined based on intra-slot FH information, but in addition to said frequency resource, the time resource of said PUCCH/PUSCH (such as number of symbols per slot, etc.) may also be controlled.
- (0078) Even if intra-slot frequency hopping is applied to PUCCH/PUSCH that spans multiple slots, the application of intra-slot frequency hopping in a given slot may also be controlled based on the number of symbols available in said slot (such as

UL symbols). For example, if the number of symbols available in a given slot is less than a predetermined threshold X, the application of intra-slot frequency hopping in said slot may be turned off. Note that X may also be, for example, 7 or 4.

(0079) In the second aspect of the present invention, if intra-slot frequency hopping is applied to PUCCH/PUSCH, it is possible to reduce overhead because the user terminal can appropriately control the pattern of inter-slot frequency hopping even without notification of the frequency resource information from the wireless base station as described in the first aspect.

(0080) (Third aspect of the present invention)

In the third aspect of the present invention, control of the timing (hopping boundary) at which there will be hopping of the frequency resource when inter-slot frequency hopping is applied to PUCCH/PUSCH that span multiple slots will be described.

(0081) <First determination method>

The hopping boundary in inter-slot frequency hopping may be determined based on the number of slots that satisfy the predetermined conditions. Said predetermined conditions may, for example, be slots for which the number of symbols that can transmit PUCCH/PUSCH in the slot is greater than or equal to a predetermined threshold value (or exceeds a predetermined threshold value).

(0082) The number of symbols that can transmit the PUCCH/PUSCH (such as UL symbols) within a slot may be specified through higher layer signaling and/or physical layer signaling. For example, the number of symbols may be specified by the slot format information (SFI).

(0083) The number of slots to which PUCCH/PUSCH may be allocated may also be specified through higher layer signaling and/or physical layer signaling.

(0084) Figure 10 is a diagram illustrating a first example of the determination of the hopping boundary of inter-slot frequency hopping according to the third aspect

of the present invention. In Figure 10A, slot #1 is a slot that does not meet the above-noted predetermined conditions, and the other slots all meet the above-noted predetermined conditions.

(0085) As shown in Figures 10A and 10B, the user terminal may not count slot #1 that does not meet the above-noted predetermined conditions as a transmission slot for PUCCH/PUSCH. In this case, the user terminal may determine the frequency resource to which PUCCH/PUSCH may be mapped in the inter-slot frequency hopping without considering slot #1.

(0086) For example, in Figure 10A, the next slot #2 following slot #1 will become the frequency resource of the second hop. Also, in Figure 10B, the frequency resource of slot #2 is the same as slot #0 without counting slot #1 due to the configuration of the number of hopping slots $M=2$.

(0087) In the first determination method, the pattern of inter-slot frequency hopping will be determined by considering only the slots capable of transmitting PUCCH/PUSCH, making it possible to more effectively obtain the frequency divergence effect of PUCCH/PUSCH.

(0088) <Second determination method>

Alternatively, the hopping boundary in inter-slot frequency hopping may be determined without using the number of slots that meet said predetermined conditions as the basis. The explanation of the second determination method will focus on the differences with the first determination method.

(0089) Figure 11 is a diagram illustrating a second example of the determination of the hopping boundary of inter-slot frequency hopping according to the third aspect of the present invention. As shown in Figures 11A and 11B, the user terminal may count slot #1 that does not meet the predetermined conditions shown above as a transmission slot for PUCCH/PUSCH. In this case, in consideration of slot #1, the user terminal may determine the frequency resource to which PUCCH/PUSCH may be mapped in the inter-slot frequency hopping.

(0090) For example, in Figure 11A, the next slot #1 following slot #0 will become the frequency resource of the second hop, meaning that the frequency resource of slot #2 will be twice the frequency offset of the frequency resource of slot #1. Also,

in Figure 11B, the frequency resource of slot #2 is the hopping frequency resource obtained when counting slot #1 due to the configuration of the number of hopping slots $M=2$.

(0091) The second determination method determines the pattern of inter-slot frequency hopping, regardless of whether the slot can transmit PUCCH/PUSCH or not, thereby making it possible to simplify the determination of said pattern.

(0092) In the third aspect described above, it will be possible to appropriately control the hopping boundary if the inter-slot frequency hopping is applied to PUCCH/PUSCH.

(0093) (Fourth aspect of the present invention)

In the fourth aspect of the present invention, the details of signaling in the case in which inter-slot frequency hopping is applied to PUCCH shall be described.

(0094) In the user terminal, a plurality of sets (PUCCH resource sets, parameter sets) that each contain parameters equal to or greater than those related to the resources for PUCCH (PUCCH resources) may be set (configured) in advance through upper layer signaling (with notification sent by the wireless base station). One of said plurality of PUCCH resource sets may be specified using a predetermined field in the downlink control information (DCI). The user terminal controls the transmission of the PUCCH based on the PUCCH resource set indicated by the predetermined field value in the DCI.

(0095) Each PUCCH resource set that may be configured through higher layer signaling may also include the frequency resource information described in the first aspect, etc., if inter-slot frequency hopping is applied to the PUCCH.

(0096) Figure 12 is a diagram illustrating an example of a PUCCH resource set according to the fourth aspect of the present invention. As shown in Figure 12A, each value of the predetermined field of the DCI indicates a PUCCH resource set. For example, in Figure 12A, the predetermined field values "00," "01," "10," and "11" indicate PUCCH resource sets #0, #1, #2, and #3, respectively.

(0097) As shown in Figure 12B, each PUCCH resource set may include at least one of the following parameters:

- Information indicating the start symbol of the PUCCH
 - Information indicating the number of PUCCH symbols in the slot
 - Information identifying the frequency resource of the first hop of the PUCCH (such as the starting PRB) (such as the index of the starting PRB)
 - Information indicating the number of resource units (such as the number of PRBs) that make up the frequency resources of the PUCCH
 - Information indicating whether frequency hopping is applied (enabling) or not (ON or OFF).
 - Information about the frequency resources of the second or subsequent hops when frequency hopping is applied (such as information indicating the frequency offset shown in Figures 4A through 4C, or information indicating the index of each frequency resource of the second or subsequent hops)
 - Information indicating whether intra-slot frequency hopping or inter-slot frequency hopping is applied to the PUSCH that spans multiple slots (information indicating the mode of frequency hopping)
- (0098) At least one parameter shown in Figure 12B may be set (configured) to semi-static through higher layer signaling rather than dynamically specified as a PUCCH resource set.
- (0099) Explicit notification of the PUCCH format is not submitted to the UE, and the user terminal (UE) may estimate the PUCCH format based on the PUCCH resource in the notification that was received. For example, if the number of symbols of the PUCCH indicated in the notification is less than 4, the UE may estimate that the notification is indicating the PUCCH format of a short PUCCH. Also, in Figure 12A, each PUCCH resource set may indicate a PUCCH resource in a PUCCH format. It may also be in a different PUCCH format for each PUCCH resource set. At least one parameter shown in Figure 12B may also be specified per PUCCH resource set and per PUCCH format. For example, the applicability of frequency hopping for each PUCCH resource set may be specified for each of the PUCCH formats 0 through 4.

- (0100) The predetermined field value in the DCI shown in Figure 12A may also indicate a PUCCH resource set per PUCCH format. For example, the predetermined field value “00” may indicate PUCCH resource set #0 of PUCCH format 0, and PUCCH resource set #4 of PUCCH format 1. In this way, the same predetermined field values may indicate the same and/or different PUCCH resource sets between PUCCH formats.
- (0101) According to the fourth aspect of the present invention, when inter-slot frequency hopping is applied to a PUCCH, a PUCCH resource set that contains the frequency resource information about the PUCCH (such as information indicating a frequency offset k shown in Figures 6A–6D, 7A, or 7B)) is specified to the user terminal such that the user terminal can appropriately control the pattern of inter-slot frequency hopping of the PUCCH based on the frequency resource information.
- (0102) (Fifth aspect of the present invention)
In the fifth aspect of the present invention, the signaling shall be described when inter-slot frequency hopping is applied to a PUSCH.
- (0103) The DCI to schedule the PUSCH in one or more slots may also contain the information indicating a symbol and/or slot (time resource information) that may be used to transmit the PUSCH in said slot. The time resource information may be, for example, information indicating the index (starting symbol index) and/or number of symbols (symbol length or duration) of the first symbol to which the PUSCH is assigned in the slot (such as an index associated with the start symbol index and/or number of symbols in a given table), or information indicating the number of slots.
- (0104) One of the plurality of PUSCH configurations (PUSCH configurations) may also be configured in the user terminal through higher layer signaling (such as RRC signaling). The plurality of PUSCH configurations includes a default PUSCH configuration (also referred to as Configuration 1 or the default configuration, etc.) until the PUSCH configuration is set through higher layer signaling.

- (0105) The allocation of frequency resources to PUSCH takes place in a given resource unit (such as a PRB, or a group containing at least one PRB (Resource Block Group (RBG))). The size of the RBG (RBG size, number of PRB within the RBG) may be determined for each PUSCH configuration depending on the number of PRB in the access BW (such as BWP) of the user terminal.
- (0106) For example, if the access BW consists of between X_0 and X_1 units of PRB, RBG size 1 may be applied for PUSCH Configuration #1 and the RBG size may be applied for PUSCH configuration #2. In addition, if the access BW consists of a predetermined number of $X_1 + 1$ to X_2 units of PRB, RBG size 3 may be applied for PUSCH Configuration #1, and RBG size 4 may be applied for PUSCH Configuration #2.
- (0107) The RBG size corresponding to the access BW for each of this type of PUSCH configuration may also be determined in a table. In the table, the RBG size may be determined for each stage of the number of PRBs for the access BW. The number of stages of the PRB number may be, for example, 4–6, and the above-noted table may contain 4–6 records. Said table may be shared between PUSCH and PUCCH, or it may be unique to each. The RBG size may also be constant regardless of the duration (number of symbols) of the PUSCH.
- (0108) If inter-slot frequency hopping is applied to a PUSCH that is constructed as described above, the frequency resource information described in the first aspect, etc., may also be specified by the DCI. Said DCI may also specify whether or not frequency hopping is to be applied.
- (0109) Here, said DCI may be a DCI that is arranged in a common search space for one or more user terminals (also referred to as a common DCI or fallback DCI, etc.), and/or it may be a DCI that is arranged in a user terminal-specific search space (also referred to as an individual DCI, or non-fallback DCI, etc.).
- (0110) A fallback DCI is a DCI for which the content may not be configured through a user terminal-specific higher layer signaling (such as RRC signaling).

A non-fallback DCI is a DCI for which the content may be configured through higher layer signaling (such as RRC signaling) that is specific to a user terminal. A non-fallback DCI may be used for scheduling PUSCH and may also be referred to as a UL grant, etc.

- (0111) Figure 13 is a diagram illustrating an example of a DCI according to the fifth aspect of the present invention. As shown in Figure 13, a DCI (fallback DCI and/or non-fallback DCI) may indicate at least one of the following information:
- Information indicating the start symbol of the PUSCH
 - Information indicating the number of PUSCH symbols in the slot
 - Frequency resource allocation information for the PUSCH (c)
 - Information indicating whether frequency hopping is applied (enabling) or not (On or OFF) (a)
 - Information about the frequency resources of the second or subsequent hops when frequency hopping is applied (such as information indicating the frequency offset shown in Figures 6A through 6C, 7A, or 7B (this may also be called the gap or bandwidth, etc.), or information indicating the index of each frequency resource of the second or subsequent hops (such as the PRB index or RE index))
 - Information indicating whether or not intra-slot frequency hopping or inter-slot frequency hopping is applied to the PUSCH that spans multiple slots (d) (information indicating the mode of frequency hopping)
- (0112) More specifically, the respective information shown in Figure 13 may also be indicated by separate fields in the DCI (also referred to as parameters or information items (IEs), etc.). Alternatively, at least two of these may be indicated by a single field (joint field) in the DCI.
- (0113) For example, information indicating whether or not frequency hopping is applied (a) may be indicated in a single field in the DCI, and both information about the frequency resources for the second and subsequent hops (b) and the frequency resource allocation information for the PUSCH (c) may be indicated in other single fields (such as resource allocation fields) in the DCI.

- (0114) Alternatively, information indicating whether frequency hopping is applied (a), information about frequency resources for the second and subsequent hops (b), and frequency resource allocation information for the PUSCH (c) may all be indicated in a single field (such as resource allocation field) in the DCI.
- (0115) The information indicating whether intra-slot frequency hopping or intra-slot frequency hopping is applied to a PUSCH that spans multiple slots (d) may also be indicated in the same joint field as the information about the PUSCH time resources (such as information indicating the start symbol and/or information indicating the number of symbols in the slot), or may be indicated in separate fields in the DCI.
- (0116) Figure 14 is a diagram illustrating an example of a joint field in the DCI according to the fifth aspect of the present invention. In Figure 14A, the X-bit joint field (such as the resource allocation field) in the DCI shows information indicating whether or not frequency hopping is applied (a), information about the frequency resources for the second and subsequent hops (b), and frequency resource allocation information for the PUSCH (c).
- (0117) For example, in Figure 14A, the $\text{ceil}[\log(Y \text{ RBs} * (Y \text{ RBs} + 1))]$ bit indicates the frequency resource allocation information for the PUSCH (a) (such as PRB number Y), and the Z bit indicates information about the frequency resources for the second and subsequent hops (b) and the frequency resource allocation information for the PUSCH (c).
- (0118) The number of bits X in the joint field may be a fixed value, a value set through higher layer signaling, or a value derived based on the access BW (such as the UL BWP) of the user terminal. For example, if X is fixed, then X=15 may be used if the DCI is a fallback DCI, while X=25 may be used if the DCI is a non-fallback DCI.

- (0119) Also, the number of bits Z indicating information about the frequency resources for the second and subsequent hops (b) and the frequency resource allocation information for the PUSCH (c) may be a fixed value or a value that is derived based on the bandwidth S of the access BW (such as UL BWP) of the user terminal or the total bandwidth S to be frequency hopped. For example, if the bandwidth S of the access BW or the total bandwidth S to be frequency hopped is less than or equal to a predetermined threshold, then $Z=1$ bit, and if the bandwidth S is greater than the predetermined threshold, then $Z=2$ bits.
- (0120) Figure 14B shows the information that indicates each bit value when $Z=1$. For example, a bit value of “0” indicates that frequency hopping is not applied, and a bit value of “1” indicates a frequency offset of “ $1/2 \cdot S$ ” if frequency hopping is applied.
- (0121) Figure 14C shows the information that indicates each bit value when $Z=2$. For example, a bit value of “00” indicates that no frequency hopping is applied, while bit values of “01”, “10”, and “11” indicate frequency offset of “ $1/2 \cdot S$ ”, “ $+1/4 \cdot S$ ”, and “ $-1/4 \cdot S$ ” when frequency hopping is applied, respectively.
- (0122) The user terminal may control the inter-slot frequency hopping of the PUSCH based on the frequency offset indicated by the $\lceil \log(Y \text{ RBs} \cdot (Y \text{ RBs} + 1)) \rceil$ bits of the frequency resource allocation information for the PUSCH (a) and the bit value of the Z bit.
- (0123) In PUSCH to which the above-noted inter-slot frequency hopping is applied, at least one of the user data, higher layer control information, or Message 3 may be transmitted. Message 3 is upper layer control information that may be sent from the user terminal in response to a random-access response (RAR, Message 2) from a wireless base station in a random-access procedure.
- (0124) According to the fifth aspect of the present invention, when inter-slot frequency hopping is applied to a PUSCH, the user terminal can appropriately control the pattern of inter-slot frequency hopping of the PUSCH based on the frequency resource information because a DCI containing frequency resource information about the PUSCH (such as information indicating the frequency offset k shown in Figures 6A-6D, 7A or 7B) will be transmitted from the wireless base station.

(0125) (Wireless communication system)

The configuration of the wireless communication system according to the present example of embodiment will be described below. In this wireless communication system, the wireless communication method according to each of the above-noted aspects may be applied. The wireless communication methods according to each of the above-noted aspects may be applied individually or in combination of at least two methods.

(0126) Figure 15 is a diagram illustrating an example of the schematic configuration of the wireless communication system according to the present example of embodiment. In wireless communication system 1, carrier aggregation (CA) and/or dual connectivity (DC) may be applied with multiple basic frequency blocks (component carriers) as a unit of system bandwidth (such as 20 MHz) of an LTE system. Wireless communication system 1 may also be called SUPER 3G, LTE-A (LTE-Advanced), IMT-Advanced, 4G, 5G, FRA (Future Radio Access), or NR (New RAT: New Radio Access Technology).

(0127) Wireless communication system 1 shown in Figure 15 is provided with wireless base station 11 that forms macro cell C1, and wireless base stations 12a to 12c that are arranged in macro cell C1 and that form small cell C2 that is narrower than macro cell C1. In addition, user terminal 20 is provided in macro cell C1 and each small cell C2. Different numerologies may also be applied between and/or within cells.

(0128) Here, the term numerology refers to the communication parameters in the frequency direction and/or time direction (such as at least one of the subcarrier spacing, bandwidth, symbol length, CP time length (CP length), subframe length, TTI time length (TTI length), number of symbols per TTI, wireless frame configuration, filtering, and windowing processing, etc.). Wireless communication system 1 may also support subcarrier spacing such as, for example, 15 kHz, 30 kHz, 60 kHz, 120 kHz, 240 kHz, and the like.

- (0129) User terminal 20 may be connected to both wireless base station 11 and wireless base station 12. It is envisioned that user terminal 20 uses macro cell C1 and small cell C2, which use different frequencies, simultaneously using CA or DC. Also, user terminal 20 may apply CA or DC using a plurality of cells (CC) (such as two or more CCs). Further, the user terminal may also utilize the license band CC and the unlicensed band CC as multiple cells.
- (0130) User terminal 20 may also communicate in each cell using Time Division Duplex (TDD) or Frequency Division Duplex (FDD). The cells of the TDD and the cells of the FDD may each be referred to as TDD carriers (frame configuration type 2), or FDD carriers (frame configuration type 1), etc.
- (0131) Also, in each cell (carrier), a single numerology may be applied, or multiple different numerologies may be applied.
- (0132) Between user terminal 20 and wireless base station 11, communication may be performed using a carrier with a relatively low frequency band (such as 2 GHz) and a narrow bandwidth (referred to as an existing carrier, or Legacy carrier, etc.). On the other hand, a bandwidth-wide carrier may be used between user terminal 20 and wireless base station 12 in a relatively high frequency band (such as 3.5GHz, 5GHz, 30–70GHz, etc.), or the same carrier may be used as is used with wireless base station 11. However, the configuration of frequency bands used by each wireless base station is not limited to this example.
- (0133) Between wireless base station 11 and wireless base station 12 (or between two wireless base stations 12), there may be a wired connection (such as a Common Public Radio Interface (CPRI) compliant optical fiber, or an X2 interface, etc.), or there may be a wirelessly connected configuration.
- (0134) Wireless base station 11 and each wireless base station 12 may each be connected to upper station device 30, and may be connected to core network 40

via upper station device 30. Upper station device 30 may include, for example, an access gateway device, a wireless network controller (RNC), or a mobility management entity (MME), and the like, but it is not limited to this example. Also, each wireless base station 12 may be connected to upper station device 30 via wireless base station 11.

- (0135) Wireless base station 11 is a wireless base station that boasts relatively wide coverage, and it may also be referred to as a macro base station, an aggregate node, an eNB (eNodeB), a gNB (gNodeB), or a transmit/receive point (TRP), etc. Also, wireless base station 12 is a wireless base station that boasts local coverage, and it may also be referred to as a small base station, a micro base station, a pico base station, a femto base station, a HeNB (Home eNodeB), a Remote Radio Head (RRH), an eNB, a gNB, or a transmit/receive point, etc. If wireless base stations 11 and 12 are not differentiated below, they shall be collectively referred to as wireless base station 10.
- (0136) Each user terminal 20 is a terminal that supports various communication methods such as LTE, LTE-A, 5G, or NR, etc., and may include a stationary communication terminal as well as a mobile communication terminal. User terminal 20 may also perform communications between terminals (D2D) with other user terminals 20.
- (0137) In wireless communication system 1, as a wireless access method, OFDMA (orthogonal frequency split multi-dimensional connection) can be applied to the downlink (DL), and SC-FDMA (single carrier-frequency split multi-dimensional connection) may be applied to the uplink (UL). OFDMA is a multicarrier transmission method that divides frequency bands into multiple narrow frequency bands (subcarriers) and maps data to each subcarrier in order to perform communication. SC-FDMA is a single-carrier transmission method that divides system bandwidth into bands consisting of one or consecutive resource blocks per terminal, and reduces interference between terminals by using different bands for multiple terminals. Note that the uplink and downlink wireless access methods are not limited to these combinations, and OFDMA may also be used in UL.
- (0138) In addition, a multicarrier waveform (such as OFDM waveform) may be used in wireless communication system 1, or a single carrier waveform (such as DFT-s-OFDM waveform) may be used.

- (0139) In wireless communication system 1, a DL shared channel (PDSCH) shared by each user terminal 20 (PDSCH: Physical Downlink Shared Channel, also referred to as a downlink data channel), a broadcast channel (PBCH: Physical Broadcast Channel), or an L1/L2 control channel, etc., may be used as the downlink (DL) channel. The PDSCH will transmit the user data, higher layer control information, and System Information Block (SIB). The PBCH will also transmit the Master Information Block (MIB).
- (0140) The L1/L2 control channel includes the downlink control channels (PDCCH (Physical Downlink Control Channel), EPDCCH (Enhanced Physical Downlink Control Channel), PCFICH (Physical Control Format Indicator Channel), and PHICH (Physical Hybrid-ARQ Indicator Channel), etc. The PDCCH will transmit the downlink control information (DCI: Downlink Control Information) including the PDSCH and PUSCH scheduling information. The PCFICH will transmit the number of OFDM symbols used for the PDCCH. The EPDCCH may be frequency-division multiplexed with the PDSCH and may be used for transmissions, such as DCI, as is the case with the PDCCH. At least one of the PHICH, PDCCH, and EPDCCH can transmit the HARQ retransmission control information (ACK/NACK) for the PUSCH.
- (0141) In wireless communication system 1, as the uplink (UL) channel, an uplink shared channel that is shared between each user terminal 20 (PUSCH: Physical Uplink Shared Channel, also referred to as an uplink data channel), uplink control channel (PUCCH: Physical Uplink Control Channel), and random-access channel (PRACH: Physical Random Access Channel), etc., may be used. The PUSCH will transmit the user data and upper layer control information. Uplink Control Information (UCI) containing at least one of the parameters such as the retransmission control information (A/N) or channel state information (CSI) of the downlink (DL) signal may be sent by the PUSCH or PUCCH. The PRACH may transmit the random-access preamble for establishing connections with cells.

(0142) <Wireless base station>

Figure 16 is a diagram illustrating an example of the overall configuration of a wireless base station pertaining to the present example of embodiment. Wireless base station 10 is provided with a plurality of transmitting and receiving antenna 101, amplifier unit 102, transmitting and receiving unit 103, baseband signal processing unit 104, call processing unit 105, and transmission line interface 106. Transmitting and receiving antenna 101, amplifier unit 102, and transmitting and receiving unit 103 may each be configured to include one or more of each part.

(0143) The user data that may be transmitted from wireless base station 10 to user terminal 20 in the downlink will be inputted into baseband signal processing unit 104 from upper station device 30 via transmission line interface 106.

(0144) Baseband signal processing unit 104 will perform transmission processing on the user data, such as processing of the Packet Data Convergence Protocol (PDCP) layer, splitting and combining the user data, transmission of the RLC layer such as Radio Link Control (RLC) retransmission control, Medium Access Control (MAC) retransmission control (such as transmission processing of the HARQ (Hybrid Automatic Repeat reQuest)), scheduling, transmission format selection, channel encoding, Inverse Fast Fourier Transform (IFFT) processing, and precoding processing, after which it will forward the result to transmitting and receiving unit 103. In addition, transmission processing such as channel encoding and Inverse Fast Fourier transform will be performed on the downlink control signal as well, and the result will be transferred to transmitting and receiving unit 103.

(0145) Transmitting and receiving unit 103 will convert the baseband signal that was pre-coded for each antenna and outputted from baseband signal processing unit 104 to a radio frequency band. The radio frequency signal that underwent frequency conversion in transmitting and receiving unit 103 will be amplified by amplifier unit 102 and transmitted from transmitting and receiving antenna 101.

(0146) This unit may be constructed of a transmitter/receiver, transmitting and receiving circuit, or transceiver that will be described based on the common knowledge in the art pertaining to the present invention. It should be noted that transmitting and receiving unit 103 may also be configured as an integrated transmitting and receiving unit, or it may be constructed of a transmitting unit and a receiving unit.

- (0147) On the other hand, for uplink (UL) signals, the radio frequency signals received at transmitting and receiving antenna 101 will be amplified in amplifier unit 102. Transmitting and receiving unit 103 will receive the UL signal that was amplified in amplifier unit 102. Transmitting and receiving unit 103 will convert the received signal to a baseband signal frequency and will output it to baseband signal processing unit 104.
- (0148) Baseband signal processing unit 104 will perform Fast Fourier Transform (FFT) processing, Inverse Discrete Fourier Transform (IDFT) processing, error correction decryption, reception of MAC retransmission control, and reception of the RLC layer and PDCP layer on the UL data contained in the UL signal that was inputted, and will forward the result to upper station device 30 via transmission line interface 106. Call processing unit 105 will perform call processing such as setting up and releasing communication channels, state management of wireless base station 10, and management of wireless resources.
- (0149) Transmission line interface 106 will send and receive signals to and from upper station device 30 via a predetermined interface. Transmission line interface 106 may also send and receive signals (backhaul signaling) to and from adjacent wireless base stations 10 via a base station-to-base station interface (such as an optical fiber compliant with a Common Public Radio Interface (CPRI) or an X2 interface).
- (0150) Transmitting and receiving unit 103 will also transmit a downlink (DL) signal (containing at least one of a DL data signal, a DL control signal, and a DL reference signal) to user terminal 20, and will receive an uplink (UL) signal (containing at least one of a UL data signal, a UL control signal, and a UL reference signal) from user terminal 20.
- (0151) Transmitting and receiving unit 103 will also receive an uplink data channel (such as PUSCH) and/or uplink control channel (such as short PUCCH and/or long PUCCH).
- (0152) Transmitting and receiving unit 103 will also transmits the control information (upper layer control information) through higher layer signaling and downlink control information (DCI) through physical layer signaling. Specifically,

transmitting and receiving unit 103 will transmit the frequency resource information (first aspect of the present invention). For example, transmitting and receiving unit 103 may transmit, through upper layer signaling, a plurality of parameter sets (PUCCH resource sets) that each contain the frequency resource information, and may transmit the downlink control information indicating one of said plurality of parameter sets (fourth aspect of the present invention). Also, transmitting and receiving unit 103 may transmit the downlink control information containing the frequency resource information described above (fifth aspect of the present invention).

- (0153) Figure 17 is a diagram illustrating an example of the functional configuration of the wireless base station according to the present example of embodiment. Figure 17 shows mainly the functional blocks of the parts that are characteristic of the present example of embodiment, and wireless base station 10 may also have other functional blocks necessary for wireless communications. As shown in Figure 17, baseband signal processing unit 104 is provided with control unit 301, transmission signal generation unit 302, mapping unit 303, received signal processing unit 304, and measurement unit 305.
- (0154) Control unit 301 will perform control of the entirety of wireless base station 10. Control unit 301 controls, for example, the generation of DL signals by transmission signal generation unit 302, mapping of DL signals by mapping unit 303, reception processing of UL signals by received signal processing unit 304 (such as demodulation, etc.), and measurement by measurement unit 305.
- (0155) More specifically, control unit 301 performs scheduling of user terminal 20. Specifically, control unit 301 may perform scheduling and/or retransmission control of the downlink data channel and/or the uplink data channel based on the UCI (such as CSI and/or BI) from user terminal 20.
- (0156) Control unit 301 may also control the configuration (format) of the uplink control channel (such as long PUCCH and/or short PUCCH), and may control the transmission of control information about the uplink control channel.
- (0157) Control unit 301 may also control the intra-slot frequency hopping and/or inter-slot frequency hopping of uplink control channels (such as long PUCCH and/or short PUCCH) that span one or more slots. In particular, control unit 301 may control the generation and/or transmission of the frequency resource information.

- (0158) Control unit 301 may also control intra-slot frequency hopping and/or inter-slot frequency hopping of the uplink data channel (such as PUSCH) that span one or more slots. In particular, control unit 301 may control the generation and/or transmission of the frequency resource information.
- (0159) Control unit 301 may also control the generation and/or transmission of the PUCCH resource set.
- (0160) Control unit 301 may control received signal processing unit 304 such that it will perform the reception processing of UCI from user terminal 20 based on the format of the uplink control channel.
- (0161) Control unit 301 may be constructed of a controller, control circuit, or controller described based on the common knowledge in the art pertaining to the present invention.
- (0162) Transmission signal generation unit 302 will generate a DL signal (including a DL data signal, a DL control signal, and a DL reference signal) based on the instructions from control unit 301, and will output the result to mapping unit 303.
- (0163) Transmission signal generation unit 302 may be a signal generator, a signal generation circuit, or a signal generation device described based on the common knowledge in the art pertaining to the present invention.
- (0164) Mapping unit 303 will map the DL signals generated by transmission signal generation unit 302 to a predetermined radio resource, and will output the result to transmitting and receiving unit 103 based on the instructions from control unit 301. Mapping unit 303 may be a mapper, mapping circuit, or mapping device described based on the common knowledge in the art pertaining to the present invention.
- (0165) Received signal processing unit 304 will perform the reception and processing (such as demapping, demodulation, and decoding, etc.) of UL signals (such as including UL data signals, UL control signals, and UL reference signals) transmitted from user terminal 20. More specifically, received signal processing unit 304 may output the received signal or the signal after performing reception and processing to measurement unit 305. In addition, received signal processing unit 304 will perform the reception and processing of the UCI based on the uplink control channel configuration as instructed by control unit 301.

- (0166) Measurement unit 305 will perform the measurement of the received signal. Measurement unit 305 may be constructed of a measuring device, measuring circuit, or measuring device described based on the common knowledge in the art pertaining to the present invention.
- (0167) Measurement unit 305 may measure the channel quality of the UL, for example, based on the received power (such as the Reference Signal Received Power (RSRP)) and/or received quality (such as Reference Signal Received Quality (RSRQ)) of the UL reference signal. The measurement results may also be outputted to control unit 301.
- (0168) <User terminal>
Figure 18 is a diagram illustrating an example of the overall configuration of a user terminal pertaining to the present example of embodiment. User terminal 20 is provided with a plurality of transmitting and receiving antenna 201 for MIMO transmission, amplifier unit 202, transmitting and receiving unit 203, baseband signal processing unit 204, and application unit 205.
- (0169) The radio frequency signals received at the plurality of transmitting and receiving antenna 201 will be amplified in each amplifier unit 202. Each transmitting and receiving unit 203 will receive the DL signal that was amplified in amplifier unit 202. Transmitting and receiving unit 203 will convert the received signal to a baseband signal frequency and will output it to baseband signal processing unit 204.
- (0170) Baseband signal processing unit 204 will perform FFT processing, error correction decryption, and reception processing of retransmission control, etc., of the baseband signal that was inputted. The DL data will be transferred to application unit 205. Application unit 205 will perform the processing of the higher layers above the physical layer and the MAC layer, etc. The broadcast information may also be forwarded to application unit 205.
- (0171) On the other hand, the uplink (UL) data will be inputted from application unit 205 to baseband signal processing unit 204. In baseband signal processing unit 204, transmission processing of the retransmission control (such as transmission processing of HARQ), channel encoding, rate matching, punctuation, Discrete Fourier Transform (DFT) processing, IFFT processing, and the like will be performed, and the result will be transferred to each transmitting and receiving

unit 203. For UCI as well, at least one of channel encoding, rate matching, punctuation, DFT processing, and IFFT processing will be performed, and the result will be transferred to each transmitting and receiving unit 203.

- (0172) Transmitting and receiving unit 203 will convert and transmit the baseband signal that was outputted from baseband signal processing unit 204 into a radio frequency band. The radio frequency signal that underwent frequency conversion in transmitting and receiving unit 203 will be amplified by amplifier unit 202 and transmitted from transmitting and receiving antenna 201.
- (0173) Transmitting and receiving unit 203 will also receive the downlink (DL) signal (including a DL data signal, a DL control signal, and a DL reference signal) of the numerology that was configured in user terminal 20, and will transmit the UL signal (including a UL data signal, a UL control signal, and a UL reference signal) for said numerology.
- (0174) Transmitting and receiving unit 203 will also send an uplink data channel (such as PUSCH) and/or uplink control channel (such as short PUCCH and/or long PUCCH).
- (0175) Transmitting and receiving unit 203 will also receive the control information (upper layer control information) through higher layer signaling and downlink control information (DCI) through physical layer signaling. In particular, transmitting and receiving unit 203 will receive the frequency resource information (first aspect of the present invention). Also, transmitting and receiving unit 203 may receive, through upper layer signaling, a plurality of parameter sets (PUCCH resource sets) that each contain the frequency resource information, and may receive the downlink control information indicating one of said plurality of parameter sets (fourth aspect of the present invention). Also, transmitting and receiving unit 203 may receive the downlink control information containing the frequency resource information described above (fifth aspect of the present invention).
- (0176) Transmitting and receiving unit 203 may be constructed of a transmitter/receiver, transmitting and receiving circuit, or transceiver that will be described based on the common knowledge in the art pertaining to the present invention. Transmitting and receiving unit 203 may also be configured as an integrated transmitting and receiving part, or it may be constructed of a transmitting part and a receiving part.

- (0177) Figure 19 is a diagram illustrating an example of the functional configuration of a user terminal pertaining to the present example of embodiment. Figure 19 primarily shows the functional blocks of the characteristic parts of the present example of embodiment, and user terminal 20 may also have other functional blocks necessary for wireless communications. As shown in Figure 19, baseband signal processing unit 204 in user terminal 20 is provided with control unit 401, transmission signal generation unit 402, mapping unit 403, received signal processing unit 404, and measurement unit 405.
- (0178) Control unit 401 performs control of the entirety of user terminal 20. Control unit 401 controls, for example, the generation of UL signals by transmission signal generation unit 402, mapping of UL signals by mapping unit 403, reception processing of UL signals by received signal processing unit 404, and measurement by measurement unit 405.
- (0179) Control unit 401 also controls the uplink control channel used to transmit UCI from user terminal 20 based on explicit instructions from wireless base station 10 or implied decisions in user terminal 20.
- (0180) Control unit 401 may also control the configuration (format) of the uplink control channel (such as long PUCCH and/or short PUCCH). Control unit 401 may control the format of the uplink control channel based on control information from wireless base station 10.
- (0181) Control unit 401 may also control the transmission of uplink control channels (such as long PUCCH and/or short PUCCH) that span one or more slots. More specifically, control unit 401 may control the frequency hopping of the uplink control channel in each slot based on information about the frequency resources (FH information in the slot) to which the uplink control channel has been mapped.
- (0182) Control unit 401 may also control the frequency hopping of the uplink control channel between a plurality of slots.
- (0183) More specifically, control unit 401 may control the frequency hopping (inter-slot frequency hopping) of the uplink control channel between a plurality of slots based on information about the frequency resources (frequency resource information) to which the uplink control channel has been mapped (first aspect of the present invention).

- (0184) Also, if control unit 401 receives a plurality of parameter sets that each contain the frequency resource information through higher layer signaling, it may control the frequency hopping of the uplink control channel between said plurality of slots based on one of said plurality of parameter sets specified by the downlink control information (fourth aspect of the present invention).
- (0185) Control unit 401 may also control the frequency hopping (inter-slot frequency hopping) of the uplink control channel between multiple slots based on the information about the frequency resources that may be used when frequency hopping (intra-slot frequency hopping) is applied in the slot (intra-slot FH information) (second aspect of the present invention).
- (0186) Here, the information about the frequency resources (the frequency resource information and/or the intra-slot FH information) may include information indicating either a frequency offset for the frequency resource of the previous hop, a frequency offset for the frequency resource set through higher layer signaling, or a frequency offset for the edge of the frequency band set at the user terminal.
- (0187) Control unit 401 may control the inter-slot frequency hopping of the uplink control channel based on information indicating whether frequency hopping (intra-slot frequency hopping) in each slot or frequency hopping (inter-slot frequency hopping) between a plurality of slots will be applied when the uplink control channel is transmitted across a plurality of slots.
- (0188) Control unit 401 may also control the transmission of an uplink data channel (such as PUSCH) across one or more slots. More specifically, control unit 401 may control the frequency hopping of the uplink data channel in each slot based on information about the frequency resource (FH information in the slot) to which the uplink data channel has been mapped.
- (0189) Control unit 401 may also control the frequency hopping of the uplink data channel between a plurality of slots.

- (0190) More specifically, control unit 401 may control the frequency hopping (inter-slot frequency hopping) of the uplink data channel between a plurality of slots based on information about the frequency resources (frequency resource information) to which the uplink data channel has been mapped (first aspect of the present invention).
- (0191) Control unit 401 may also control frequency hopping (inter-slot frequency hopping) of the uplink data channel between a plurality of slots based on the downlink control information when receiving said downlink control information containing the above-noted information about the frequency resources (fifth aspect of the present invention).
- (0192) Control unit 401 may also control the frequency hopping (inter-slot frequency hopping) of the uplink control channel between multiple slots based on the information about the frequency resources that may be used when frequency hopping (intra-slot frequency hopping) is applied in the slot (intra-slot FH information) (second aspect of the present invention).
- (0193) Here, the information about the frequency resources (the frequency resource information and/or the intra-slot FH information) may include information indicating either a frequency offset for the frequency resource of the previous hop, a frequency offset for the frequency resource set through higher layer signaling, or a frequency offset for the edge of the frequency band set at the user terminal.
- (0194) Control unit 401 may control the inter-slot frequency hopping of the uplink data channel based on information indicating whether frequency hopping (intra-slot frequency hopping) in each slot or frequency hopping (inter-slot frequency hopping) between a plurality of slots will be applied when the uplink data channel is transmitted across a plurality of slots.
- (0195) Control unit 401 may also determine the PUCCH resources to be used in the PUCCH format based on the upper layer signaling and/or downlink control information.
- (0196) Control unit 401 may control at least one of transmission signal generation unit 402, mapping unit 403, and transmitting and receiving unit 203 in order to perform the transmission processing of the UCI based on the PUCCH format.

- (0197) Control unit 401 may be constructed of a controller, control circuit, or controller described based on the common knowledge in the art pertaining to the present invention.
- (0198) Transmission signal generation unit 402 will generate (such as encoding, rate matching, puncture, or modulation, etc.) the UL signals (including UL data signals, UL control signals, UL reference signals, and UCI) based on the instructions from control unit 401 and will output the results to mapping unit 403. Transmission signal generation unit 402 may be a signal generator, a signal generation circuit, or a signal generation device described based on the common knowledge in the art pertaining to the present invention.
- (0199) Mapping unit 403 will map the UL signals generated by transmission signal generation unit 402 to a radio resource, and will output the result to transmitting and receiving unit 203 based on the instructions from control unit 401. Mapping unit 403 may be a mapper, mapping circuit, or mapping device described based on the common knowledge in the art pertaining to the present invention.
- (0200) Received signal processing unit 404 will perform reception and processing (such as demapping, demodulation, or decoding, etc.) of the DL signals (DL data signals, scheduling information, DL control signals, and DL reference signals). Received signal processing unit 404 will output the information that was received from wireless base station 10 to control unit 401. Received signal processing unit 404 will output, for example, notification information, system information, upper layer control information through higher layer signaling such as RRC signaling, and physical layer control information (L1/L2 control information), or the like to control unit 401.
- (0201) Received signal processing unit 404 may be composed of a signal processor, signal processing circuit, or signal processing device described based on the common knowledge in the art pertaining to the present invention. In addition, received signal processing unit 404 may constitute a receiving unit according to the present invention.
- (0202) Measurement unit 405 will measure the channel status based on a reference signal (such as CSI-RS) from wireless base station 10 and will output the measurement results to control unit 401. Measurement of the channel status may be performed for each CC.

- (0203) The measurement unit 405 may be composed of a signal processor, signal processing circuit, or signal processing apparatus, or a measurement device, measurement circuit or measurement device that may be described based on the common knowledge in the art pertaining to the present invention.
- (0204) <Hardware configuration>
- The block diagram used in the description of the above-noted examples of embodiment shows blocks of functional units. These functional blocks (components) may be realized by any combination of hardware and/or software. In addition, there are no particular restrictions on the method of realizing each function block. In other words, each functional block may be realized using one physically and/or logically coupled device, or may be directly and/or indirectly (such as using wired and/or wireless) connected to two or more physically and/or logically separated devices, and implemented using these multiple devices.
- (0205) For example, a wireless base station, and user terminal, etc., in one example of embodiment of the present invention may also function as a computer for processing the wireless communication method according to the present invention. Figure 20 is a diagram illustrating an example of the hardware configuration of a wireless base station and a user terminal pertaining to the present example of embodiment; Wireless base station 10 and user terminal 20 described above may be physically configured as a computer device including processor 1001, memory 1002, storage 1003, communication apparatus 1004, input apparatus 1005, output apparatus 1006, and bus 1007, etc.
- (0206) In the following description, the term “apparatus” may be replaced with terms such as circuit, device, or unit, etc. The hardware configuration of wireless base station 10 and user terminal 20 may be configured to include one or more of each of the devices shown in the diagram, or it may be configured without some of the devices.
- (0207) For example, although only one processor 1001 is illustrated, it is also acceptable to have multiple processors. The processing may also be performed by one processor, or the processing may be performed by one or more processors simultaneously, sequentially, or using other methods. Processor 1001 may be also be mounted using one or more chips.

- (0208) Each function in wireless base station 10 and user terminal 20 may be realized, for example, by causing processor 1001 to load the predetermined software (programs) on hardware such as the processor 1001, memory 1002, and the like, to perform operations to control communication via communication apparatus 1004, or to control read and/or write data in memory 1002 and storage 1003.
- (0209) Processor 1001, for example, may operate an operating system to control the entire computer. Processor 1001 may be constructed of a Central Processing Unit (CPU) that contains an interface with the peripheral device, a controller, a computing device, a register, and the like. For example, baseband signal processor 104 (204) and call processor 105, etc., as described above may be realized by processor 1001.
- (0210) Processor 1001 will also read out the programs (program code), software modules, data, etc., from storage 1003 and/or communication apparatus 1004 to memory 1002 in order to perform various processing accordingly. As this program, it is acceptable to use a program that causes the computer to perform at least a portion of the operations described in the above-noted examples of embodiment. For example, control unit 401 of user terminal 20 may be realized by a control program stored in memory 1002 and operated by processor 1001, and it may also be realized by other functional blocks as well.
- (0211) Memory 1002 is a computer-readable recording medium, which may be composed of at least one of, for example, ROM (Read Only Memory), EPROM (Erasable Programmable ROM), EEPROM (Electrically EPROM), RAM (Random Access Memory), and other suitable storage medium. Memory 1002 may also be referred to as a register, cache, or main memory (main storage apparatus), etc. Memory 1002 may store the executable programs (program code), software modules, and the like for implementing the wireless communication method according to one example of embodiment of the present invention.

- (0212) Storage 1003 is a computer-readable recording medium, which may be composed of at least one of a flexible disk, a floppy (registered trademark) disk, an optical magnetic disc (such as a compact disc (CD-ROM (Compact Disc ROM), etc.), a digital versatile disc, a Blu-ray (registered trademark) disc), a removable disk, a hard disk drive, a smart card, a flash memory device (such as card, stick, key drive), a magnetic stripe, a database, a server, or another suitable storage medium. Storage 1003 may also be referred to as an auxiliary storage apparatus.
- (0213) Communication apparatus 1004 is hardware (transmitting and receiving device) to perform communications between computers over a wired and/or wireless network, such as for example, network devices, network controllers, network cards, or communication modules, and the like. Communication apparatus 1004 may include a high frequency switch, duplexer, filter, or frequency synthesizer, and the like in order to realize, for example, frequency division duplex (FDD) and/or time division duplex (TDD). For example, the above-noted transmitting and receiving antenna 101 (201), amplifier 102 (202), transmitting and receiving unit 103 (203), transmission line interface 106, and the like may be realized by communication apparatus 1004.
- (0214) Input apparatus 1005 is an input device (such as a keyboard, a mouse, a microphone, a switch, a button, or a sensor, etc.) that can receive input from an external source. Output apparatus 1006 is an output device (such as a display, speaker, or LED (Light Emitting Diode) lamp, etc.) that performs output to an external unit. Input apparatus 1005 and output apparatus 1006 may also have an integral configuration (such as a touch panel).
- (0215) Each apparatus, such as processor 1001 and memory 1002 may also be connected by bus 1007 in order to communicate information. Bus 1007 may be configured as a single bus or it may be configured with different buses between devices.

- (0216) Wireless base station 10 and user terminal 20 may also include hardware such as a microprocessor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Programmable Logic Device (PLD), a Field Programmable Gate Array (FPGA), and the like, and some or all of each functional block may be realized using this hardware. For example, processor 1001 may be implemented using at least one of these hardware.
- (0217) (Variants)
- It should be noted that the terms described in this Specification and/or the terms required to understand this Specification may be replaced with terms having the same or similar meaning. For example, the channel and/or symbol may be a signal (signaling). The signal may also be a message. Reference signals may be abbreviated as RS (Reference Signal), or may be referred to as pilots or pilot signals, etc., according to applicable standards. Component carriers (CC) may also be referred to as cells, frequency carriers, or carrier frequencies, etc.
- (0218) The radio frame may also be configured by one or more time periods (frames) within the time domain. Each time period (frame) of the one or more radio frames may be referred to as a subframe. Further, a subframe may be constructed of one or more slots within the time domain. The subframe may have a fixed time length (such as 1 ms) that is independent of the numerology.
- (0219) Furthermore, the slot may be composed of one or more symbols (such as OFDM (Orthogonal Frequency Division Multiplexing) symbols, or SC-FDMA (Single Carrier Frequency Division Multiple Access) symbols) within the time domain. The slots may also be time units based on the numerology. A slot may

also include a plurality of minislots. Each minislot may be constructed of one or more symbols within a time domain. A minislot may also be referred to as a subslot.

- (0220) The radio frames, subframes, slots, minislots, and symbols all represent time units when transmitting signals. The radio frames, subframes, slots, minislots, and symbols may each use another corresponding designation. For example, one subframe may be referred to as a transmission time interval (TTI), multiple consecutive subframes may be referred to as a TTI, and one slot or one minislot may be referred to as a TTI. In other words, the subframe and/or TTI may be a subframe (1 ms) in an existing LTE, it may be a shorter period of time than 1 ms (such as a 1–13 symbol), or it may be a longer period of time than 1 ms. The units representing TTI may be referred to as slots or minislots, etc., rather than as subframes.
- (0221) Here, TTI refers to, for example, the minimum time unit of scheduling in wireless communication. For example, in an LTE system, a wireless base station will assign the radio resources (frequency bandwidth, transmission power, etc. that can be used at each user terminal) to each user terminal in units of TTI. The definition of TTI is not limited to this example.
- (0222) The TTI may be a transmission time unit for channel-coded data packets (transport blocks), code blocks, and/or codewords, or it may be a processing unit such as scheduling, link adaptation, and the like. When a TTI is given, the time interval (such as number of symbols) over which the transport block, code block, and/or codeword are actually mapped may be shorter than the TTI.
- (0223) If one slot or one minislot is referred to as a TTI, one or more TTI (in other words, one or more slots or one or more minislots) may be the minimum time unit

for scheduling. The number of slots (minislots) that constitute the minimum time unit of the scheduling may also be controlled.

- (0224) A TTI having a time length of 1 ms may be referred to as a conventional TTI (TTI in LTE Rel. 8–12), a normal TTI, a long TTI, a conventional subframe, a normal subframe, or a long subframe, etc. A TTI that is shorter than the conventional TTI may be referred to as a shortened TTI, short TTI, partial or fractional TTI, shortened subframe, short subframe, minislots, or subslot.
- (0225) It should be noted that a long TTI (such as the conventional TTI or subframe, etc.) may be replaced with a TTI having a time length that is greater than 1 ms, and a short TTI (such as a shortened TTI, etc.) may be replaced with a TTI having a TTI length that is less than the TTI length of a long TTI and greater than or equal to 1 ms.
- (0226) The resource block (RB) is a resource allocation unit for the time and frequency regions, and it may include one or more consecutive subcarriers (subcarrier (subcarrier)) in the frequency region. The RB may also include one or more symbols in the time domain, and may be one slot, one minislot, one subframe, or one TTI in length. A single TTI or a single subframe may also each be constructed of one or more resource blocks. One or more RB may be referred to as a Physical RB (PRB), Sub-Carrier Group (SCG), Resource Element Group (REG), PRB pair, or RB pair, etc.
- (0227) The resource block may also be constructed of one or more resource elements (RE). For example, a single RE may be a radio resource region of a single subcarrier and a single symbol.
- (0228) It should be noted that the structures described above, such as the radio frames, subframes, slots, minislots, and symbols, are no more than examples. For example, the number of subframes contained in the radio frame, the number of slots per subframe or radio frame, the number of minislots contained in the slot, the number

of symbols and RBs contained in the slot or minislot, the number of subcarriers contained in the RB, and the configuration such as the number of symbols, symbol length, cyclic prefix (CP) length, etc., in the TTI can be varied.

- (0229) The information and parameters, etc., described in this Specification may also be represented using absolute values, relative values from predetermined values, or other corresponding information. For example, the radio resource may be directed by a predetermined index.
- (0230) The names used in this Specification for the parameters, etc., are not limited in any respect. For example, because various channels (such as PUCCH (Physical Uplink Control Channel), PDCCH (Physical Downlink Control Channel)) and information elements can be identified by any suitable name, the various names assigned to these various channels and information elements are not in any way limited names.
- (0231) The information, signals, and the like described in this Specification may be represented using any of a variety of different techniques. For example, the data, instructions, commands, information, signals, bits, symbols, chips, etc., that may be mentioned throughout the description above may be represented by voltage, current, electromagnetic waves, magnetic or magnetic particles, light fields or photons, or any combination thereof.
- (0232) In addition, the information, signals, and the like may be outputted from the upper layer to the lower layer and/or from the lower layer to the upper layer. The information and signals, etc., may be inputted or outputted via a plurality of network nodes.
- (0233) The information or signals, etc., that were inputted or outputted may be stored at a particular location (such as memory) or may be managed using a management table. The information or signals, etc., that were inputted or outputted may be overwritten, updated, or added. The outputted information or signals, etc., may also be deleted. The inputted information or signals, etc., may also be transmitted to other devices.

- (0234) Notification of information is not limited to the aspects/examples of embodiment described in this Specification, and may be made using other methods. For example, the notification of information may be performed by physical layer signaling (such as Downlink Control Information (DCI), Uplink Control Information (UCI)), higher layer signaling (such as RRC (Radio Resource Control) signaling, broadcast information (such as Master Information Block (MIB), System Information Block (SIB), Medium Access Control (MAC) signaling), other signals, or combinations thereof.
- (0235) Physical layer signaling may be referred to as L1/L2 (Layer 1/Layer 2) control information (L1/L2 control signals), or L1 control information (L1 control signals), and the like. RRC signaling may also be referred to as an RRC message, such as an RRC Connection Setup (RRCConnectionSetup) message, or an RRC Connection Reconfiguration (RRCConnectionReconfiguration) message, etc. Notification of the MAC signaling may also be performed, for example, using a MAC control element (MAC CE).
- (0236) Also, notification of a given piece of information (such as notification of being “X”) is not limited to explicit notification, and it may be made implicitly (such as by not giving notice of the given information or by providing notification of other information).
- (0237) The determination may be made by a value represented by one bit (0 or 1), by a true (true) or false (false) value (boolean), or by a numerical comparison (such as a comparison with a given value).
- (0238) Software, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise, should be broadly interpreted to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executable files, execution threads, procedures, functions, and the like.

- (0239) The software, instructions, information, and the like may also be transmitted and received via a transmission medium. For example, if the software is sent from a website, server, or other remote source using wired technology (such as a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL)) and/or wireless technology (such as infrared, microwave, etc.), these wired and/or wireless technologies are included in the definition of transmission medium.
- (0240) The terms “system” and “network” as used in this Specification may be used interchangeably.
- (0241) In this Specification, the terms “base station (BS),” “wireless base station,” “eNB,” “gNB,” “cell,” “sector,” “cell group,” “carrier,” and “component carrier” may be used interchangeably. A base station may also be referred to as a fixed station NodeB, eNodeB (eNB), access point, transmission point, reception point, transmission/reception point, femtocell, or small cell, etc.
- (0242) The base station may house one or more (such as three) cells (also referred to as sectors). If a base station houses multiple cells, the entire coverage area of the base station may be divided into multiple smaller areas, and each smaller area may also provide communication services by a base station subsystem (such as a remote radio head (RRH)). The term “cell” or “sector” refers to a portion or whole of a coverage area of a base station and/or base station subsystem performing communication services in this coverage.
- (0243) In this Specification, the terms “mobile station (MS),” “user terminal,” “user equipment (UE),” and “terminal” may be used interchangeably.

- (0244) The mobile station may be referred to as a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other appropriate term.
- (0245) The base station and/or mobile station may also be referred to as a transmission device, a receiver device, or the like.
- (0246) The wireless base station in this Specification may also be replaced with the term “user terminal.” For example, each aspect/example of embodiment of the present invention may be applied to a configuration in which communications between a wireless base station and a user terminal is replaced by communications between a plurality of user terminals (D2D). In this case, user terminal 20 may have a configuration that includes the functions of wireless base station 10 as described above. In addition, words such as “uplink” and “downlink” may be replaced with “sidelink.” For example, the uplink channel may be replaced with a sidelink channel.
- (0247) Similarly, the user terminal in this Specification may be replaced by a wireless base station. In this case, it is also acceptable to use a configuration in which wireless base station 10 has the functions of user terminal 20 as described above.
- (0248) In this Specification, the operations performed by a base station may in some cases be performed by its upper node. It is clear that the various operations performed for communications with a terminal in a network that includes one or more network nodes having a base station may be performed by a base station, one or more network nodes other than the base station (such as, but not limited to, Mobility Management Entity (MME), Serving-Gateway (S-GW), etc.), or a combination thereof.
- (0249) Each aspect/example of embodiment described in this Specification may be used alone, in combination, or switched in execution. Also, the processing steps, sequences, flowcharts, etc. of each aspect/example of embodiment described in

this Specification may be interchanged, as long as there is no inconsistency. For example, the methods described in this Specification present elements of various steps in an exemplary order, and are not limited to the particular order presented.

- (0250) Each aspect/example of embodiment described in this Specification may be applied to LTE (Long Term Evolution) LTE-A (LTE-Advanced), LTE-B (LTE-Beyond), SUPER 3G, IMT-Advanced, 4G (4th generation mobile communication system), 5G (5th generation mobile communication system), FRA (Future Radio Access), New-RAT (Radio Access Technology), NR (New Radio), NX (New Radio Access), FX (Future generation radio access), GSM (registered trademark) (Global System for Mobile communications), CDMA2000, UMB (Ultra Mobile Broadband), IEEE 802.11 (Wi-Fi (registered trademark)), IEEE 802.16 (WiMAX (registered trademark)), IEEE 802.20, UWB (Ultra-WideBand), Bluetooth (registered trademark), and systems utilizing other suitable wireless communication methods and/or enhanced next generation systems based thereon.
- (0251) The notation of “based on” as used in this Specification does not mean “based only on” unless otherwise specified. In other words, the notation “based on” means both “based only on” and “based at least on.”
- (0252) None of the references to elements using the designation “first” or “second,” etc., as used in this Specification generally limit the amount or order of those elements. These nomenclatures may be used herein as a convenient method of distinguishing between two or more elements. Therefore, reference to the first and second elements does not mean that only two elements can be employed, or that the first element must in some way precede the second element.
- (0253) The term “determination (decision) (determining)” as used in this Specification may encompass a wide variety of operations. For example, a “determination (decision)” may be considered to be a “determination (decision),” such as

calculating, computing, processing, deriving, investigating, looking up (such as searching on a table, database or another data structure), and ascertaining. The “determination (decision)” may also be considered to be a “determination (decision)” of receiving (such as receiving information), transmitting (such as transmitting information), input, output, or accessing (such as accessing data in memory), etc. In addition, “determination (decision)” may be considered to be “determination (decision),” such as resolving, selecting, choosing, establishing, or comparing. In other words, a “determination (decision)” may be considered to be a “determination (decision)” of some kind of action.

- (0254) The terms “connected” and “coupled”, or any variations thereof as used in this Specification may mean any connection or coupling, whether made directly or indirectly, between two or more elements, and may include one or more intermediate elements between the two elements that are “connected” or “coupled.” The coupling or connection between elements may be physical, logical, or a combination thereof. For example, the term “connection” may be replaced with “access.”
- (0255) In this Specification, when two elements are connected, one or more wires, cables, and/or printed electrical connections can be considered to be “connected” or “coupled” to each other, such as using electromagnetic energy having wavelengths in radio frequency regions, microwave regions, and/or light (both visible and invisible) regions, as some non-limiting and non-comprehensive examples.
- (0256) The terms “A and B differ” as used in this Specification may mean that “A and B are mutually different.” Terms such as “separated from” or “coupled with” may be similarly interpreted.
- (0257) If terms such as “including,” “comprising,” and variations thereof are used in this Specification or Scope of Patent Claims, these terms are intended to be as

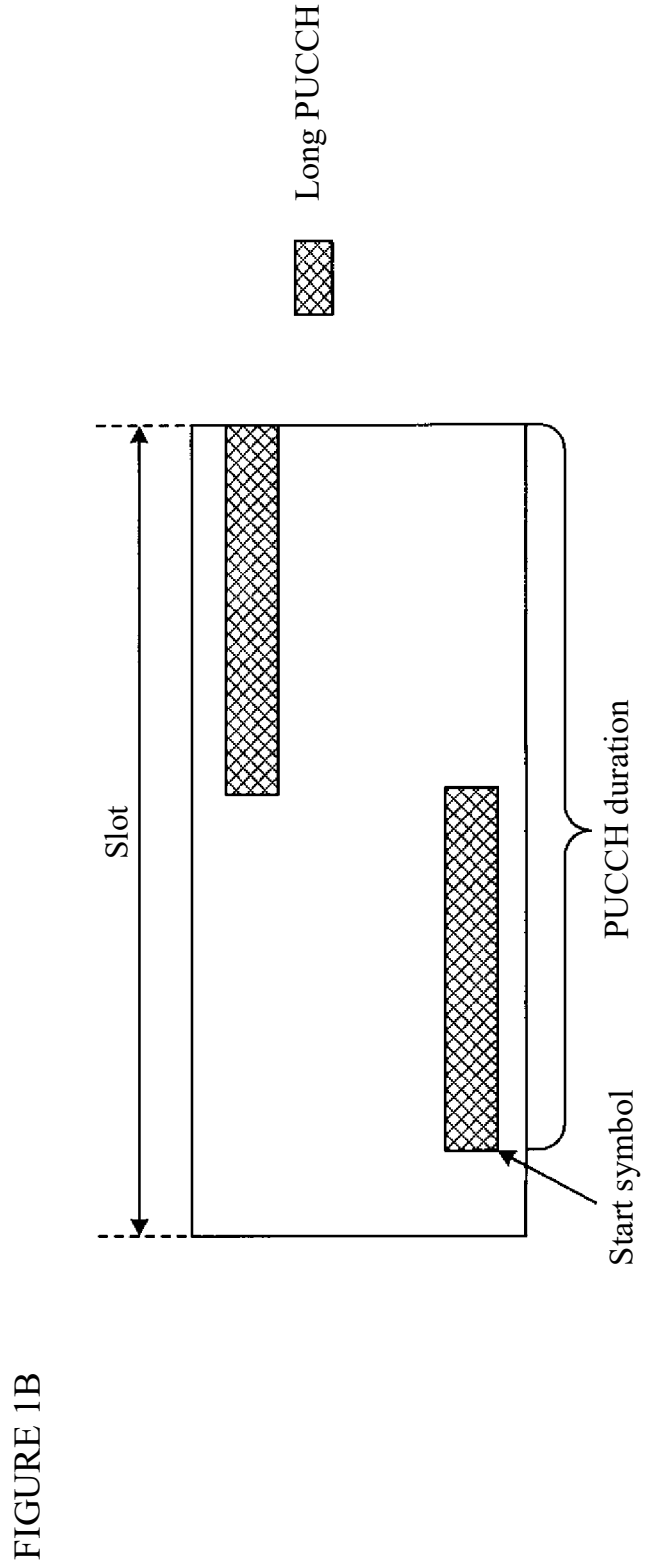
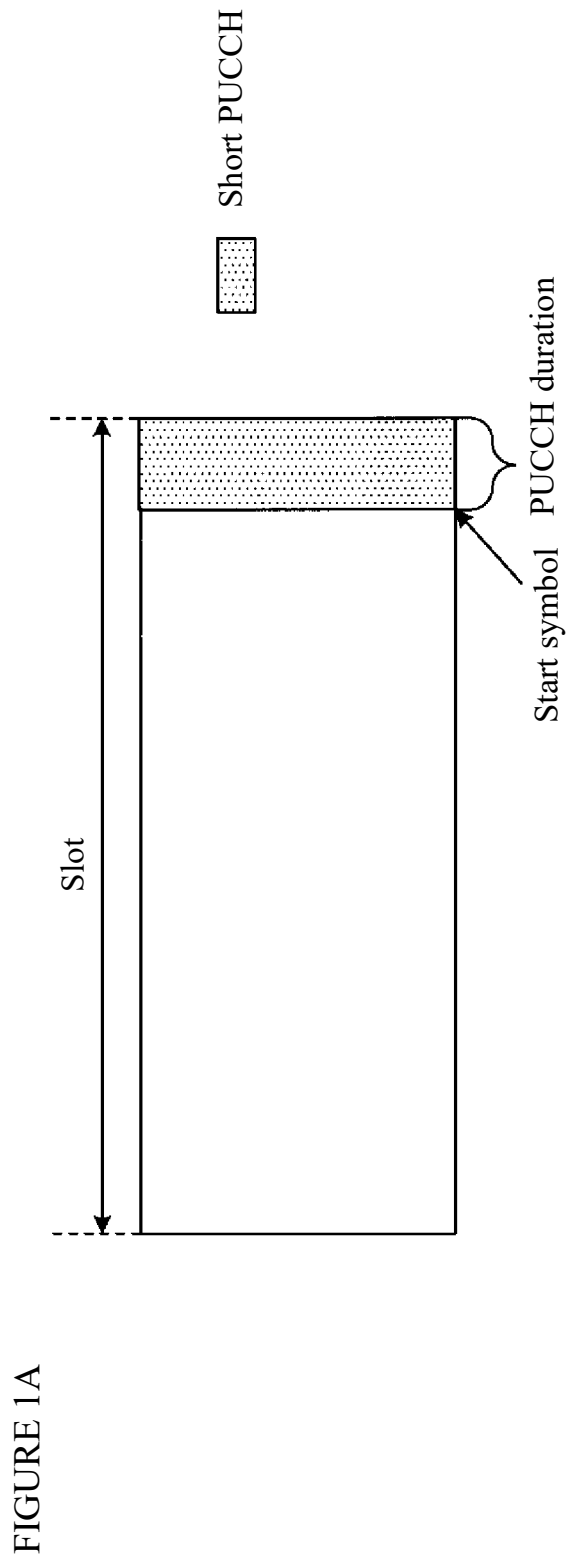
inclusive as the phrase “provided with.” Furthermore, the term “or” as used in this Specification or Scope of Patent Claims is intended not to be an exclusive logical sum.

- (0258) Although the present invention has been described in detail above, it will be apparent to those skilled in the art that the invention is not limited to the example of embodiment described in this Specification. The present invention may be implemented as variants or modified examples of embodiment without departing from the spirit and scope of the present invention as determined based on the description in the Scope of Patent Claims. Therefore, the description in this Specification is intended to provide an illustrative description, and does not give any restrictive meaning to the present invention.

SCOPE OF CLAIMS

- (CLAIM 1) A user terminal characterized in that it is provided with a transmission unit that transmits an uplink data channel across a plurality of slots, and a control unit that controls frequency hopping of said uplink data channel between said plurality of slots.
- (CLAIM 2) The user terminal as described in Claim 1 characterized in that it is further provided with a receiving unit to receive the information related to the frequency resources to which said uplink data channel will be mapped, wherein said control unit will control said frequency hopping of said uplink data channel between said plurality of slots based on said information related to the frequency resources.
- (CLAIM 3) The user terminal as described in Claim 2 characterized in that said receiving unit will receive the downlink control information that contains said information related to the frequency resources, and said control unit will control said frequency hopping of said uplink data channel between said plurality of slots based on said information about the frequency resources.
- (CLAIM 4) The user terminal as described in Claim 1 characterized in that said control unit will control said frequency hopping of said uplink data channel between said plurality of slots based on the information related to the frequency resources that may be used when frequency hopping is applied in a slot.
- (CLAIM 5) The user terminal as described in any one of Claims 2 to 4 characterized in that said information related to the frequency resources includes information indicating either a frequency offset for a frequency resource of a previous hop, a frequency offset for a frequency resource set through higher layer signaling, or a frequency offset for the edge of a frequency band set at said user terminal.
- (CLAIM 6) A wireless communication method in a user terminal characterized in that it has a process to transmit an uplink data channel that spans a plurality of slots, and a process to control the frequency hopping of said uplink data channel between said plurality of slots.

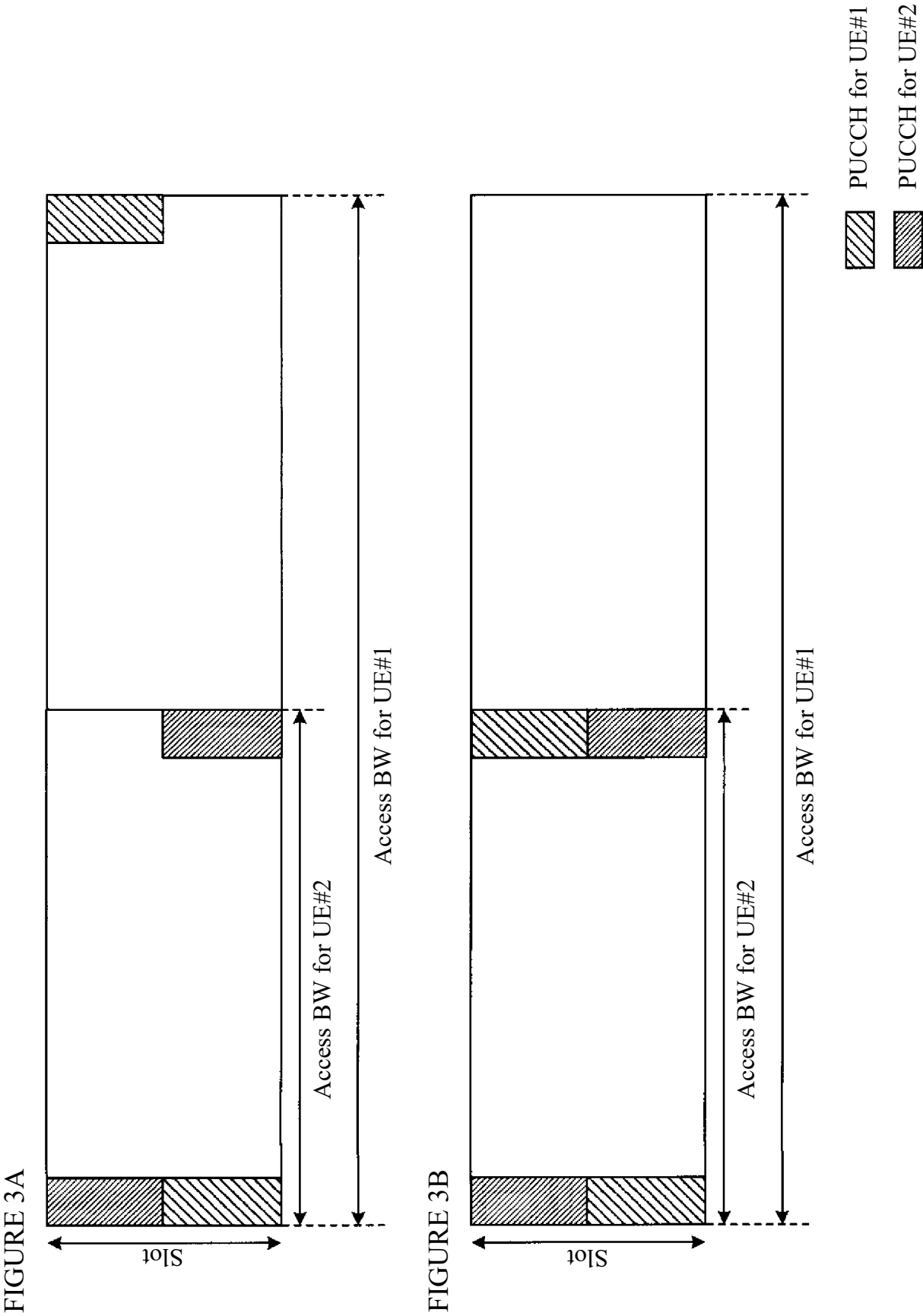
(FIGURE 1)



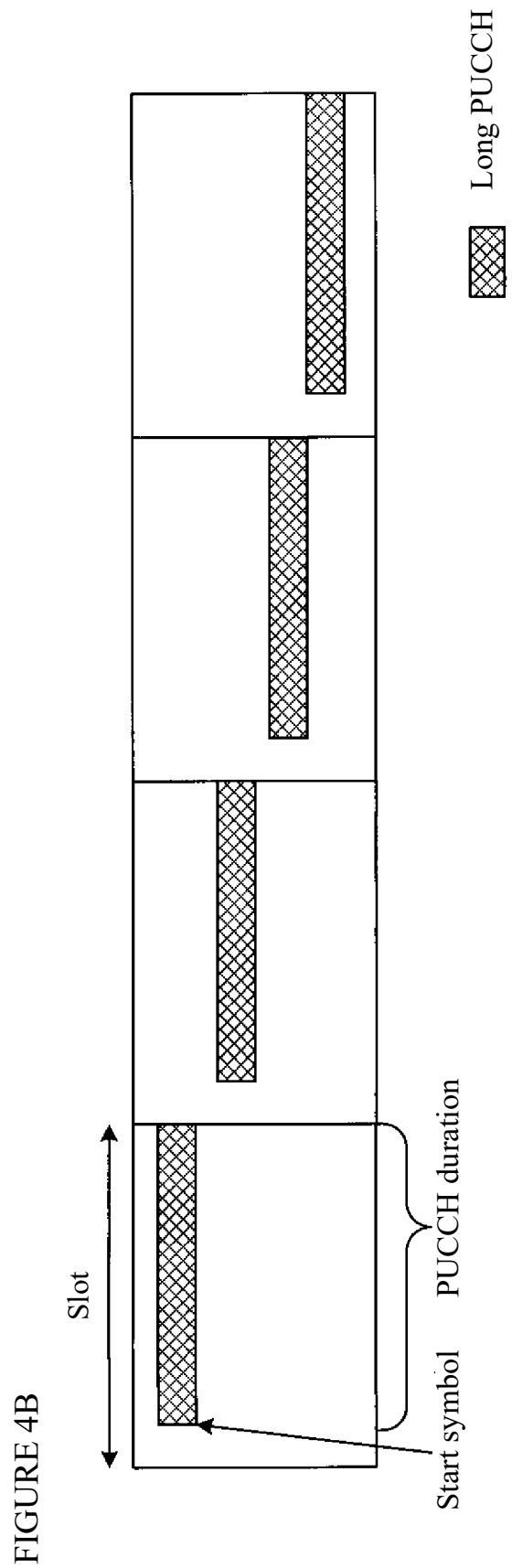
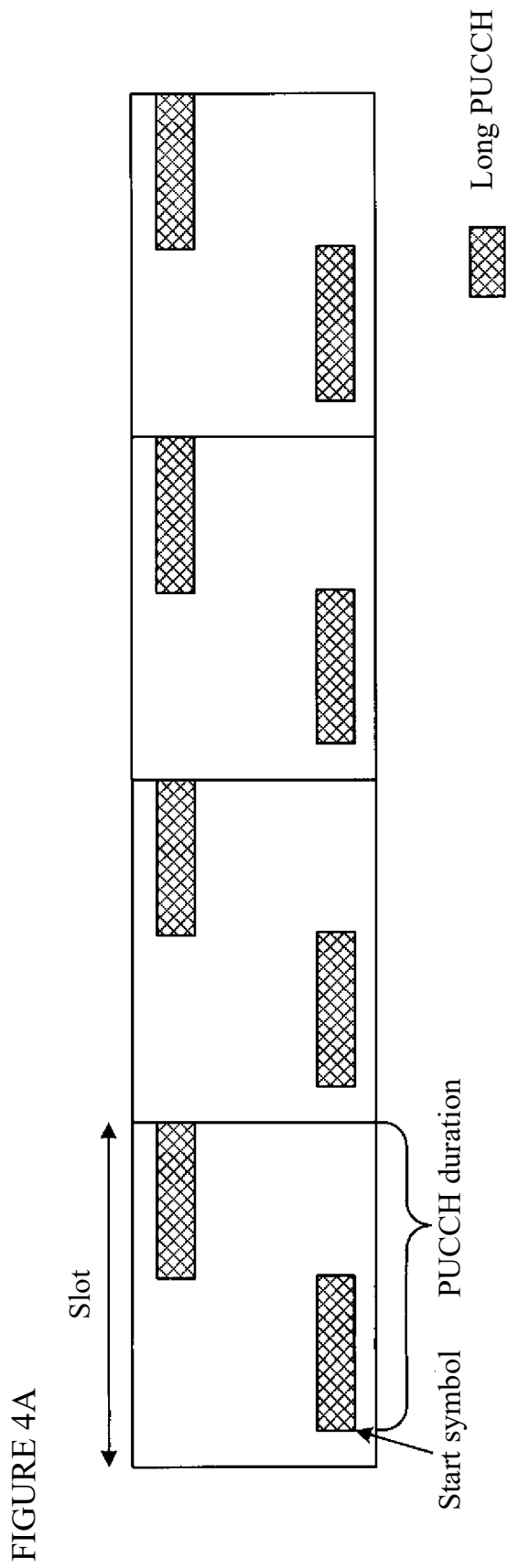
(FIGURE 2)

PUCCH format	Number of symbols	Number of bits
0	1-2	≤ 2
1	4-14	≤ 2
2	1-2	> 2
3	4-14	$> N$
4	4-14	$> 2, < N$

(FIGURE 3)



(FIGURE 4)



(FIGURE 5)

FIGURE 5A

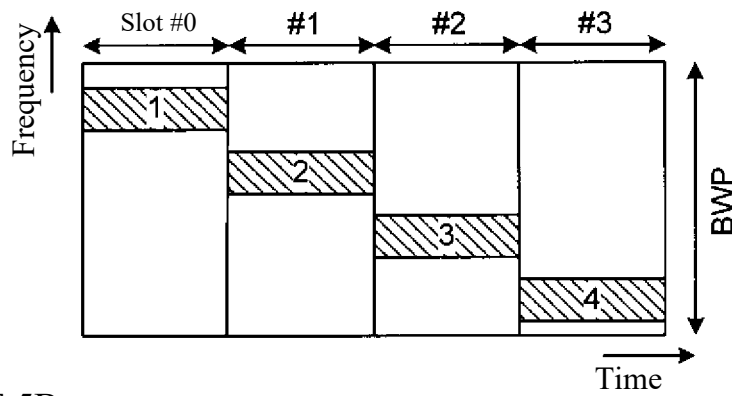


FIGURE 5B

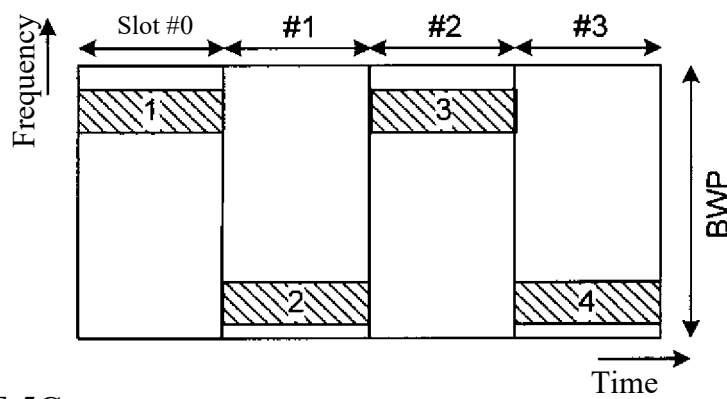


FIGURE 5C

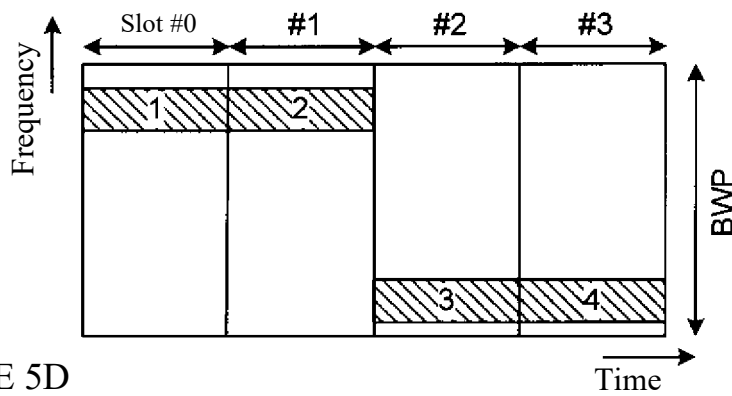
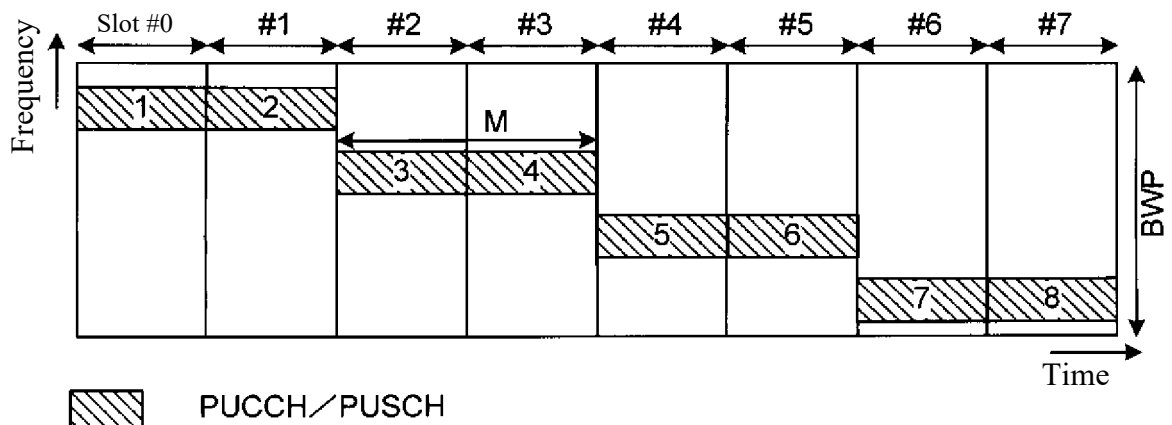


FIGURE 5D



(FIGURE 6)

FIGURE 6A

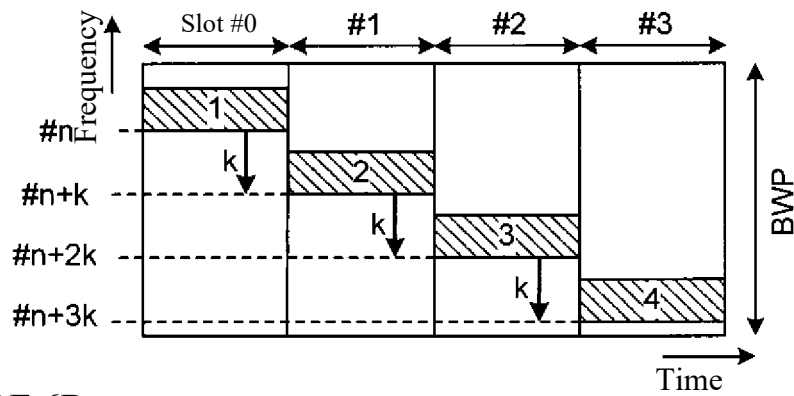


FIGURE 6B

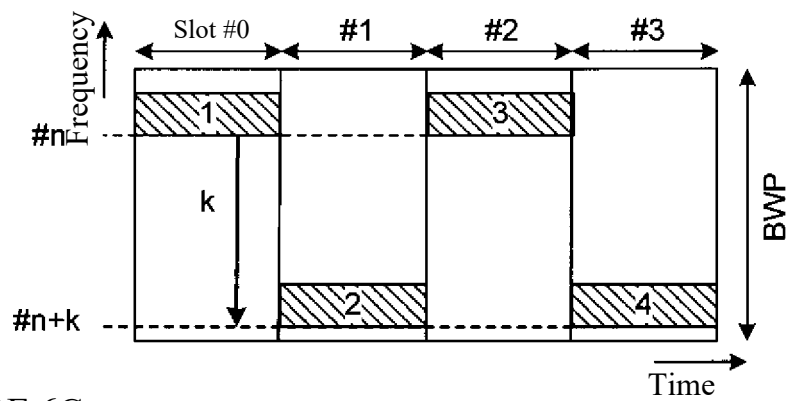


FIGURE 6C

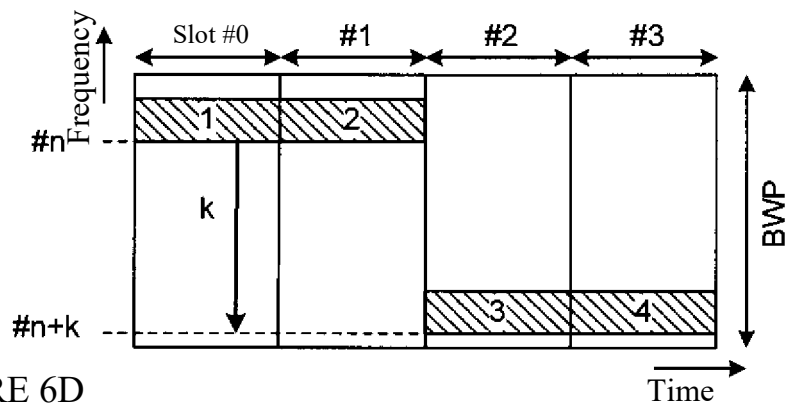
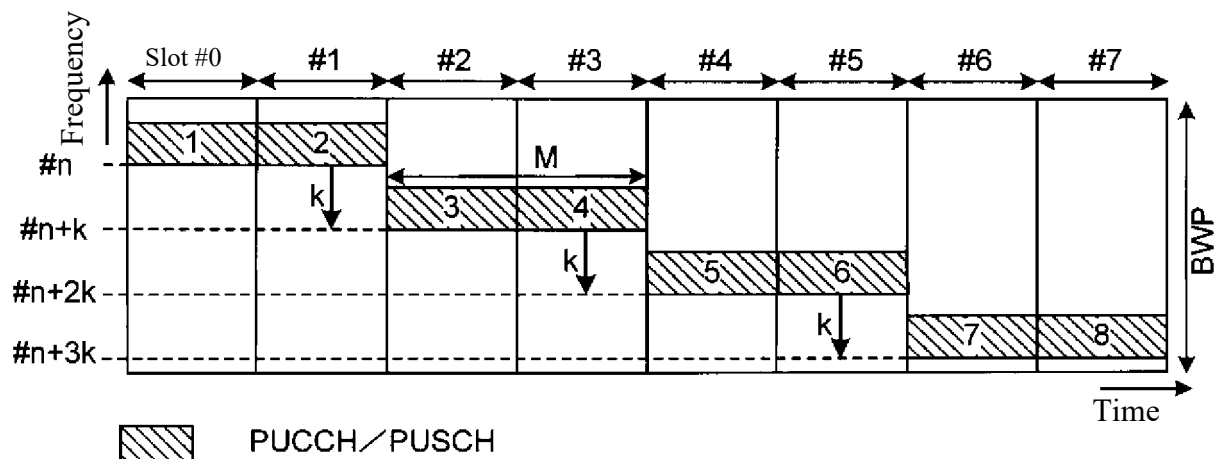


FIGURE 6D



(FIGURE 7)

FIGURE 7A

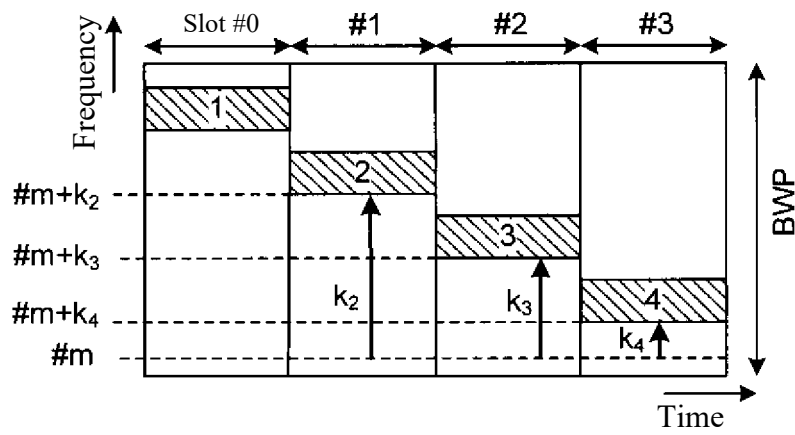


FIGURE 7B

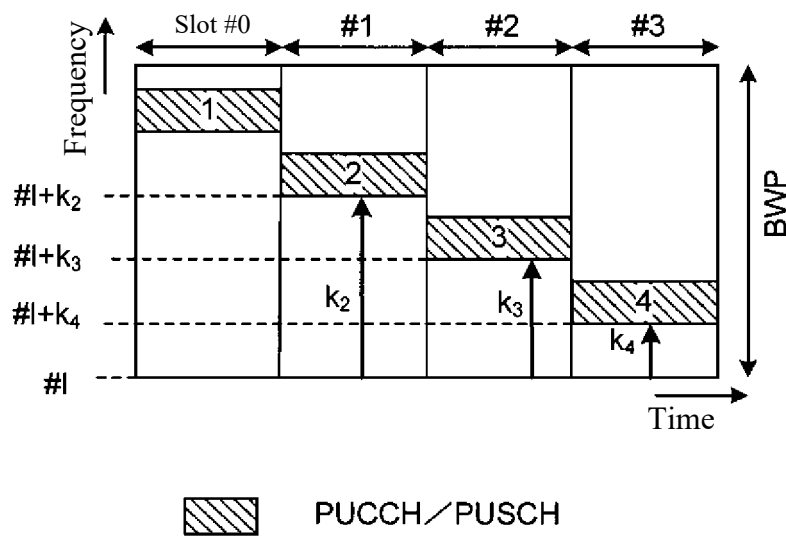


FIGURE 8A



(FIGURE 9)

FIGURE 9A

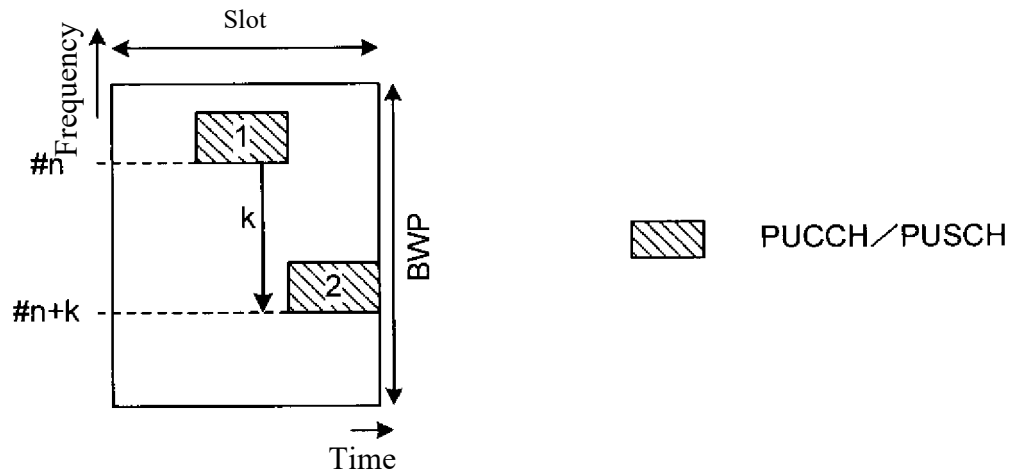


FIGURE 9B

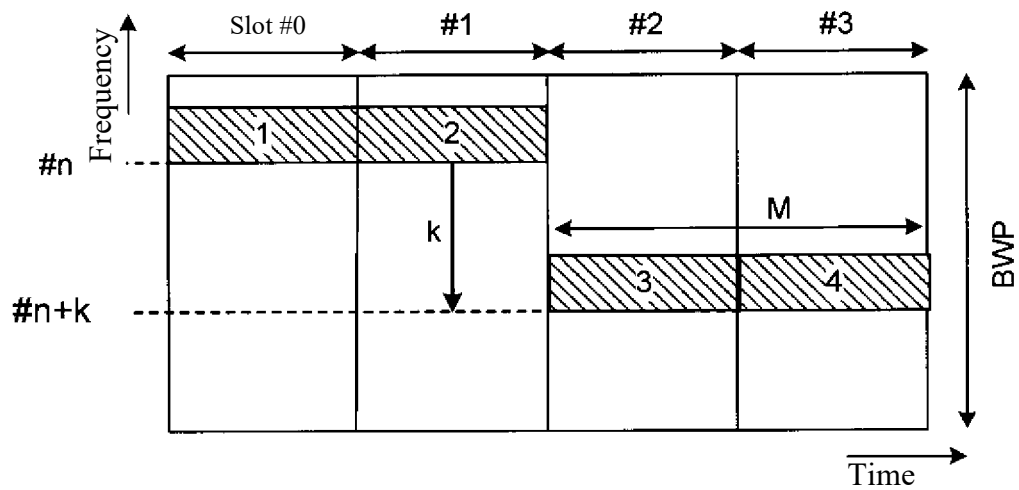
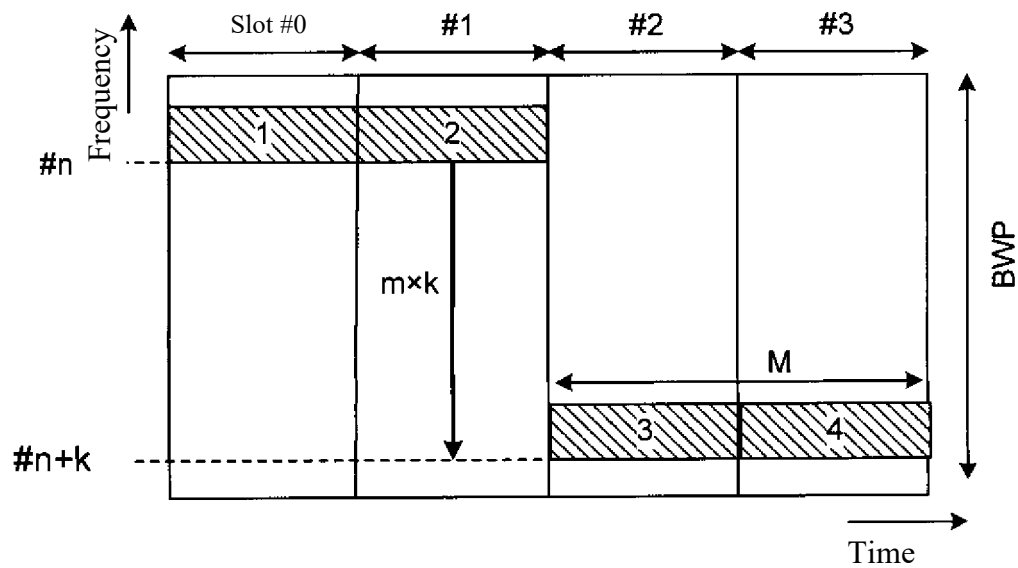
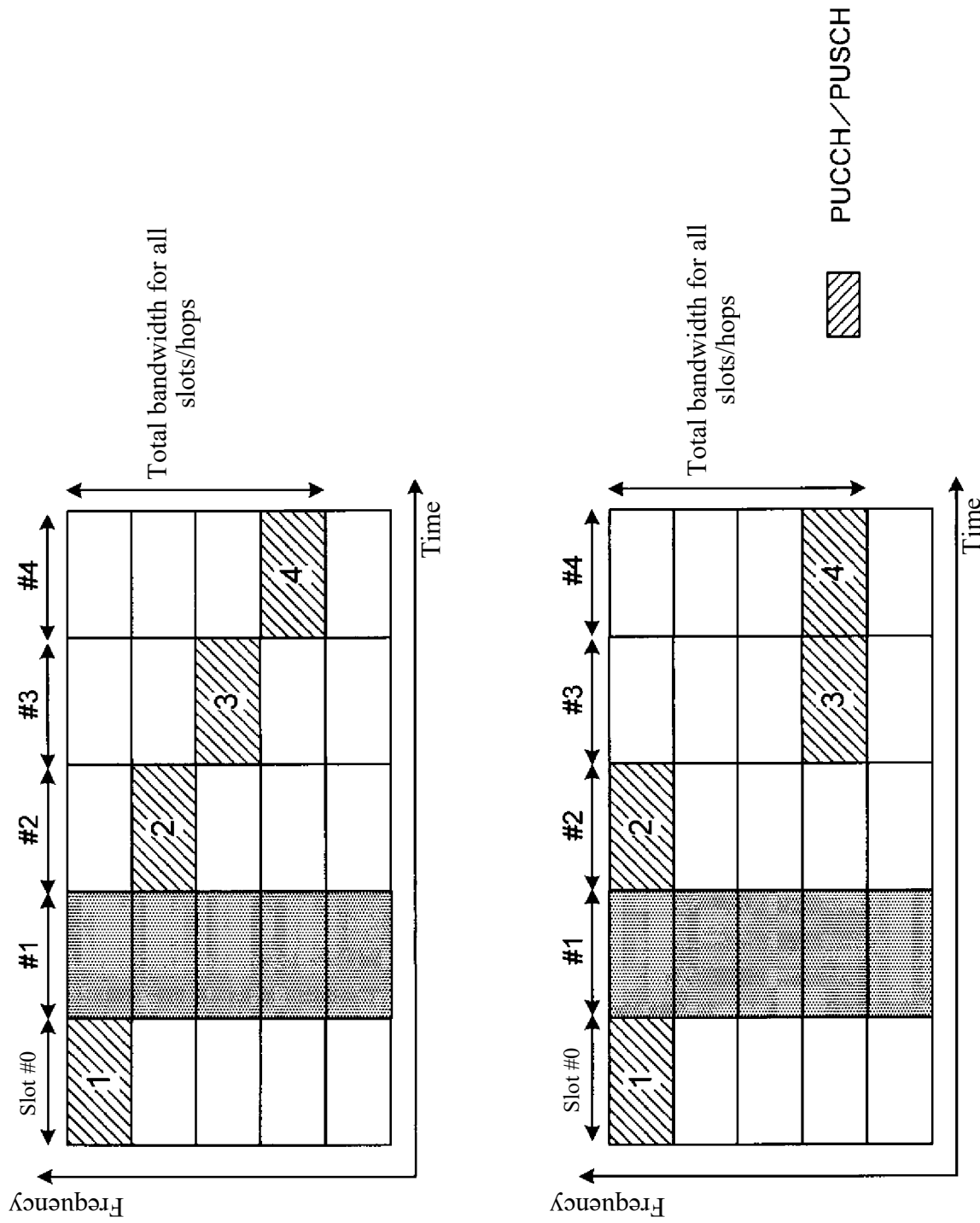


FIGURE 9C



(FIGURE 10)



(FIGURE 11)

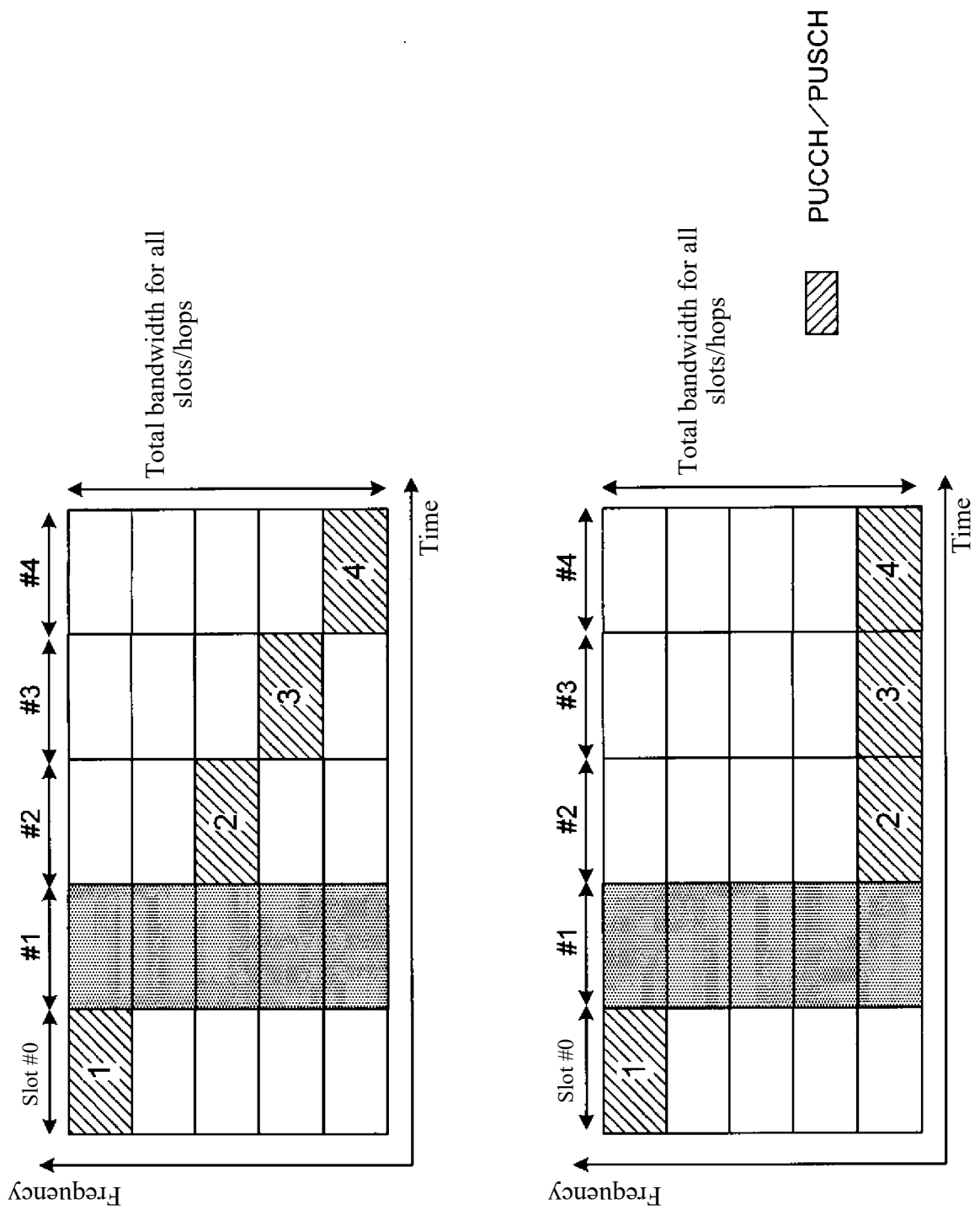


FIGURE 11A

FIGURE 11B

(FIGURE 12)

FIGURE 12A

Prescribed field value in the DCI	PUCCH resource set
00	PUCCH resource set #0
01	PUCCH resource set #1
10	PUCCH resource set #2
11	PUCCH resource set #3

FIGURE 12B

Parameters included in each PUCCH resource set

Start symbol
Number of symbols in the slot
Index that identifies the frequency resources for the first hop
Number of PRB
Whether or not frequency hopping is applied
Information on frequency resources for the second and subsequent hops
Frequency hopping mode for multiple slots

(FIGURE 13)

Information contained in the DCI

Start symbol
Number of symbols in the slot
Frequency resource allocation information for the PUSCH (c)
Whether or not frequency hopping is applied (a)
Information on frequency resources for the second and subsequent hops (b)
Mode of frequency hopping for multiple slots (d)

(FIGURE 14)

FIGURE 14A

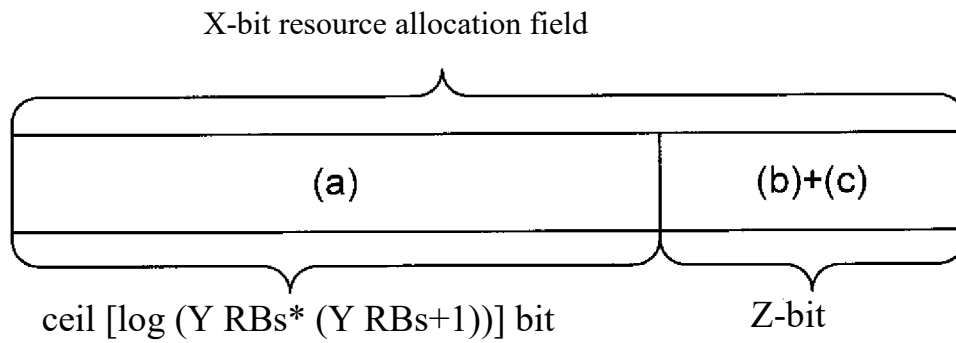


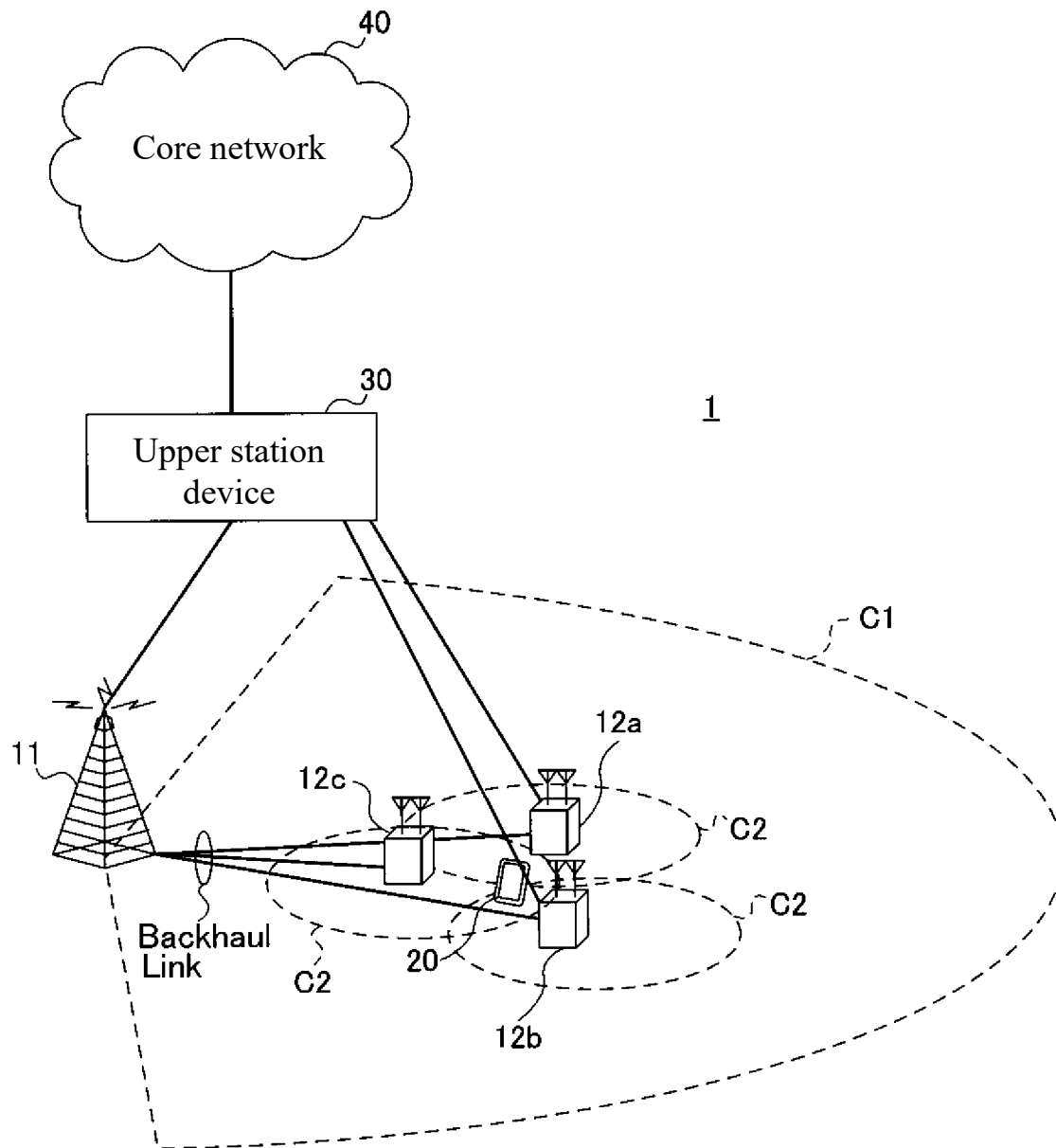
FIGURE 14B

Z=1	(b)+(c)
0	0 (no hopping)
1	$1/2 * S$

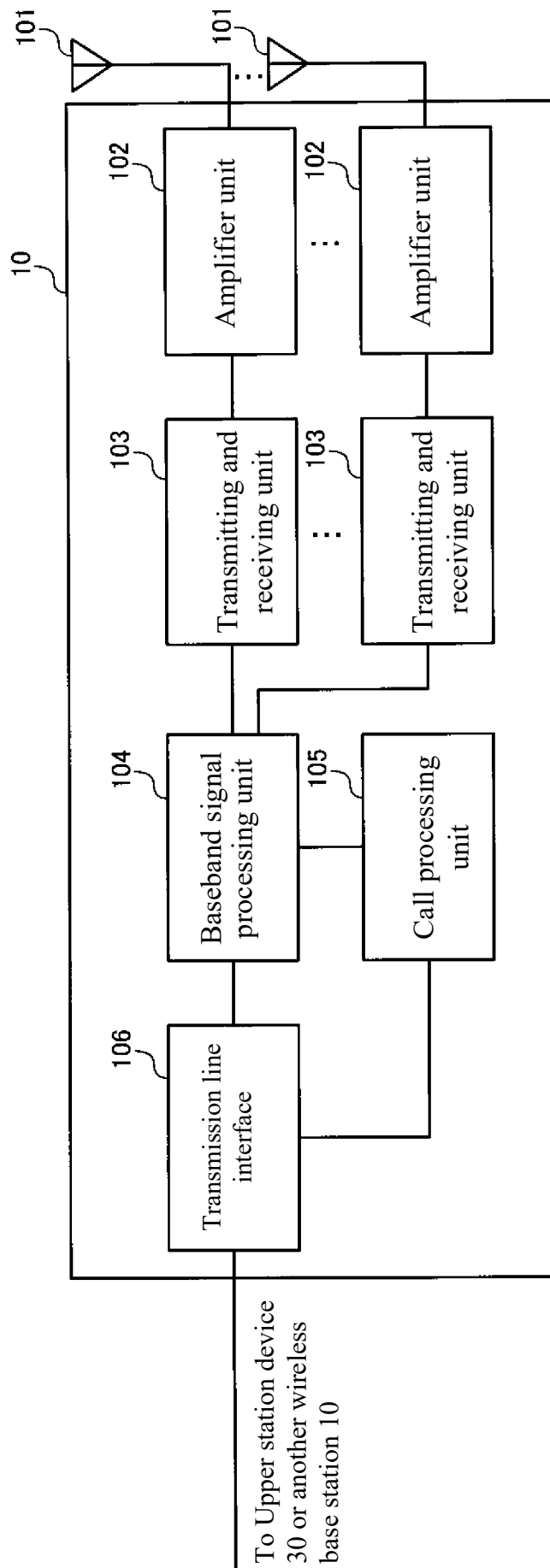
FIGURE 14C

Z=2	(b)+(c)
00	0 (no hopping)
01	$1/2 * S$
10	$(+1/4) * S$
11	$(-1/4) * S$

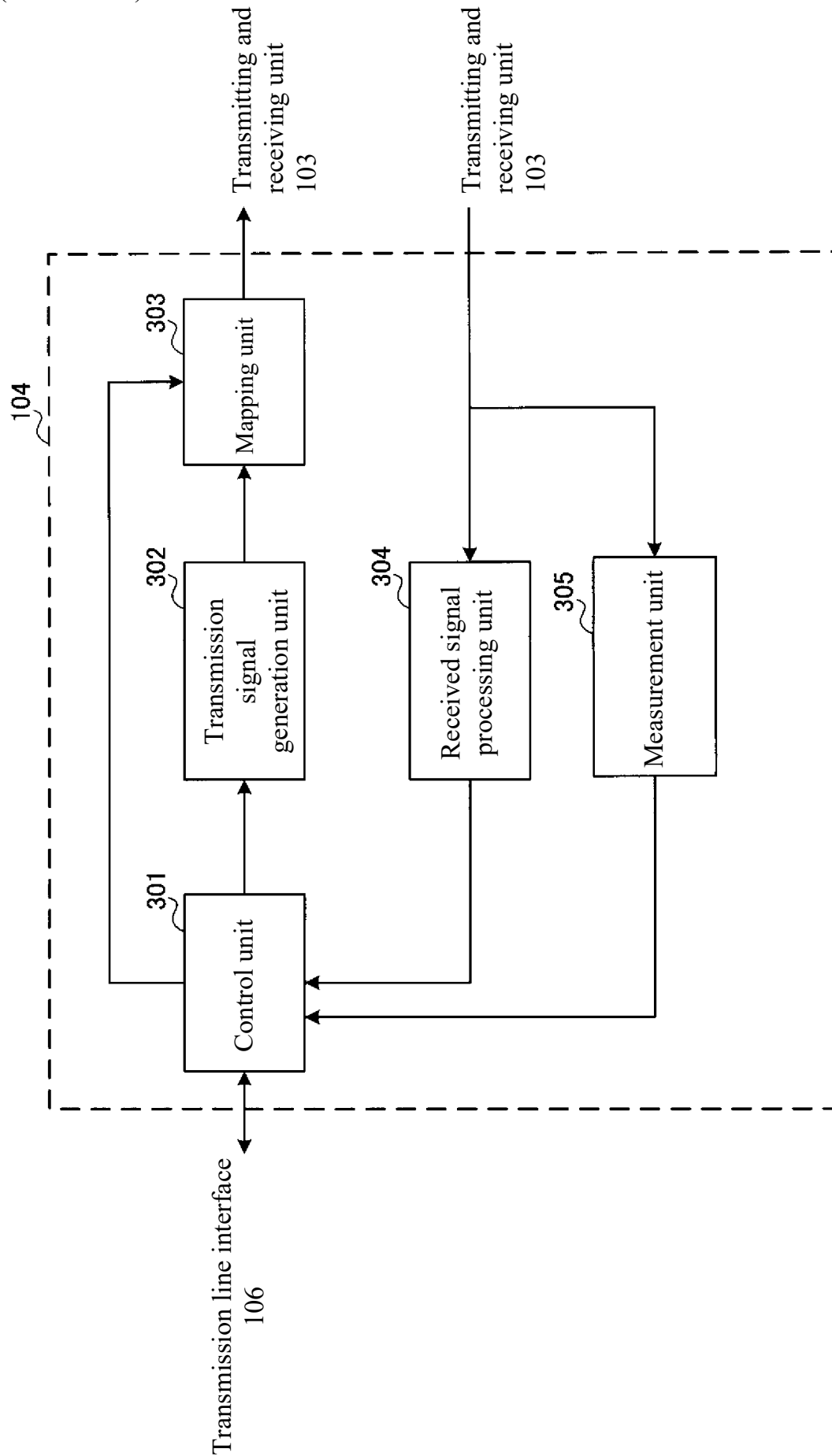
(FIGURE 15)



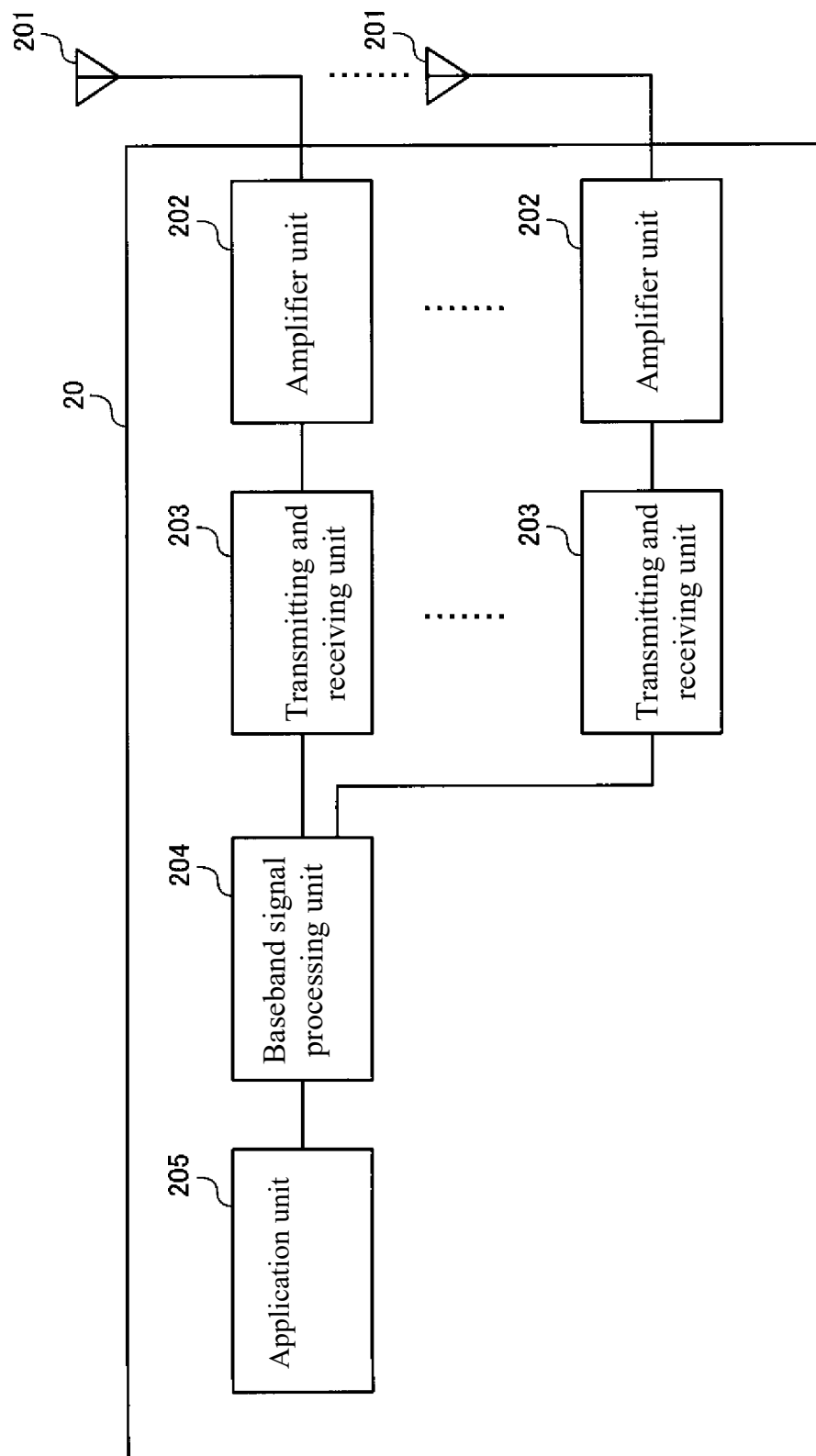
(FIGURE 16)



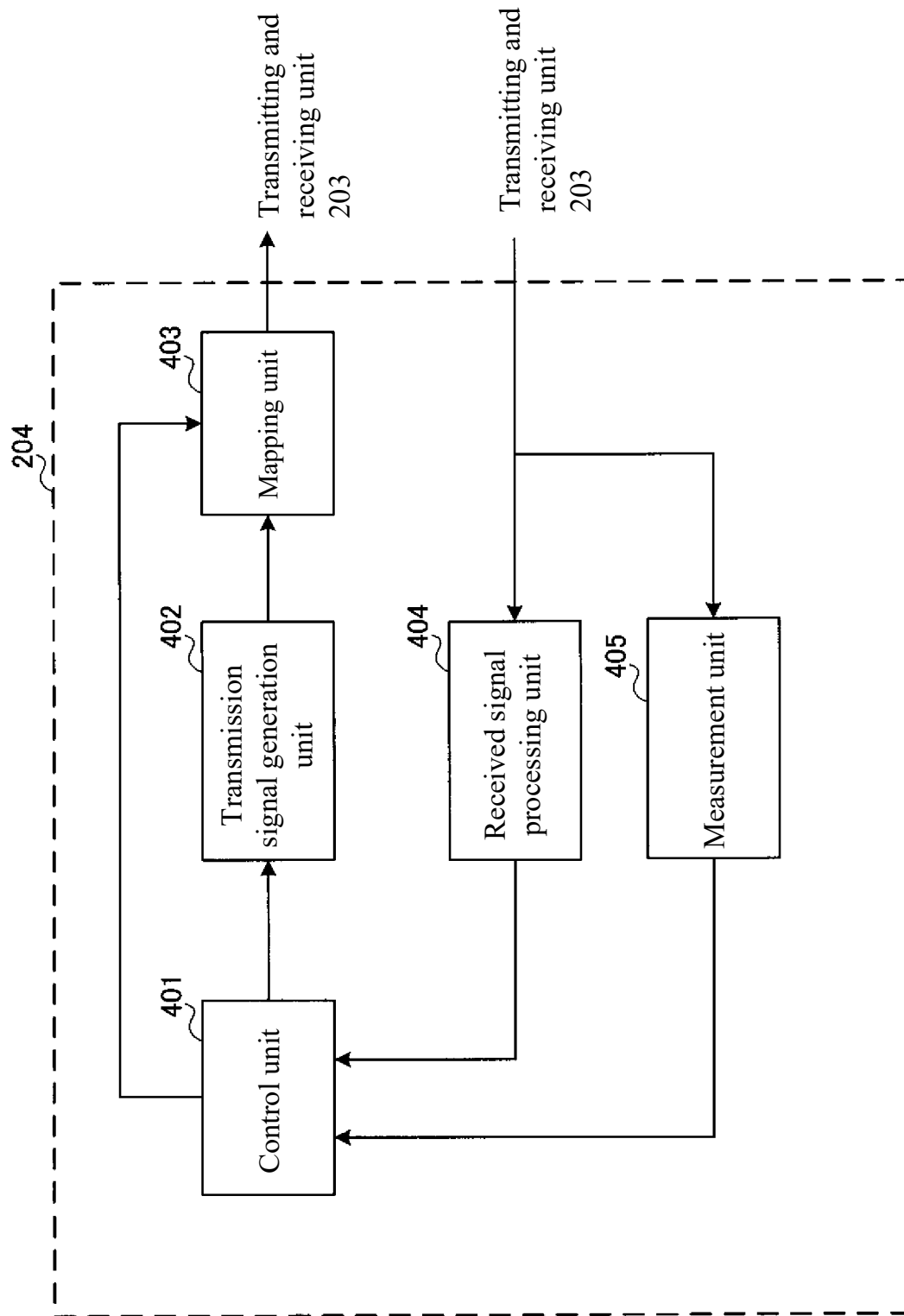
(FIGURE 17)



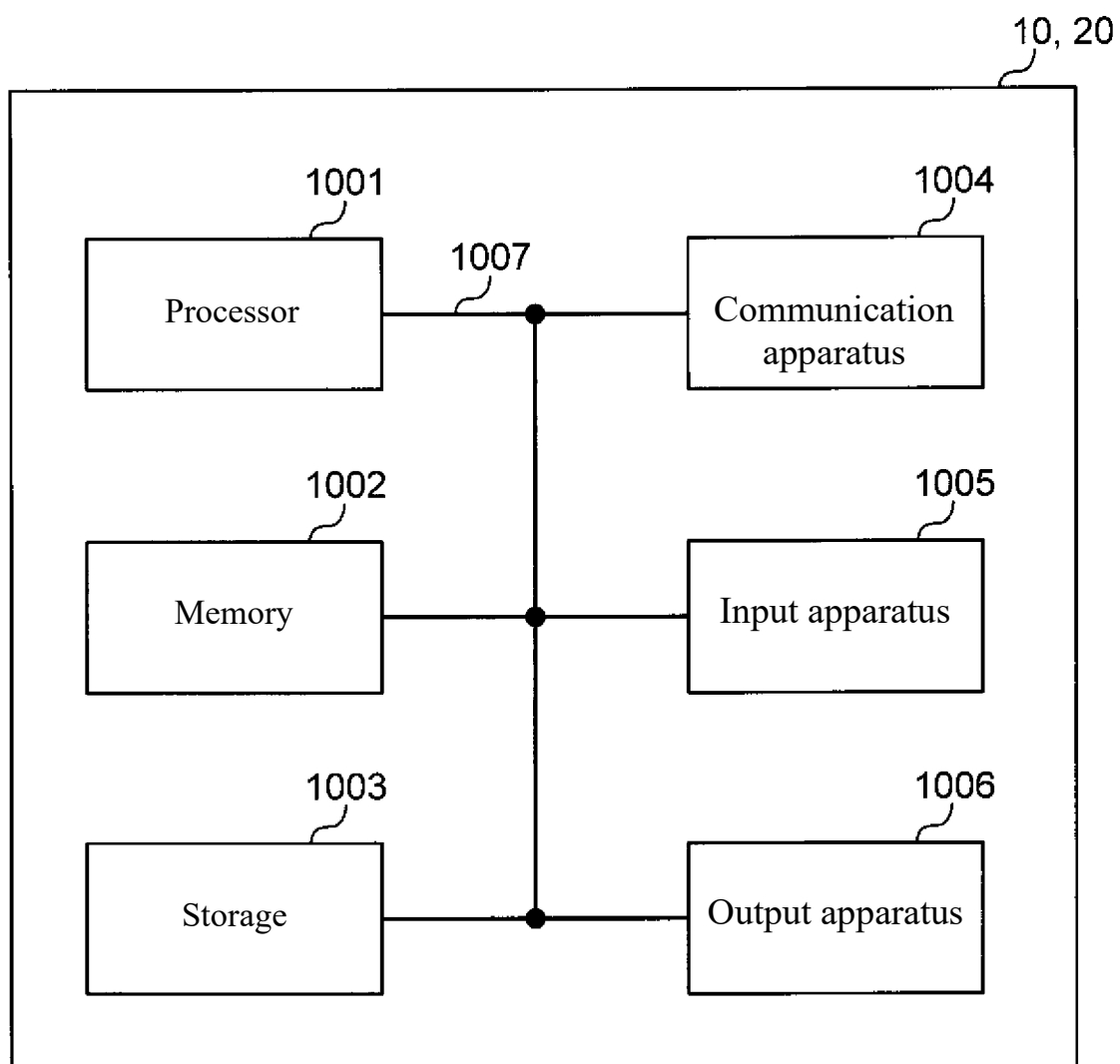
(FIGURE 18)



(FIGURE 19)



(FIGURE 20)



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/041378

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. H04B1/713 (2011.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. H04B1/713

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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

IEEE Xplore

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2014-168279 A (PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA) 11 September 2014, paragraphs [0070], [0085], [0087], [0096]-[0098], fig. 5, 6, 9 & US 2012/0057449 A1, paragraphs [0120], [0121], [0136], [0138], [0147]-[0149], fig. 5, 6, 9 & WO 2010/137341 A1 & EP 2437401 A1 & CN 102449921 A & KR 10-2012-0039520 A	1-3, 5-6
A	WO 2016/142978 A1 (NEC CORP.) 15 September 2016, paragraphs [0066]-[0068], [0090], [0091], fig. 6, 7 (Family: none)	1-6

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09.01.2018

Date of mailing of the international search report

16.01.2018

Name and mailing address of the ISA/

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

A. Classification of the field to which the invention belongs (International Patent Classification (IPC)) Int. Cl. H04B 1/713 (01/2011) i															
B. Fields searched Minimum documentation searched (International Patent Classification (IPC)) Int. Cl. H04B 1/713															
Documentation searched other than the minimum documentation that may be included in the fields searched <table border="0"> <tr> <td>Japanese Utility Model Application Publications</td> <td>1922–1996</td> </tr> <tr> <td>Japanese Unexamined Utility Model Application Publications</td> <td>1971–2018</td> </tr> <tr> <td>Japanese Utility Model Application Registered Publications</td> <td>1996–2018</td> </tr> <tr> <td>Japanese Registered Utility Model Application Publications</td> <td>1994–2018</td> </tr> </table>				Japanese Utility Model Application Publications	1922–1996	Japanese Unexamined Utility Model Application Publications	1971–2018	Japanese Utility Model Application Registered Publications	1996–2018	Japanese Registered Utility Model Application Publications	1994–2018				
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Japanese Unexamined Utility Model Application Publications	1971–2018														
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Cited literature category *	Name of the cited literature and indication of the relevant location when part of the literature is relevant	Relevant No. in the Scope of Patent Claims													
X	JP 2014-168279 A (Panasonic Intellectual Property Corporation of America) 09/11/2014, Paragraphs (0070), (0085), (0087), (0096)–(0098), Figures 5–6, 9 & US 2012/0057449 A1, pars. (0120)–(0121), (0136), (0138), (0147)–(0149), Figure 5–6, 9 & WO 2010/137341 A1 & EP 2437401 A1 & CN 102449921 A & KR 10-2012-0039520 A	1–3, 5–6													
A	WO 2016/142978 A1 (NEC Corporation) 09/15/2016, Paragraphs (0066)–(0068), (0090)–(0091), Figures 6–7 (no family)	1–6													
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Date of the completion of the international search 01/09/2018		Date of the mailing of the international search report 01/16/2018													
Name and mailing address of the international search organization Japan Patent Office (ISA/JP) Postal Code 100-8915 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo		Patent Office Examiner (authorized employee) Kazuaki Yoshie Telephone No. 03-3581-1101 Extension 3556	<table border="1"> <tr> <td>5K</td> <td>5887</td> </tr> </table>	5K	5887										
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