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(54) **APPARATUS AND METHOD FOR SIGNAL CONSTITUTION FOR DOWNLINK OF OFDMA-BASED CELLULAR SYSTEM**

SIGNALSTRUKTURVORRICHTUNG UND -VERFAHREN FÜR DIE ABWÄRTSSTRECKE EINES OFDMA-BASIERTEN ZELLULAREN SYSTEMS

DISPOSITIF ET PROCEDE DE CONSTITUTION DE SIGNAL POUR LIAISON DESCENDANTE DE SYSTEME CELLULAIRE AVEC ACCES A MULTIPLEXAGE PAR REPARTITION ORHTOGONALE DE LA FREQUENCE

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EP 1 570 588 B1

Description

BACKGROUND OF THE INVENTION

(a) Field of the Invention

[0001] The present invention relates to an apparatus and method for signal constitution for a downlink of an OFDMA (Orthogonal Frequency Division Multiplexing Access) based cellular system. More specifically, the present invention relates to an apparatus and method for adaptive pilot symbol assignment and sub-carrier allocation that reduces transmission power consumption and overhead caused by pilot symbols and increases the total data rate on the downlink of an OFDMA-based cellular system.

(b) Description of the Related Art

[0002] In the design of pilot assignment, it is necessary to use a sufficiently large number of pilot symbols for the sake of preventing a deterioration of reception performance caused by a channel variation, and to prevent an excessive increase of a power loss or a bandwidth loss caused by pilot symbols above an expected value. The positioning (assignment) of pilot symbols is of a great significance to the receiver of an OFDMA-based system, which estimates a transfer function value of channels in a two-dimensional (time, frequency) space. Hence, both the time domain and the frequency domain must be taken into consideration in pilot symbol assignment so as to transmit the pilot symbols. In case of using a plurality of antennas, the pilot symbols of the multiple antennas are assigned in consideration of both the time domain and the frequency domain.

[0003] The distance between pilot symbols must be quite small in designing pilot symbols in the worst environment, or when using non-optimal channel estimation filters having a lower complexity.

[0004] Let f_{sc} be a sub-carrier bandwidth, then the maximum pilot distance N_F in the frequency domain based on the conventional sampling theory (F. Classen, M. Speth, and H. Meyr, "Channel estimation units for an OFDM system suitable for mobile communication", in ITG Conference on Mobile Radio, Neu-Ulm, Germany, Sept. 1995) is determined by the following formula:

[Formula 1]

$$N_F \leq \frac{1}{\tau_{\max} f_{sc}}$$

where τ_{max} is the maximum exceedance delay time of a channel. The maximum pilot distance N_T in the frequency domain is determined by the following formula:

[Formula 2]

$$N_T \leq \frac{1}{2 f_D T_s}$$

where f_D is the maximum Doppler frequency; and T_s is the symbol time.

[0005] The symbol time T_s, during which the maximum pilot distance is proportional to the coherent time, is normalized by the number of symbols. So, the maximum pilot distance in the time domain is proportional to the coherent bandwidth and normalized by the sub-carrier bandwidth.

[0006] The balanced design (P. Hoeher et al., "Pilot-symbol-aided channel estimation in time and frequency", Multi-carrier Spread-Spectrum, accepted for publication in Kluwer Academic Publishers, 1997) defines that the estimation uncertainty in the time domain is equal to that in the frequency domain. Here, P. Hoeher et al. suggest a design guide having two-fold oversampling as defined by a heuristic formula as follows:

[Formula 3]

$$2 f_D T_s \cdot N_T \approx \tau_{\max} f_{sc} \cdot N_F \approx \frac{1}{2}$$

where N_F is the pilot distance in the frequency domain. The above-mentioned pilot symbol assignment is primarily a rectangular pilot symbol assignment, which is illustrated in FIG. 1. FIGS. 2 and 3 show a straight pilot symbol assignment and a hexagonal pilot symbol assignment, respectively. Generally, the hexagonal pilot symbol assignment allows more efficient sampling, compared with two-dimensional signals, and exhibits excellent performance relative to other assignments. An example of the pilot symbol assignment is disclosed in "Efficient pilot patterns for channel estimation in OFDM systems over HF channels" (M. J. Fernandez-Getino Garcia et al., in Proc IEEE VTC1999).

[0007] As the pilot symbol assignment becomes denser, the channel estimation performance becomes more excellent but the data rate is decreased. Hence, a trade-off lies between the data rate and the channel estimation performance (i.e., pilot symbol distance).

[0008] There exits a pilot symbol distance that optimizes the trade-off between the improved channel estimation and the signal-to-noise ratio (SNR) reduced by data symbols. By varying the pilot symbol distances N_F and N_T, the values approximate to the optimum with reference to the performance of bit error rate (BER) can be determined. In FIG. 1, for example, $N_F = 4$ and $N_T = 3$ in op-

timum means that one twelfth (about 8%) of the consumed transmission power and bandwidth are used for pilot symbols.

[0009] In this optimal assignment of pilot symbols, the channel environment and the moving speed of the mobile users are of a great importance as parameters to be considered.

[0010] The prior art document EP 938 208 A1 relates to a transmission method and a transmission apparatus for transmitting signals on the basis of a OFDM/TDMA-system, wherein a plurality of subcarriers being orthogonal to each other are allocated to a variable number of channels, each channel containing a variable number of subcarriers depending on information to be transmitted in said signals, wherein, for the transmission of said signals in a GSM-system having a constant number of predetermined GSM-frequency channels and a constant number of predetermined GSM-timeslots being grouped in GSM-frames, the number of said subcarriers is allocated corresponding to the bandwidth of said GSM-frequency channels, so that a multiple of one resulting OFDM/TDMA-timeslot matches with one or a multiple of one GSM-timeslots, wherein a pilot symbol is allocated to every n-th subcarrier in said GSM-frequency-channels, whereby n is an integer and >1, and wherein said signals are transmitted.

SUMMARY OF THE INVENTION

[0011] It is an advantage of the present invention to provide an apparatus and method for adaptive pilot symbol assignment and sub-carrier allocation that reduces transmission power and overhead caused by pilot symbols and increases the total data rate on a downlink in an OFDMA-based cellular system.

[0012] In one aspect of the present invention, there is provided a downlink signal constitution method, which is for a downlink of a cellular system using an orthogonal frequency division multiplexing access method, the downlink signal constitution method including: (a) coding, interleaving, and symbol-mapping data of a common channel and a control channel, and assigning fundamental pilot symbols, necessary for a demodulation of the common channel and the control channel, to time, frequency, and antenna; (b) receiving data to be transmitted through a traffic channel of each user, and determining a transmission mode of each user according to the user's moving speed, channel information, and traffic requirement; (c) determining additional pilot symbols, additionally necessary for a demodulation of the traffic channel, according to the transmission mode and moving speed by users; and (d) coding, interleaving and symbol-mapping the data of the traffic channel according to the transmission mode by users, and assigning the mapped symbols and the additional pilot symbols according to time, frequency and antenna.

[0013] In another aspect of the present invention, there is provided a downlink signal constitution method, which is for a cellular system using an orthogonal frequency division multiplexing access method, the downlink signal constitution method including: (a) dividing users into a first user group including high-speed mobile users and a second user group including the rest of the users, in consideration of each user's moving speed and traffic volume; (b) allocating a first sub-carrier band for the first user group, and a second sub-carrier band for the second user group; and (c) assigning pilot symbols to the first and second sub-carrier bands, the pilot symbols assigned to the first sub-carrier band being different in assignment density from the pilot symbols assigned to the second sub-carrier.

[0014] In a further aspect of the present invention, there is provided a downlink signal constitution apparatus, which is for a cellular system using an orthogonal frequency division multiplexing access method, the downlink signal constitution apparatus including: a first memory for storing traffic channel information of each user; a second memory for storing channel information, traffic requirement, and moving speed information of each user; a transmission user and transmission mode determiner for determining a transmission user and a transmission mode according to a defined method using the information stored in the second memory; a traffic channel processor for reading the traffic channel information stored in the first memory according to the transmission mode determined by the transmission user and transmission mode determiner, and performing coding, interleaving, and symbol-mapping of the traffic channel; an additional pilot symbol generator for generating additional pilot symbols necessary for a demodulation of the traffic channel, using the transmission mode determined by the transmission user and transmission mode determiner and the moving speed information stored in the second memory; and a time/sub-carrier/antenna mapper for multiplying the traffic channel symbols output from the traffic channel processor and the additional pilot symbols output from the additional pilot symbol generator by a channel gain by channels/users, and mapping the resulting symbols to time, sub-carrier, and antenna by a defined method.

[0015] In a still further aspect of the present invention, there is provided a recording medium with a built-in program, which implements a downlink signal constitution method for a cellular system using an orthogonal frequency division multiplexing access method, the program including: a function of coding, interleaving, and symbol-mapping data of a common channel and a control channel, and assigning fundamental pilot symbols, necessary for a demodulation of the common channel and the control channel, to time, frequency, and antenna; a function of receiving data to be transmitted through a traffic channel of each user, and determining a transmission mode of each user according to the user's moving speed, channel information, and traffic requirement; a function of determining additional pilot symbols, additionally necessary for a demodulation of the traffic channel,

according to the transmission mode and moving speed by users; and a function of coding, interleaving and symbol-mapping the data of the traffic channel according to the transmission mode by users, and assigning the mapped symbols and the additional pilot symbols according to time, frequency, and antenna.

[0016] In a still further aspect of the present invention, there is provided a recording medium with a built-in program, which implements a downlink signal constitution method for a cellular system using an orthogonal frequency division multiplexing access method, the program including: a function of dividing users into a first user group including high-speed mobile users and a second user group including the rest of the users, in consideration of each user's moving speed and traffic volume; a function of allocating a first sub-carrier band for the first user group, and a second sub-carrier band for the second user group; and a function of assigning pilot symbols to the first and second sub-carrier bands, the pilot symbols assigned to the first sub-carrier band being different in assignment density from the pilot symbols assigned to the second sub-carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention, and, together with the description, serve to explain the principles of the invention:

FIG. 1 is an exemplary diagram of a rectangular pilot symbol assignment;
FIG. 2 is an exemplary diagram of a straight pilot symbol assignment;
FIG. 3 is an exemplary diagram of a hexagonal pilot symbol assignment;
FIG. 4 is a flow chart showing a symbol assignment method for a downlink of an OFDMA-based cellular system according to an embodiment of the present invention;
FIG. 5 is a detailed diagram showing a symbol assignment method for the traffic channel of FIG. 4;
FIG. 6 is a diagram showing a downlink signal constitution method according to the embodiment of the present invention;
FIG. 7 is an exemplary diagram of a pilot symbol assignment for low-speed mobile users using four antennas;
FIG. 8 is an exemplary diagram of a pilot symbol assignment for high-speed mobile users using two antennas;
FIG. 9 is an exemplary diagram showing a downlink signal constitution method when using additional antennas only in a part of the whole band in an FDD system;
FIG. 10 is a diagram of a downlink signal constitution apparatus for an OFDMA-based cellular system according to the embodiment of the present invention;
FIG. 11 is a detailed flow chart showing a pilot symbol assignment according to sub-carrier allocation; and
FIG. 12 is an exemplary diagram showing a pilot symbol assignment according to a sub-carrier allocation for high-speed mobile users and a moving speed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] In the following detailed description, only the preferred embodiment of the invention has been shown and described, simply by way of illustration of the best mode contemplated by the inventor(s) of carrying out the invention. As will be realized, the invention is capable of modification in various obvious respects, all without departing from the invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not restrictive.

[0019] FIG. 4 is a diagram showing a downlink symbol assignment method for an OFDMA-based cellular system according to an embodiment of the present invention.

[0020] The symbol assignment method according to the embodiment of the present invention comprises, as shown in FIG. 4, a symbol assignment step S100 for common/control channels, a symbol assignment step S200 for traffic channels, and a traffic channel signal constitution step S300.

[0021] More specifically, the symbol assignment step S100 for common/control channels performs coding, interleaving, and symbol mapping on data of common and control channels, and assigns the mapped symbols to time, frequency, and antennas. Also, fundamental pilot symbols necessary for demodulation of the common and control channels are assigned to time, frequency, and antennas.

[0022] The symbol assignment step S200 for traffic channels receives data to be transferred through the traffic channel of each user; determines each user's transmission mode according to the user's moving speed, channel information, and traffic requirement; performs coding, interleaving, and symbol-mapping according to the transmission mode of the user; and assigns the traffic channel symbols of each user to time, frequency, and antennas. Also, pilot symbols additionally necessary for a demodulation of the traffic channel are generated according to the transmission mode by users, and assigned to time, frequency, and antennas.

[0023] The traffic channel signal constitution step S300 constitutes the signal of the traffic channel using the traffic channel symbols of each user and the additional pilot symbols output from the step S200.

[0024] FIG. 5 is a detailed diagram of the symbol assignment S200 for traffic channels shown in FIG. 4.

[0025] When the base station has information about the moving speed and channel status of each user, a required number of pilot symbols are inserted, reducing

transmission power and overhead caused by pilot symbols.

[0026] According to the embodiment of the present invention, the transmitter antennas are divided into basic antennas and additional antennas. The basic antenna refers to an antenna used for transmitting common and control channels, while the additional antenna refers to an antenna additionally used to enhance the transmission rate or performance of the traffic channel of the user.

[0027] In the OFDMA system, one frequency band is divided into a plurality of sub-carrier bands to transmit the traffic channel of each user through the allocated sub-carriers. Namely, the OFDMA system properly allocates a sub-carrier band according to the user's moving speed, channel environment, and traffic requirement, or selects a defined sub-carrier band, determines the number of transmitter antennas according to the user's moving speed, channel environment, and traffic requirement, and then assigns additionally necessary pilot symbols to the allocated sub-carrier band.

[0028] More specifically, as illustrated in FIG. 5, the OFDMA system stores data to be transmitted through a traffic channel, in step S210.

[0029] The transmission mode and the number of additional antennas are determined in consideration of the user's channel information (i.e., channel status), traffic requirement, and moving speed, in step S220.

[0030] In step S230, the system assigns pilot symbols for additional antennas, when the additional antennas are needed according to the transmission mode determined in the step S220.

[0031] The additional pilot symbols according to the moving speed of the basic antennas and the additional antennas are then assigned in consideration of the user's moving speed, in step S240.

[0032] The system performs coding, interleaving, and symbol mapping using the transmission mode determined in the step S220 and the traffic channel data stored in the step S210 to generate coded, interleaved, and symbol-mapped traffic channel symbols, in step S250.

[0033] In the step S220, the transmission mode for each user is determined independently, or the transmission mode for multiple users is determined by optimization in consideration of the total transmission rate, the quality of service, or the total transmission power.

[0034] FIG. 6 is an exemplary diagram showing a downlink signal constitution method according to the embodiment of the present invention.

[0035] In FIG. 6, when using one basic antenna and at most three additional antennas, the pilot symbols are assigned to the sub-carrier band, which is allocated to a user 1 moving at high speed with one basic antenna, a user 2 moving at low speed with one additional antenna, a user 3 moving at low speed with three additional antennas, and a user 4 moving at high speed with one additional antenna.

[0036] In FIG. 6, seventeen OFDM symbols constitute one slot. FIG. 6 shows the case where a demodulation can be enabled with one pilot symbol in one slot in the time domain because the moving speed is low.

[0037] Referring to FIG. 6, the common and control channels are used to transmit OFDM symbols such as pilot symbols of the basic antenna, and demodulate them irrespective of the moving speed of the users. The traffic channel is used to transmit the additional pilot symbols necessary according to the moving speed of the users and the number of antennas in the allocated sub-carrier band by users.

[0038] FIG. 7 is an exemplary diagram showing a pilot symbol assignment in the sub-carrier band allocated to a low-speed mobile user using one basic antenna and three additional antennas according to the embodiment of the present invention.

[0039] The pilot symbols ($N_F = 5$) of the basic antenna (antenna 0) and the common and control channels are transmitted for the first OFDMA symbol, and the traffic channel is transmitted for the other OFDMA symbols. The pilot symbols of the additional antennas (antenna 1, antenna 2, antenna 3) are additionally transmitted. In the meantime, the symbols of the traffic channel can be generated by any one of the following methods: (1) a first method of generating traffic channel symbols previously in consideration of the number of additional pilots; (2) a second method of generating the maximum number of traffic channel symbols and then puncturing at positions to transmit additional pilot symbols; and (3) a third method of generating traffic channel symbols previously in consideration of the number of a part of additional pilot symbols, and then puncturing at positions to transmit the rest of the additional pilot symbols.

[0040] FIG. 8 is an exemplary diagram showing a pilot symbol assignment in the sub-carrier band allocated to a high-speed mobile user using one basic antenna and one additional antenna according to the embodiment of the present invention.

[0041] The pilot symbols ($N_F = 5$) of the basic antenna (antenna 0) and the common and control channels are transmitted for the first OFDMA symbol, and the traffic channel is transmitted for the other OFDMA symbols. The pilot symbols of the additional antenna (antenna 1) are additionally transmitted.

[0042] In the meantime, the symbols of the traffic channel can be generated by one of the following methods: (1) a first method of generating traffic channel symbols previously in consideration of the number of additional pilots; (2) a second method of generating the maximum number of traffic channel symbols and then puncturing at positions to transmit additional pilot symbols; and (3) a third method of generating traffic channel symbols previously in consideration of the number of a part of additional pilot symbols, and then puncturing at positions to transmit the rest of the additional pilot symbols.

[0043] In summary, there are four cases of pilot symbol assignment in relation to the number of antennas of the traffic channel:

(1) moving at a low speed with one basic antenna - using no additional pilot symbol;
(2) moving at low speed with additional antennas - assigning pilot symbols for additional antennas;
(3) moving at high speed with one basic antenna - additionally inserting pilot symbols for basic antenna in conformity to the high-speed environment; and
(4) moving at high speed with additional antennas - additionally inserting pilot symbols for basic and additional antennas in consideration of the moving speed.

[0044] To use the methods illustrated in FIGS. 4 to 8, the base station must have information about the channel information, moving speed, and traffic requirement of each user. The moving speed is measured at the base station, or is measured at the mobile station and then reported to the base station. The traffic requirement is reported to the base station by the mobile station, or is detected by the base station from the amount or characteristic of data to be transmitted. The channel information is measured at the base station, or is measured at the mobile station and then reported to the base station. The former case is primarily for the TDD (Time Division Duplex) based system, and the latter one is for the FDD (Frequency Division Duplex) based system.

[0045] In the former case, the mobile station sends a signal (e.g., preamble, pilot, etc.) for channel measurement, and then the base station measures the channel information of the uplink by the respective antennas based on the received signal. The base station acquires channel information of the downlink using the reciprocity of channels because the uplink and the downlink have the same channel information because they use the same frequency band.

[0046] Contrarily, in the FDD system, the mobile station previously sends pilots of additional antennas so as to perform a channel estimation of the additional antennas.

[0047] FIG. 9 is an exemplary diagram showing a downlink signal constitution method when using additional antennas only in a defined band in the FDD system.

[0048] Namely, FIG. 9 shows the addition of an appropriate quantity of pilot symbols for additional antennas to the first symbol only in a defined band so as to reduce overhead caused by transmitting pilots of additional antennas.

[0049] In FIG. 9, one basic antenna (antenna 1) is used, and the third band is a band available for using at most three additional antennas, the fourth band being a band available for using at most one additional antenna, the other bands not being available for using additional antennas.

[0050] FIG. 10 is a diagram of a downlink signal constitution apparatus 100 for an OFDMA-based cellular system according to the embodiment of the present invention.

[0051] The downlink signal constitution apparatus 100 comprises a common/control channel processor 110, a fundamental pilot symbol generator 120, a traffic channel information memory 130, a traffic channel processor 140, a channel information/traffic requirement/moving speed memory 150, a transmission user and transmission mode determiner 160, an additional pilot symbol generator 170, and a time/sub-carrier/antenna mapper 180.

[0052] The common/control channel processor 110 encodes and interleaves the common/control channel information, and maps the coded and interleaved common/control channel information to symbols to generate a coded/interleaved/symbol-mapped common/control channel symbol. The fundamental pilot symbol generator 120 generates a fundamental pilot symbol. The fundamental pilot symbol is a pilot symbol transmitted irrespective of the transmission mode of the traffic channel of the user, and in FIGS. 6 and 9, refers to a pilot symbol transmitted for the first OFDM symbol of the slot.

[0053] The traffic channel information memory 130 stores the user's traffic channel information, and the channel information/traffic requirement/moving speed memory 150 stores the user's channel information, traffic requirement, and moving speed information.

[0054] The transmission user and transmission mode determiner 160 determines the transmission user and each transmission mode according to a defined method using the information stored in the channel information/traffic requirement/moving speed memory 150. The traffic channel processor 140 reads the traffic channel information stored in the traffic channel information memory 130 according to the transmission mode determined by the transmission user and transmission mode determiner 160, encodes and interleaves the traffic channel information, and maps the coded and interleaved traffic channel information to generate a coded/interleaved/symbol-mapped traffic channel symbol.

[0055] The additional pilot symbol generator 170 generates an additional pilot symbol according to the number of antennas and the moving speed determined by each user's transmission mode. The additional pilot symbol is a pilot symbol additionally transmitted other than the fundamental pilot symbol for the respective users, and in FIGS. 6 and 9, refers to the pilot symbols other than the pilot symbol transmitted for the first OFDM symbol of the slot.

[0056] The time/sub-carrier/antenna mapper 180 multiplies the coded/interleaved/symbol-mapped common/control channel symbol generated from the common/control channel processor 110, the coded/interleaved/symbol-mapped traffic channel symbol generated from the traffic channel processor 130, the fundamental pilot symbol generated from the fundamental pilot symbol generator 120, and the additional pilot symbol generated from the additional pilot symbol generator 170 by channel gain information by channels or users, and maps the channel symbols to time, sub-carrier, and antenna by a defined method.

[0057] The time/sub-carrier/antenna mapper 180 can

use any one of the following methods: (1) a first method of generating traffic channel symbols previously in consideration of the number of additional pilots; (2) a second method of generating the maximum number of traffic channel symbols and then puncturing at positions to transmit additional pilot symbols; and (3) a third method of generating traffic channel symbols previously in consideration of the number of a part of additional pilot symbols, and then puncturing at positions to transmit the rest of the additional pilot symbols.

[0058] The output of the downlink signal constitution apparatus 100 is OFDM-modulated through OFDM modulators 200a, 200b, ..., and 200n, and is subjected to D/A conversion, frequency up-conversion, filtering, and amplification through radio transmitters 300a, 300b, ..., and 300n, and transmitted via antennas 400a, 400b, ..., and 400n.

[0059] FIG. 11 is a detailed flow chart of a pilot symbol assignment method according to sub-carrier allocation in the embodiment of the present invention.

[0060] According to the embodiment of the present invention, some of the sub-carriers are allocated according to the traffic requirement and the moving speed by an appropriate method in the downlink of the OFDMA-based cellular system, and then the pilot symbols of the traffic channel of the corresponding sub-carrier are properly assigned by the pilot symbol assignment method according to the moving speed, or the like.

[0061] More specifically, referring to FIG. 11, data to be transmitted through a traffic channel are stored, in step S410, and it is determined in step S420 whether the moving speed is high or low.

[0062] If the moving speed is determined as low in the step S420, then the sub-carriers are allocated according to channel status, traffic requirement, and low-speed determination information, in step S430, and pilot symbols for low speed are assigned to the allocated sub-carriers, in step S450.

[0063] If the moving speed is determined as high in the step S420, then the sub-carriers are allocated according to channel status, traffic requirement, and high-speed determination information, in step S440, and pilot symbols for high speed are assigned to the allocated sub-carriers, in step S460.

[0064] The pilot symbols assigned in the steps S450 and S460 are output to a data symbol assignment input.

[0065] FIG. 12 is an exemplary diagram of sub-carrier allocation according to the moving speed of the user, and pilot symbol assignment of the corresponding sub-carrier.

[0066] Typically, sub-carrier allocation is achieved by users or data types. Here, the sub-carriers are allocated according to each user's moving speed. In the case of pilot symbol assignment for mobile users in an express train running at a speed of 250 km/h in consideration of the user's quality of service, for example, the pilot symbols are assigned very densely with a small pilot symbol distance, and the number of data symbols to be transmitted is reduced with a deterioration of the data rate. However, for users who are stationary or moving at a speed of less than 120 km/h, the pilot symbols are much more densely assigned than needed, with a deterioration of efficiency. Thus the users can be divided into a user group having a moving speed of 250 km/h and a user group having a moving speed of less than 120 km/h, based on the fact that there is no speed to be considered between 120 and 250 km/h.

[0067] In FIG. 12, when the high-speed mobile users are the users of an express train running at a speed of 250 km/h and the proportion of users in service is less than 0.1 % of all users all over the country, only some of all the sub-carriers can be allocated to the high-speed mobile users. The sub-carriers allocated must assign proper pilot symbols to the high-speed mobile users. The rest of the sub-carriers are allocated to mobile users having a speed of less than 120 km/h, and proper pilot symbols are assigned to the users. In this case, the pilot symbols of the sub-carriers for the high-speed mobile users are inserted more densely than those of the rest of the sub-carriers, thus enhancing the data rate of the whole system.

[0068] While this invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent assignments included within the scope of the appended claims.

[0069] The present invention determines the number of transmit antennas according to each user's moving speed, channel status, or user request, and properly assigns pilot symbols in the downlink of an OFDMA-based cellular system, thereby reducing a transmission power consumption and an overhead caused by pilots.

[0070] Furthermore, the present invention allocates some sub-carriers to assign proper pilot symbols for ultrahigh-speed mobile users, and the rest of the sub-carriers to the other users to assign proper pilot symbols to the users, based on the fact that the ultrahigh-speed mobile users have a traffic volume almost insignificant to the whole traffic volume, thereby optimizing the transmission power caused by the pilot symbols as well as enhancing the total data rate.

Claims

1. A downlink signal constitution method, which is for a downlink of a cellular system using an orthogonal frequency division multiplexing access method, the downlink signal constitution method comprising: (a) coding, interleaving, and symbol-mapping data of a common channel and a control channel, and assigning fundamental pilot symbols, necessary for a demodulation of the common channel-and the control channel, to time, frequency, and antenna; (b) receiv-

ing data to be transmitted through a traffic channel of each user, and determining a transmission mode of each user according to the user's moving speed, channel information, and traffic requirement; (c) determining additional pilot symbols, additionally necessary for a demodulation of the traffic channel, according to the transmission mode and moving speed by users; and (d) coding, interleaving, and symbol-mapping the data of the traffic channel according to the transmission mode of users, and assigning the mapped symbols and the additional pilot symbols according to time, frequency, and antenna.

2. The downlink signal constitution method as claimed in claim 1, wherein the assignment of pilot symbols for the sub-carriers used by a first user group is different from the assignment of pilot symbols for the subcarriers used by a second user group.

3. The downlink signal constitution method as claimed in claim 2, wherein the assignment of pilot symbols for the sub-carriers used by the first user group is denser than the assignment of pilot symbols for the subcarriers used by the second user group.

4. The downlink signal constitution method as claimed in claim 3, wherein the first user group is a higher-speed user group than the second user group, and some of all the sub-carriers is previously allocated for the first user group.

5. The downlink signal constitution method as claimed in claim 1, wherein the step (c) of determining additional pilot symbols includes : using no additional pilot symbol, when the transmission mode of the traffic channel is using only a basic antenna with the moving speed of a mobile station being less than a reference value ; and using pilot symbols for additional antenna, when the transmission mode of the traffic channel is using an additional antenna with the moving speed of the mobile station being less than the reference value.

6. The downlink signal constitution method as claimed in claim 1, wherein the step (c) of determining additional pilot symbols includes : additionally inserting pilot symbols for basic antenna in consideration of the moving speed of a mobile station, when the transmission mode of the traffic channel is using only a basic antenna with the moving speed of the mobile station exceeding a reference value ; and additionally inserting pilot symbols for basic and additional antennas in consideration of the moving speed of the mobile station, when the transmission mode of the traffic channel is using an additional antenna with the moving speed of the mobile station exceeding the reference value.

7. The downlink signal constitution method as claimed in claim 1, wherein the step (d) of assigning additional pilot symbols includes generating traffic channel symbols previously in consideration of the number of the additional pilots.

8. The downlink signal constitution method as claimed in claim 1, wherein the step (d) of assigning additional pilot symbols includes generating symbols according to a maximum number of traffic channel symbols, and then puncturing at positions for transmitting the additional pilot symbols.

9. The downlink signal constitution method as claimed in claim 1, wherein the step (d) of assigning additional pilot symbols includes generating traffic channel symbols previously in consideration of a portion of the number of the additional pilot symbols, and then puncturing at positions for transmitting the rest of the additional pilot symbols.

10. The downlink signal constitution method as claimed in claim 1, comprising: (e) dividing users into a first user group including high-speed mobile users and a second user group including the rest of the users, in consideration of each user's moving speed and traffic requirement; (f) allocating a first sub-carrier band for the first user group, and a second sub-carrier band for the second user group; and (g) assigning pilot symbols to the first and second sub-carrier bands, the pilot symbols assigned to the first sub-carrier band being different in assignment density from the pilot symbols assigned to the second sub-carrier.

11. The downlink signal constitution method as claimed in claim 10, wherein the assignment of pilot symbols to the first sub-carrier band is denser than the assignment of pilot symbols to the second sub-carrier band.

12. The downlink signal constitution method as claimed in claim 11, wherein a proportion of the first sub-carrier band in the whole sub-carrier band is less than a proportion of the second sub-carrier band.

13. A downlink signal constitution apparatus (100), which is for a cellular system using an orthogonal frequency division multiplexing access method, the downlink signal constitution apparatus comprising: a first memory (130) for storing traffic channel information of each user; a second memory (150) for storing channel information, traffic requirement, and moving speed information of each user; a transmission user and transmission mode determiner (160) for determining a transmission user and a transmission mode according to a defined method using the information stored in the second memory; a traffic

channel processor (140) for reading the traffic channel information stored in the first memory according to the transmission mode determined by the transmission user and transmission mode determiner (160), and performing coding, interleaving, and symbol-mapping of the traffic channel ; an additional pilot symbol generator (170) for generating additional pilot symbols necessary for a demodulation of the traffic channel, using the transmission mode determined by the transmission user and transmission mode determiner (160) and the moving speed information stored in the second memory; and a time/sub-carrier/antenna mapper (180) for multiplying the traffic channel symbols output from the traffic channel processor (140) and the additional pilot symbols output from the additional pilot symbol generator (170) by a channel gain of channels or users, and mapping the resulting symbols to time, sub-carrier, and antenna by a defined method.

14. The downlink signal constitution apparatus (100) as claimed in claim 13, further comprising: a common/control channel processor (110) for receiving common/control channel information, and performing coding, interleaving, and symbolmapping of the received common/control channels; and a fundamental pilot symbol generator (120) for generating a fundamental pilot symbol necessary for demodulation of thecommon/control channels.

15. A recording medium with a built-in program, which implements a downlink signal constitution method for a cellular system using an orthogonal frequency division multiplexing access method, The program comprising program means for implementing the steps of: coding, interleaving, and symbol-mapping data of a common channel and a control channel, and assigning fundamental pilot symbols, necessary for a demodulation of the common channel and the control channel, to time, frequency, and antenna; receiving data to be transmitted through a traffic channel of each user, and determining a transmission mode of each user according to the user's moving speed, channel information, and traffic requirement; determining additional pilot symbols, additionally necessary for a demodulation of the traffic channel, according to the transmission mode and moving speed of users; and coding, interleaving, and symbol-mapping the data of the traffic channel according to the transmission mode of users, and assigning the mapped symbols and the additional pilot symbols according to time, frequency and antenna.

16. The recording medium with a built-in program as claimed in claim 15, the program comprising program means for implementing the steps of: dividing users into a first user group including high-speed mobile users and a second user group including the rest of the users, in consideration of each user's moving speed and traffic requirement; allocating a first sub-carrier band for the first user group, and a second sub-carrier band for the second user group; and assigning pilot symbols to the first and second sub-carrier bands, the pilot symbols assigned to the first sub-carrier band being different in assignment density from the pilot symbols assigned to the second sub- carrier.

Patentansprüche

1. Abwärtsstreckensignal-Bildungsverfahren, das für eine Abwärtsstrecke eines zellularen Systems dient, das ein orthogonales Frequenzvielfachzugriffsverfahren verwendet, wobei das Abwärtsstreckensignal-Bildungsverfahren Folgendes aufweist: (a) Codieren, Verschachteln und symbolmäßiges Abbilden von Daten eines allgemeinen Kanals und eines Steuerkanals und Zuordnen elementarer Pilotsymbole, die für eine Demodulation des allgemeinen Kanals und des Steuerkanals nötig sind, bezüglich Zeit, einer Frequenz und Antenne; (b) Empfangen von über einen Verkehrskanal eines jeweiligen Anwenders zu sendenden Daten und Bestimmen eines Sendemoduss eines jeweiligen Anwenders gemäß der Bewegungsgeschwindigkeit des Anwenders, der Kanalinformation und des Verkehrserfordernisses; (c) Bestimmen zusätzlicher Pilotsymbole, die für eine Demodulation des Verkehrskanals zusätzlich nötig sind, gemäß dem Sendemodus und der Bewegungsgeschwindigkeit durch Anwender; und (d) Codieren, Verschachteln und symbolmäßiges Abbilden der Daten des Verkehrskanals gemäß dem Sendemodus von Anwendern und Zuordnen der abgebildeten Symbole und der zusätzlichen Pilotsymbole gemäß Zeit, Frequenz und Antenne.

2. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei die Zuordnung von Pilotsymbolen für die durch eine erste Anwendergruppe verwendeten Hilfsträger unterschiedlich von der Zuordnung von Pilotsymbolen für die durch eine zweite Anwendergruppe verwendeten Hilfsträger ist.

3. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 2, wobei die Zuordnung von Pilotsymbolen für die durch eine erste Anwendergruppe verwendeten Hilfsträger dichter als die Zuordnung von Pilotsymbolen für durch eine zweite Anwendergruppe verwendeten Hilfsträger ist.

4. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 3, wobei die erste Anwendergruppe einer Anwendergruppe höherer Geschwindigkeit als die zweite Anwendergruppe ist und einige von allen Hilfsträgern zuvor der ersten Anwendergruppe zugeteilt

werden.

5. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei der Schritt (c) zum Bestimmen zusätzlicher Pilotsymbole Folgendes enthält: Verwenden keines zusätzlichen Pilotsymbols, wenn der Sendemodus des Verkehrskanals nur eine Basisantenne verwendet, während die Bewegungsgeschwindigkeit einer mobilen Station kleiner als ein Referenzwert ist; und Verwenden von Pilotsymbolen für eine zusätzliche Antenne, wenn der Sendemodus des Verkehrskanals eine zusätzliche Antenne verwendet, während die Bewegungsgeschwindigkeit der mobilen Station kleiner als der Referenzwert ist.

6. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei der Schritt (c) zum Bestimmen zusätzlicher Pilotsymbole Folgendes enthält: zusätzliches Einfügen von Pilotsymbolen für eine Basisantenne unter Berücksichtigung der Bewegungsgeschwindigkeit einer mobilen Station, wenn der Sendemodus des Verkehrskanals nur eine Basisantenne verwendet, während die Bewegungsgeschwindigkeit der mobilen Station größer als ein Referenzwert ist; und zusätzliches Einfügen von Pilotsymbolen für eine Basisantenne und zusätzliche Antennen unter Berücksichtigung der Bewegungsgeschwindigkeit der mobilen Station, wenn der Sendemodus des Verkehrskanals eine zusätzliche Antenne verwendet, während die Bewegungsgeschwindigkeit der mobilen Station größer als der Referenzwert ist.

7. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei der Schritt (d) zum Zuordnen zusätzlicher Pilotsymbole ein vorheriges Erzeugen von Verkehrskanalsymbolen unter Berücksichtigung der Anzahl der zusätzlichen Pilotsignale enthält.

8. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei der Schritt (d) zum Zuordnen zusätzlicher Pilotsymbole ein Erzeugen von Symbolen gemäß einer maximalen Anzahl von Verkehrskanalsymbolen und ein darauffolgendes Einfügen bei Positionen zum Senden der zusätzlichen Pilotsymbole enthält.

9. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, wobei der Schritt (d) zum Zuordnen zusätzlicher Pilotsymbole ein vorheriges Erzeugen von Verkehrskanalsymbolen unter Berücksichtigung eines Anteils der zusätzlichen Pilotsymbole und ein darauffolgendes Einfügen bei Positionen zum Senden des Rests der zusätzlichen Pilotsymbole enthält.

10. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 1, das Folgendes aufweist: (e) Aufteilen von Anwendern in eine erste Anwendergruppe mit mobilen Anwendern hoher Geschwindigkeit und eine zweite Anwendergruppe mit dem Rest der Anwender unter Berücksichtigung einer Bewegungsgeschwindigkeit eines jeweiligen Anwenders und eines Verkehrserfordernisses; (f) Zuteilen eines ersten Hilfsträgerbands für die erste Anwendergruppe und eines zweiten Hilfsträgerbands für die zweite Anwendergruppe; und (g) Zuordnen von Pilotsymbolen zu dem ersten und dem zweiten Hilfsträgerband, wobei die dem ersten Hilfsträgerband zugeordneten Pilotsymbole bezüglich einer Zuordnungsdichte unterschiedlich von den dem zweiten Hilfsträgerband zugeordneten Pilotsymbolen sind.

11. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 10, wobei die Zuordnung von Pilotsymbolen zum ersten Hilfsträgerband dichter als die Zuordnung von Pilotsymbolen zum zweiten Hilfsträgerband ist.

12. Abwärtsstreckensignal-Bildungsverfahren nach Anspruch 11, wobei ein Anteil des ersten Hilfsträgerbands im gesamten Hilfsträgerband kleiner als ein Anteil des zweiten Hilfsträgerbands ist.

13. Abwärtsstreckensignal-Bildungsvorrichtung (100), die für ein zellulares System dient, das ein orthogonales Frequenzvielfachzugriffsverfahren verwendet, wobei die Abwärtsstreckensignal-Bildungsvorrichtung Folgendes aufweist: einen ersten Speicher (130) zum Speichern von Verkehrskanalinformation eines jeweiligen Anwenders; einen zweiten Speicher (150) zum Speichern von Kanalinformation, eines Verkehrserfordernisses und von Bewegungsgeschwindigkeitsinformation eines jeweiligen Anwenders; eine Bestimmungseinheit für einen Sendeanwender und einen Sendemodus (160) zum Bestimmen eines Sendeanwenders und eines Sendemodus gemäß einem definierten Verfahren unter Verwendung der im zweiten Speicher gespeicherten Information; einen Verkehrskanalprozessor (140) zum Lesen der im ersten Speicher gespeicherten Verkehrskanalinformation gemäß dem durch die Bestimmungseinheit für einen Sendeanwender und einen Sendemodus (160) bestimmten Sendemodus und zum Durchführen eines Codierens, eines Verschachtelns und eines symbolmäßigen Abbildens des Verkehrskanals; einen zusätzlichen Pilotsymbol-Generator (170) zum Erzeugen zusätzlicher Pilotsymbole, die für eine Demodulation des Verkehrskanals nötig sind, unter Verwendung des durch die Bestimmungseinheit für einen Sendeanwender und einen Sendemodus (160) bestimmten Sendemodus und der im zweiten Speicher gespeicherten Bewegungsgeschwindigkeitsinformation; und eine Zeit/Hilfsträger/Antenne-Abbildungseinheit (180)

zum Multiplizieren der vom Verkehrskanalprozessor (140) ausgegebenen Verkehrskanalsymbole und der vom zusätzlichen Pilotsymbol-Generator (170) ausgegebenen zusätzlichen Pilotsymbole mit einer Kanalverstärkung von Kanälen oder Anwendern und zum Abbilden der resultierenden Symbole zu Zeit, Hilfsträger und Antenne durch ein definiertes Verfahren.

14. Abwärtsstreckensignal-Bildungsvorrichtung (100) nach Anspruch 13, die weiterhin Folgendes aufweist: einen Prozessor für einen allgemeinen Kanal / Steuerkanal (110) zum Empfangen von Information für den allgemeinen Kanal / Steuerkanal und zum Durchführen eines Codierens, eines Verschachtelns und eines symbolmäßigen Abbildens der allgemeinen Kanäle / Steuerkanäle; und einen Generator für elementare Pilotsymbole (120) zum Erzeugen eines elementaren Pilotsymbols, das zur Demodulation der allgemeinen Kanäle / Steuerkanäle nötig ist.

15. Aufzeichnungsmedium mit einem eingebauten Programm, das ein Abwärtsstreckensignal-Bildungsverfahren für ein zellulares System implementiert, das ein orthogonales Frequenzvielfachzugriffsverfahren verwendet, wobei das Programm ein Programmmittel zum Implementieren der folgenden Schritte aufweist: Codieren, Verschachteln und symbolmäßiges Abbilden von Daten eines allgemeinen Kanals und eines Steuerkanals und Zuordnen elementarer Pilotsymbole, die für eine Demodulation des allgemeinen Kanals und des Steuerkanals nötig sind, bezüglich Zeit, Frequenz und Antenne; Empfangen von über einen Verkehrskanal zu sendenden Daten eines jeweiligen Anwenders und Bestimmen eines Sendemodus eines jeweiligen Anwenders gemäß der Bewegungsgeschwindigkeit des Anwenders, der Kanalinformation und dem Kanalerfordernis; Bestimmen zusätzlicher Pilotsymbole, die für eine Demodulation des Verkehrskanals zusätzlich nötig sind, gemäß dem Sendemodus und der Bewegungsgeschwindigkeit des Anwenders; und Codieren, Verschachteln und symbolmäßiges Abbilden der Daten des Verkehrskanals gemäß dem Sendemodus von Anwendern und Zuordnen der abgebildeten Symbole und der zusätzlichen Pilotsymbole gemäß Zeit, Frequenz und Antenne.

16. Aufzeichnungsmedium mit einem eingebauten Programm nach Anspruch 15, wobei das Programm ein Programmmittel zum Implementieren der folgenden Schritte aufweist: Aufteilen von Anwendern in eine erste Anwendergruppe mit mobilen Anwendern hoher Geschwindigkeit und eine zweite Anwendergruppe mit dem Rest der Anwender unter Berücksichtigung einer Bewegungsgeschwindigkeit eines jeweiligen Anwenders und eines Verkehrserfordernisses; Zuteilen eines ersten Hilfsträgerbands für die erste Anwendergruppe und eines zweiten Hilfsträgerbands für die zweite Anwendergruppe; und Zuordnen von Pilotsymbolen zu dem ersten und dem zweiten Hilfsträgerband, wobei die dem ersten Hilfsträgerband zugeordneten Pilotsymbole bezüglich einer Zuordnungsdichte unterschiedlich von den dem zweiten Hilfsträger zugeordneten Pilotsymbolen sind.

Revendications

1. Procédé de constitution de signal pour liaison descendante, qui est pour une liaison descendante d'un système cellulaire utilisant un procédé d'accès à multiplexage par répartition orthogonale de la fréquence, le procédé de constitution de signal pour liaison descendante comprenant les étapes consistant à : (a) coder, entrelacer et mapper en symboles des données d'un canal commun et d'un canal de commande, et attribuer des symboles pilotes fondamentaux, nécessaires pour une démodulation du canal commun et du canal de commande, au temps, à la fréquence et à l'antenne ; (b) recevoir des données à transmettre à travers un canal de trafic de chaque utilisateur, et déterminer un mode de transmission de chaque utilisateur selon la vitesse de déplacement, les informations de canal et l'exigence de trafic de l'utilisateur ; (c) déterminer des symboles pilotes supplémentaires, en outre nécessaires pour une démodulation du canal de trafic, en fonction du mode de transmission et de la vitesse de déplacement des utilisateurs ; et (d) coder, entrelacer et mapper en symboles les données du canal de trafic en fonction du mode de transmission des utilisateurs, et attribuer les symboles mappés et les symboles pilotes supplémentaires en fonction du temps, de la fréquence et de l'antenne.

2. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'attribution de symboles pilotes pour les sous-porteuses utilisées par un premier groupe d'utilisateurs est différente de l'attribution de symboles pilotes pour les sous-porteuses utilisées par un deuxième groupe d'utilisateurs.

3. Procédé de constitution de signal pour liaison descendante selon la revendication 2, dans lequel l'attribution de symboles pilotes pour les sous-porteuses utilisées par le premier groupe d'utilisateurs est plus dense que l'attribution de symboles pilotes pour les sous-porteuses utilisées par le deuxième groupe d'utilisateurs.

4. Procédé de constitution de signal pour liaison descendante selon la revendication 3, dans lequel le premier groupe d'utilisateurs est un groupe d'utilisa-

teurs de vitesse supérieure à celle du deuxième groupe d'utilisateurs, et certaines de toutes les sous-porteuses sont attribuées au préalable pour le premier groupe d'utilisateurs.

5. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'étape (c) consistant à déterminer des symboles pilotes supplémentaires comprend les étapes consistant à : n'utiliser aucun symbole pilote supplémentaire, lorsque le mode de transmission du canal de trafic utilise uniquement une antenne de base avec la vitesse de déplacement d'une station mobile qui est inférieure à une valeur de référence ; et utiliser des symboles pilotes pour une antenne supplémentaire, lorsque le mode de transmission du canal de trafic utilise une antenne supplémentaire avec la vitesse de déplacement de la station mobile qui est inférieure à la valeur de référence.

6. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'étape (c) consistant à déterminer des symboles pilotes supplémentaires comprend les étapes consistant à insérer en outre des symboles pilotes pour l'antenne de base en tenant compte de la vitesse de déplacement d'une station mobile, lorsque le mode de transmission du canal de trafic utilise uniquement une antenne de base avec la vitesse de déplacement de la station mobile qui dépasse une valeur de référence ; et insérer en outre des symboles pilotes pour des antennes de base et des antennes supplémentaires en tenant compte de la vitesse de déplacement de la station mobile, lorsque le mode de transmission du canal de trafic utilise une antenne supplémentaire avec la vitesse de déplacement de la station mobile qui dépasse la valeur de référence.

7. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'étape (d) consistant à attribuer des symboles pilotes supplémentaires comprend l'étape consistant à générer des symboles de canal de trafic au préalable en tenant compte du nombre de pilotes supplémentaires.

8. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'étape (d) consistant à attribuer des symboles pilotes supplémentaires comprend les étapes consistant à générer des symboles en fonction d'un nombre maximal de symboles de canal de trafic, puis perforer à des positions pour transmettre les symboles pilotes supplémentaires.

9. Procédé de constitution de signal pour liaison descendante selon la revendication 1, dans lequel l'étape (d) consistant à attribuer des symboles pilotes supplémentaires comprend les étapes consistant à générer des symboles de canal de trafic au préalable en tenant compte d'une portion du nombre de symboles pilotes supplémentaires, puis perforer à des positions pour transmettre le reste des symboles pilotes supplémentaires.

10. Procédé de constitution de signal pour liaison descendante selon la revendication 1, comprenant les étapes consistant à : (e) diviser les utilisateurs en un premier groupe d'utilisateurs comprenant des utilisateurs mobiles de grande vitesse et un deuxième groupe d'utilisateurs comprenant le reste des utilisateurs, en tenant compte de la vitesse de déplacement et de l'exigence de trafic de chaque utilisateur ; (f) attribuer une première bande de sous-porteuses pour le premier groupe d'utilisateurs, et une deuxième bande de sous-porteuses pour le deuxième groupe d'utilisateurs ; et (g) attribuer des symboles pilotes aux première et deuxième bandes de sous-porteuses, les symboles pilotes attribués à la première bande de sous-porteuses étant différents en densité d'attribution des symboles pilotes attribués à la deuxième bande de sous-porteuses.

11. Procédé de constitution de signal pour liaison descendante selon la revendication 10, dans lequel l'attribution de symboles pilotes à la première bande de sous-porteuses est plus dense que l'attribution de symboles pilotes à la deuxième bande de sous-porteuses.

12. Procédé de constitution de signal pour liaison descendante selon la revendication 11, dans lequel une proportion de la première bande de sous-porteuses dans toute la bande de sous-porteuses est inférieure à une proportion de la deuxième bande de sous-porteuses.

13. Appareil de constitution de signal pour liaison descendante (100), qui est pour un système cellulaire utilisant un procédé d'accès à multiplexage par répartition orthogonale de la fréquence, l'appareil de constitution de signal pour liaison descendante comprenant : une première mémoire (130) pour stocker des informations de canal de trafic de chaque utilisateur ; une deuxième mémoire (150) pour stocker les informations de canal, l'exigence de trafic et les informations de vitesse de déplacement de chaque utilisateur ; un déterminateur d'utilisateur de transmission et de mode de transmission (160) pour déterminer un utilisateur de transmission et un mode de transmission en fonction d'un procédé défini en utilisant les informations stockées dans la deuxième mémoire ; un processeur de canal de trafic (140) pour lire les informations de canal de trafic stockées dans la première mémoire en fonction du mode de transmission déterminé par le déterminateur d'utili-

sateur de transmission et de mode de transmission (160), et pour effectuer le codage, l'entrelacement et le mappage en symboles du canal de trafic ; un générateur de symboles pilotes supplémentaires (170) pour générer des symboles pilotes supplémentaires nécessaires pour une démodulation du canal de trafic, utiliser le mode de transmission déterminé par le déterminateur d'utilisateur de transmission et de mode de transmission (160) et les informations de vitesse de déplacement stockées dans la deuxième mémoire ; et un mappeur de temps/sous-porteuse/antenne (180) pour multiplier les symboles de canal de trafic délivrés du processeur de canal de trafic (140) et les symboles pilotes supplémentaires délivrés du générateur de symboles pilotes supplémentaires (170) par un gain de canal de canaux d'utilisateurs, et mapper les symboles résultants sur le temps, la sous-porteuse et l'antenne par un procédé défini.

14. Appareil de constitution de signal pour liaison descendante (100) selon la revendication 13, comprenant en outre : un processeur de canal commun/de commande (110) pour recevoir des informations de canal commun/de commande, et effectuer le codage, l'entrelacement et le mappage en symboles des canaux communs/de commande reçus ; et un générateur de symbole pilote fondamental(120) pour générer un symbole pilote fondamental nécessaire pour la démodulation des canaux communs/de commande.

15. Support d'enregistrement avec un programme intégré, qui met en oeuvre un procédé de constitution de signal pour liaison descendante pour un système cellulaire utilisant un procédé d'accès à multiplexage par répartition orthogonale de la fréquence, le programme comprenant des moyens de programme pour mettre en oeuvre les étapes consistant à coder, entrelacer et mapper en symboles des données d'un canal commun et d'un canal de commande, et attribuer des symboles pilotes fondamentaux, nécessaires pour une démodulation du canal commun et du canal de commande, au temps, à la fréquence et à l'antenne ; recevoir des données à transmettre à travers un canal de trafic de chaque utilisateur, et déterminer un mode de transmission de chaque utilisateur selon la vitesse de déplacement, les informations de canal et l'exigence de trafic de l'utilisateur ; déterminer des symboles pilotes supplémentaires, en outre nécessaires pour une démodulation du canal de trafic, en fonction du mode de transmission et de la vitesse de déplacement des utilisateurs ; et coder, entrelacer et mapper en symboles les données du canal de trafic en fonction du mode de transmission des utilisateurs, et attribuer les symboles mappés et les symboles pilotes supplémentaires en fonction du temps, de la fréquence et de l'antenne.

16. Support d'enregistrement avec un programme intégré selon la revendication 15, le programme comprenant des moyens de programmes pour mettre en oeuvre les étapes consistant à : diviser les utilisateurs en un premier groupe d'utilisateurs comprenant des utilisateurs mobiles de grande vitesse et un deuxième groupe d'utilisateurs comprenant le reste des utilisateurs, en tenant compte de la vitesse de déplacement et de l'exigence de trafic de chaque utilisateur ; attribuer une première bande de sous-porteuses pour le premier groupe d'utilisateurs, et une deuxième bande de sous-porteuses pour le deuxième groupe d'utilisateurs ; et attribuer des symboles pilotes aux première et deuxième bandes de sous-porteuses, les symboles pilotes attribués à la première bande de sous-porteuses étant différents en densité d'attribution des symboles pilotes attribués à la deuxième bande de sous-porteuses.

Fig. 1

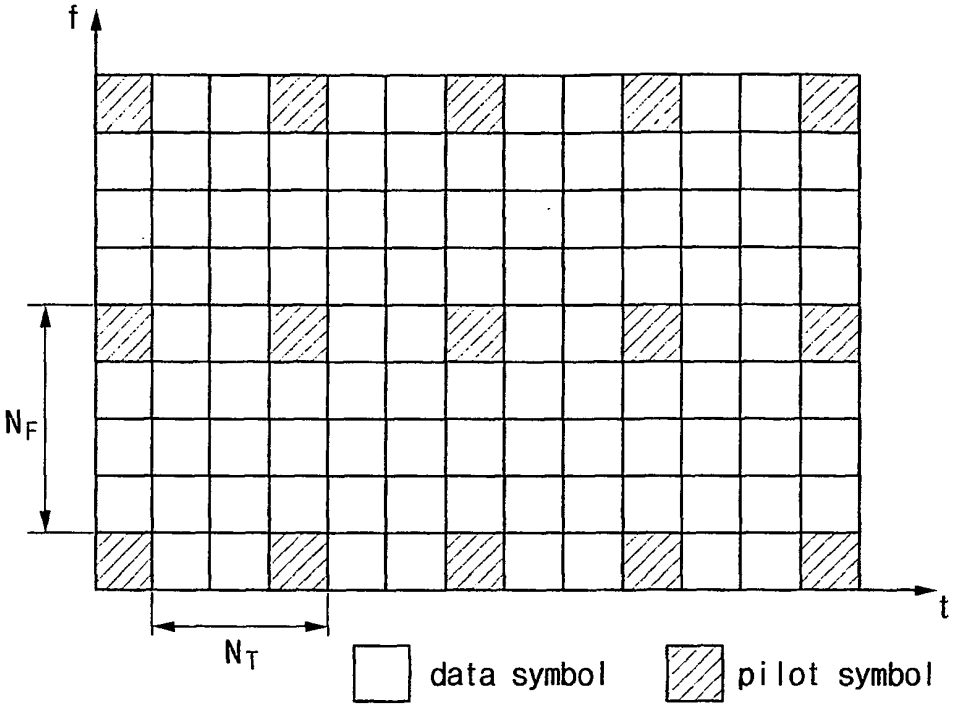

f
t
N_F
N_T
data symbol
pilot symbol

Fig. 2

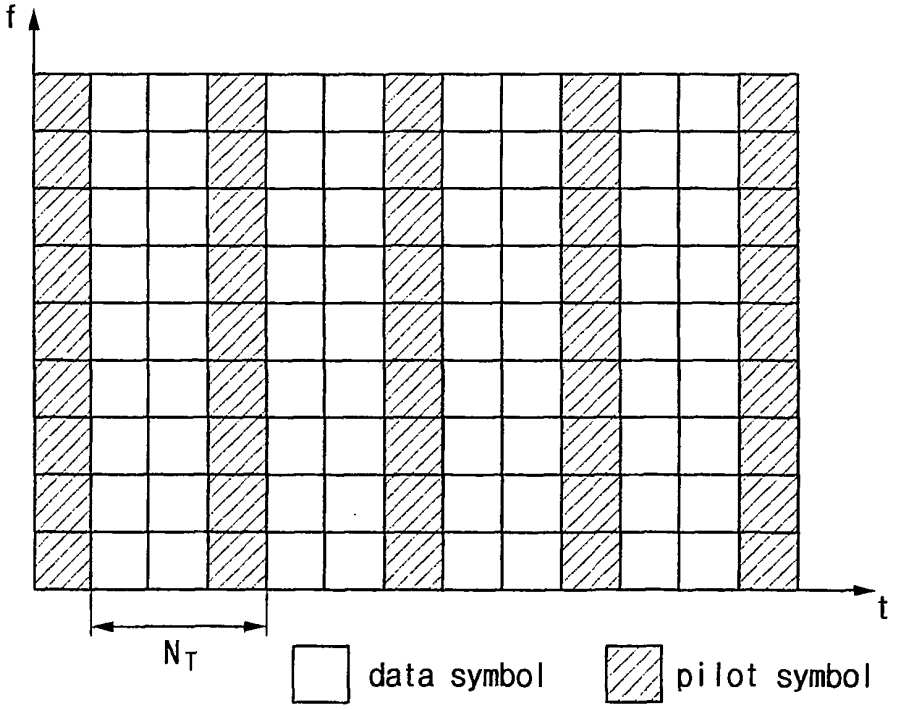

f
t
N_T
data symbol
pilot symbol

Fig. 3

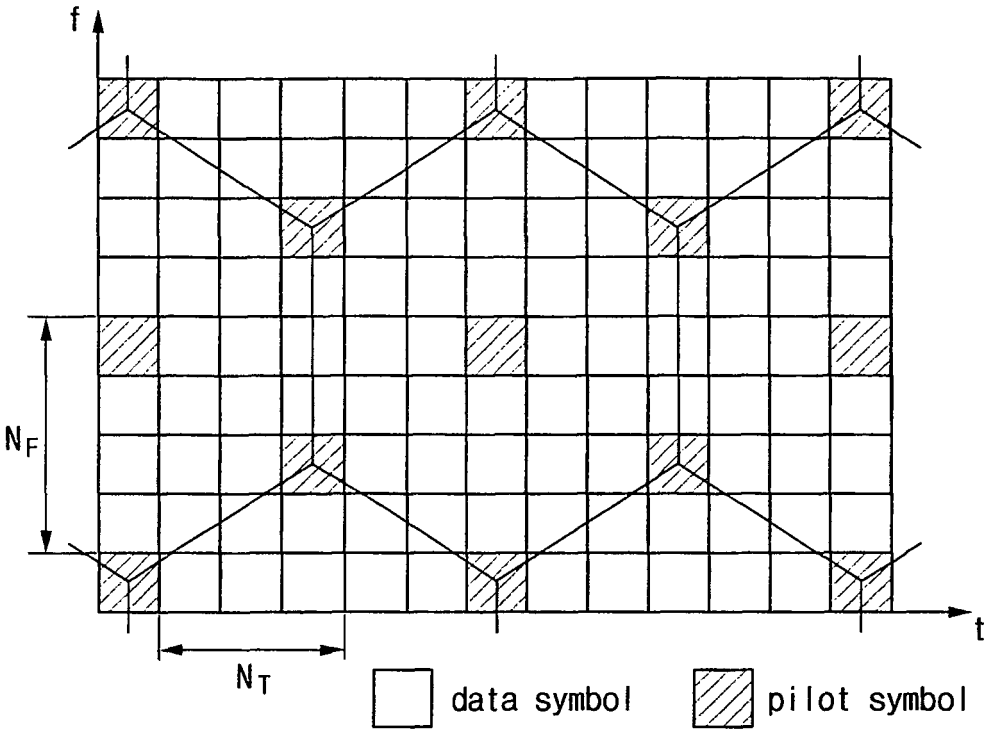

f
t
N_F
N_T
data symbol
pilot symbol

Fig. 4

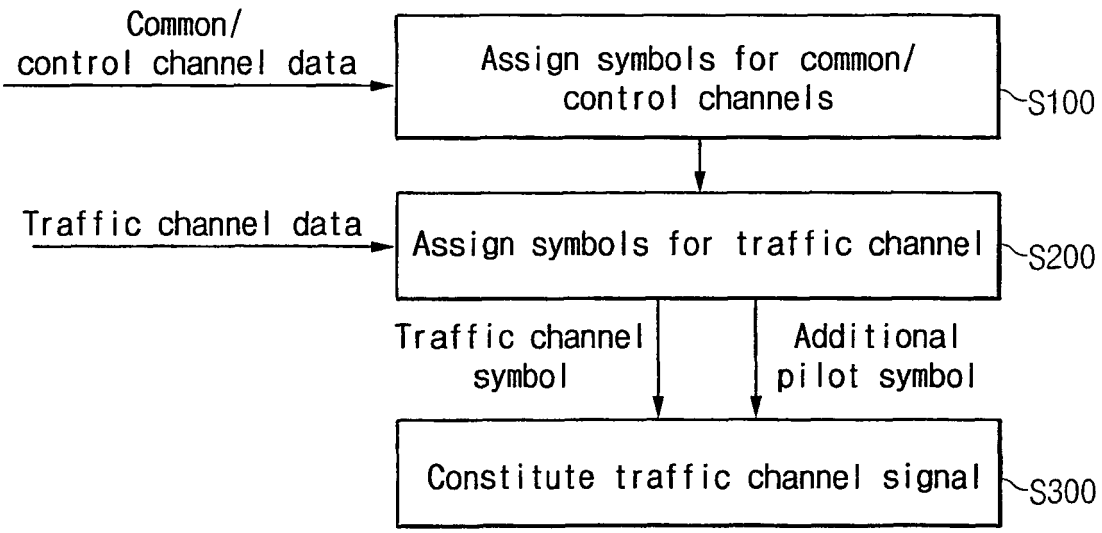

Common/
control channel data
Assign symbols for common/
control channels
S100
Traffic channel data
Assign symbols for traffic channel
S200
Traffic channel
symbol
Additional
pilot symbol
Constitute traffic channel signal
S300

Fig. 5

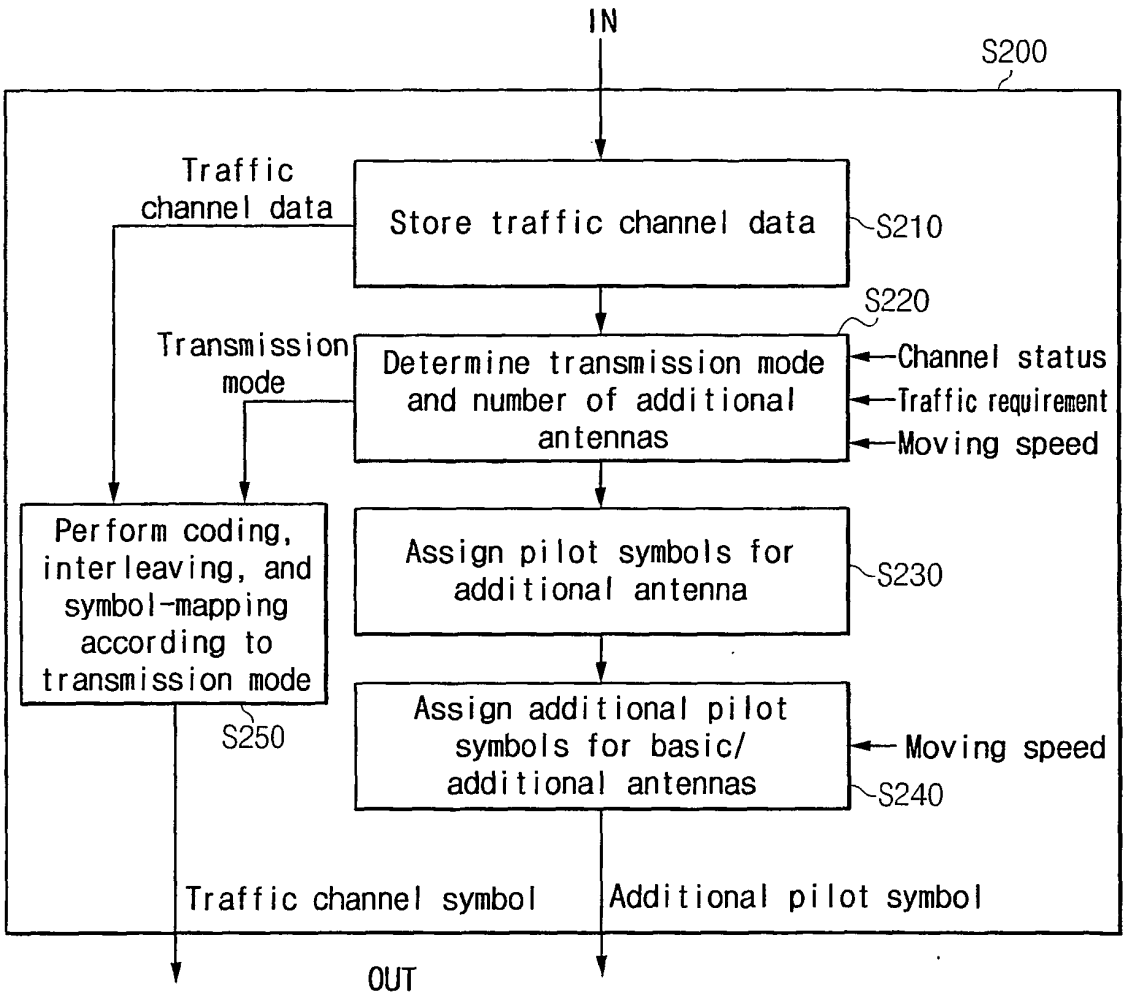

IN
S200
Traffic channel data
Store traffic channel data
S210
S220
Transmission mode
Determine transmission mode and number of additional antennas
Channel status
Traffic requirement
Moving speed
Perform coding, interleaving, and symbol-mapping according to transmission mode
S250
Assign pilot symbols for additional antenna
S230
Assign additional pilot symbols for basic/ additional antennas
Moving speed
S240
Traffic channel symbol
Additional pilot symbol
OUT

Fig. 6

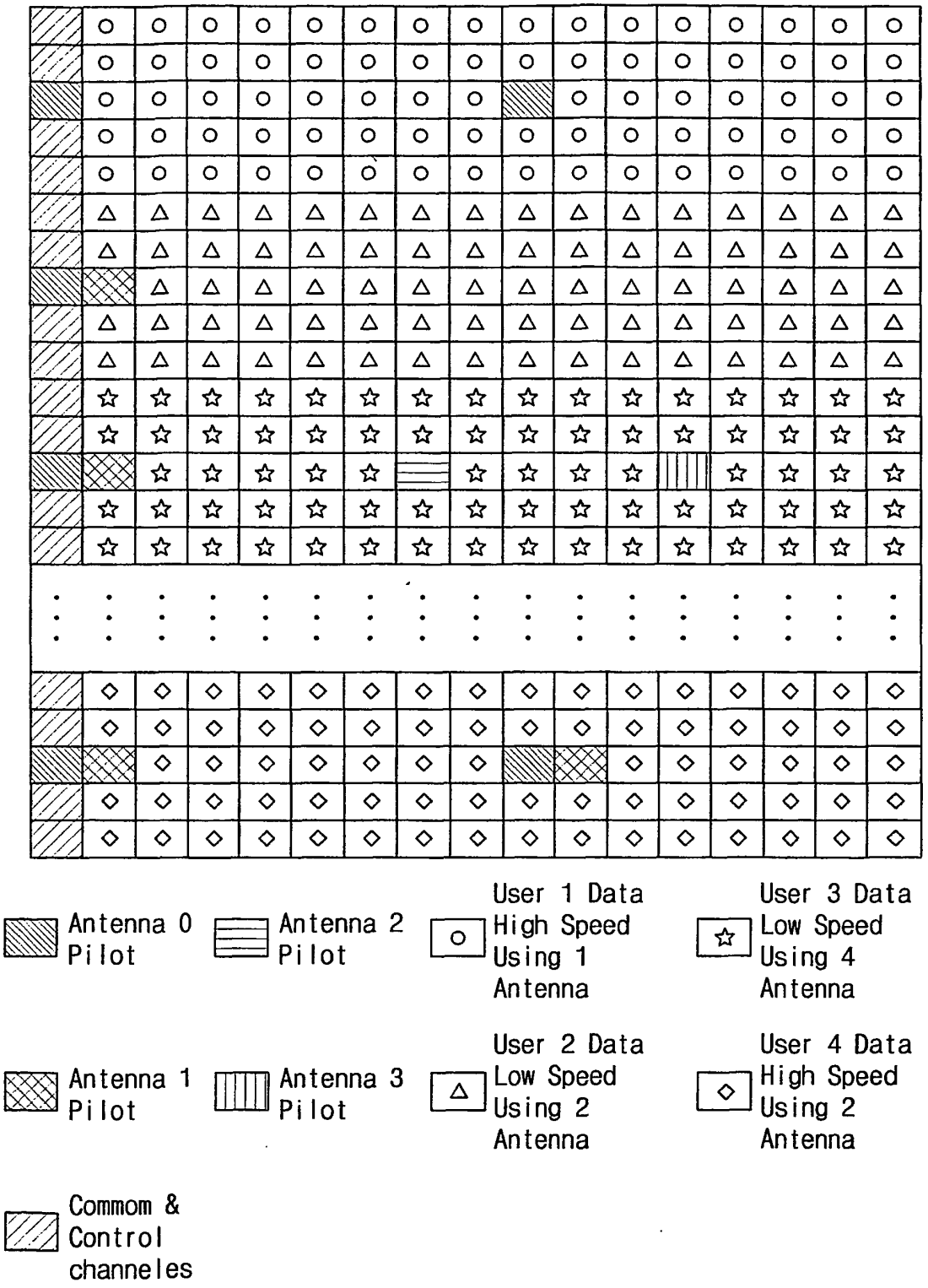

Antenna 0 Pilot
Antenna 2 Pilot
User 1 Data High Speed Using 1 Antenna
User 3 Data Low Speed Using 4 Antenna
Antenna 1 Pilot
Antenna 3 Pilot
User 2 Data Low Speed Using 2 Antenna
User 4 Data High Speed Using 2 Antenna
Commom & Control channeles

Fig. 7

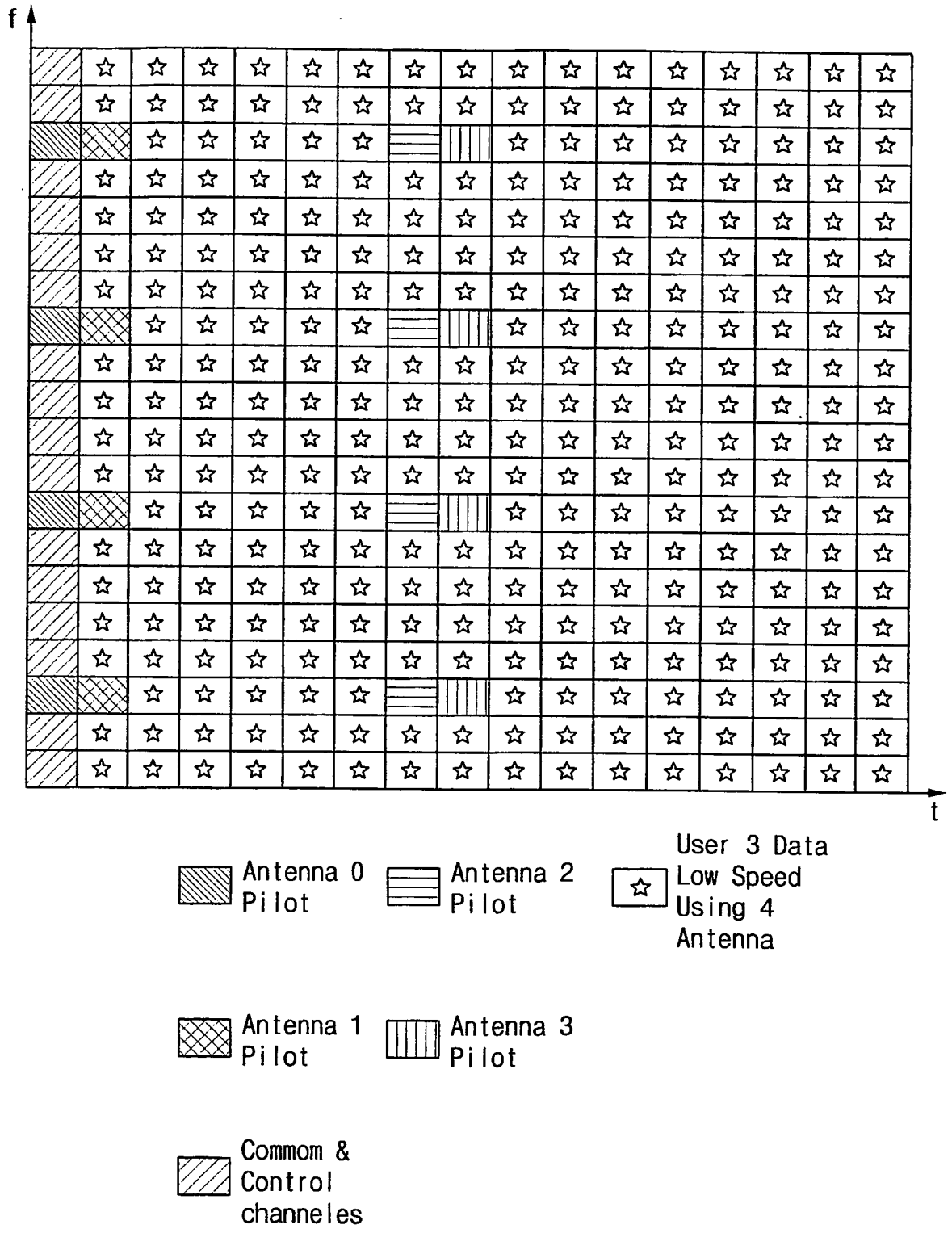

f
t
Antenna 0 Pilot
Antenna 2 Pilot
User 3 Data Low Speed Using 4 Antenna
Antenna 1 Pilot
Antenna 3 Pilot
Commom & Control channeles

Fig. 8

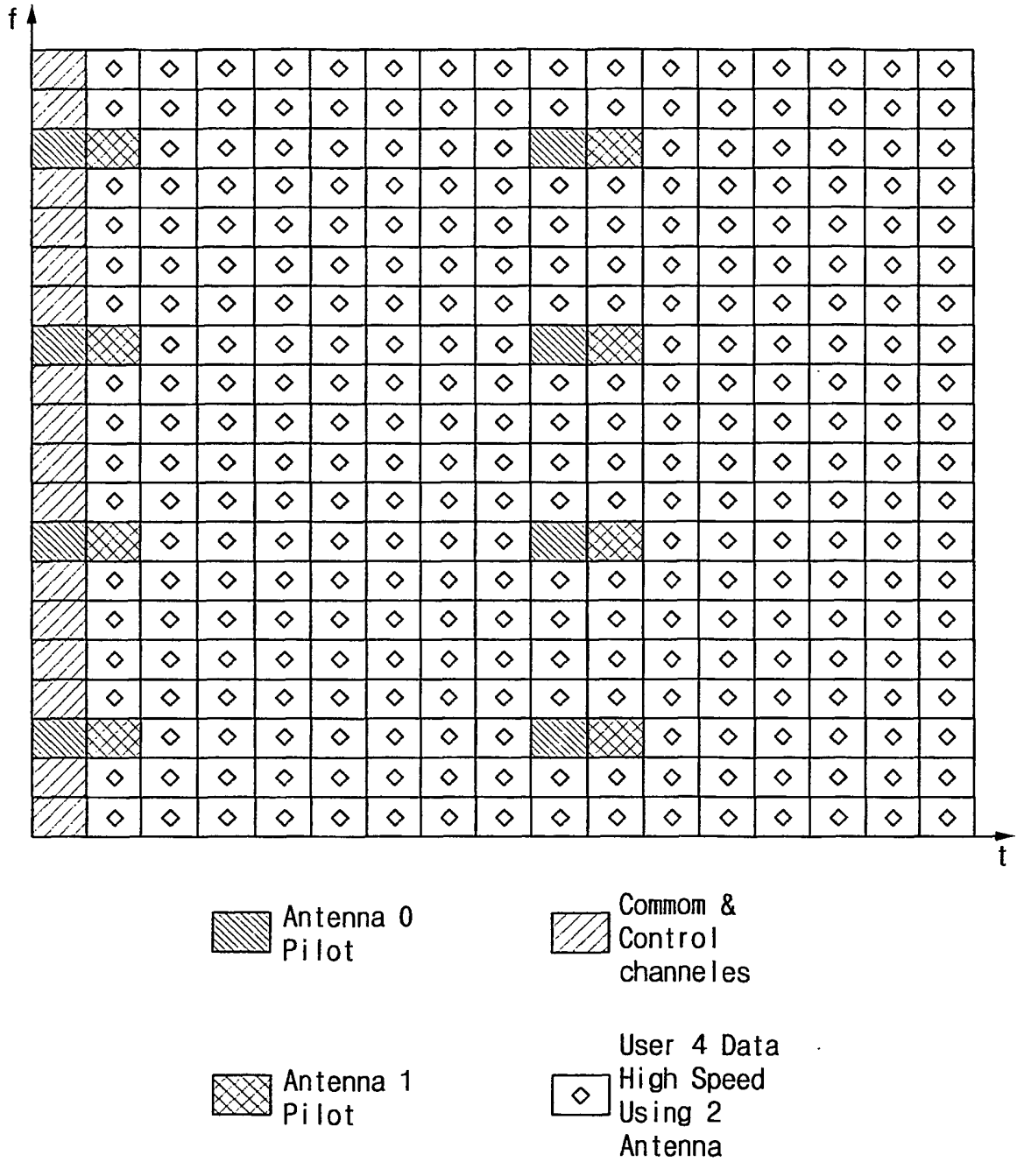

f
t
Antenna 0 Pilot
Commom & Control channeles
Antenna 1 Pilot
User 4 Data High Speed Using 2 Antenna

Fig. 9

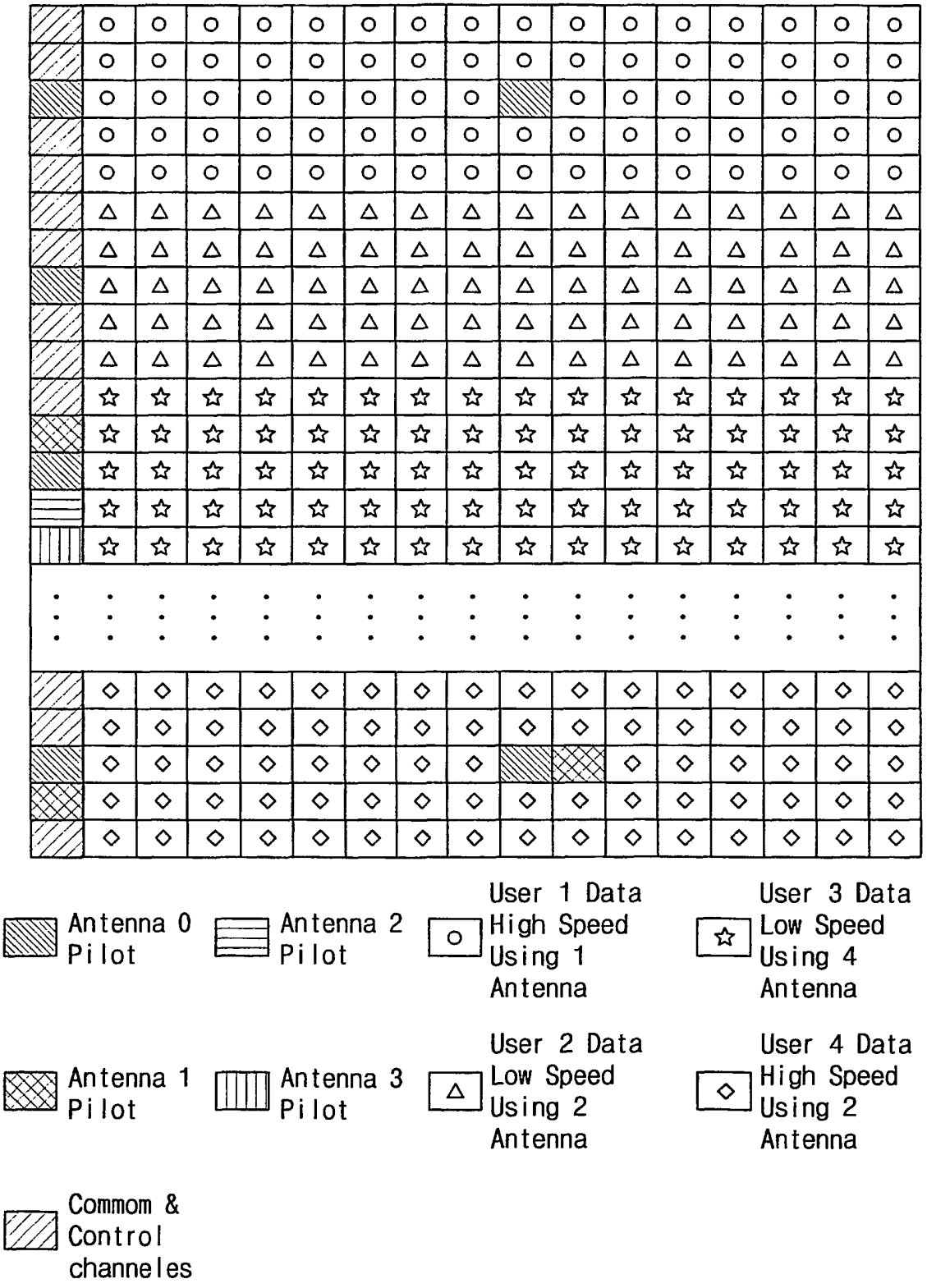

Antenna 0 Pilot
Antenna 2 Pilot
User 1 Data High Speed Using 1 Antenna
User 3 Data Low Speed Using 4 Antenna
Antenna 1 Pilot
Antenna 3 Pilot
User 2 Data Low Speed Using 2 Antenna
User 4 Data High Speed Using 2 Antenna
Commom & Control channeles

Fig. 10

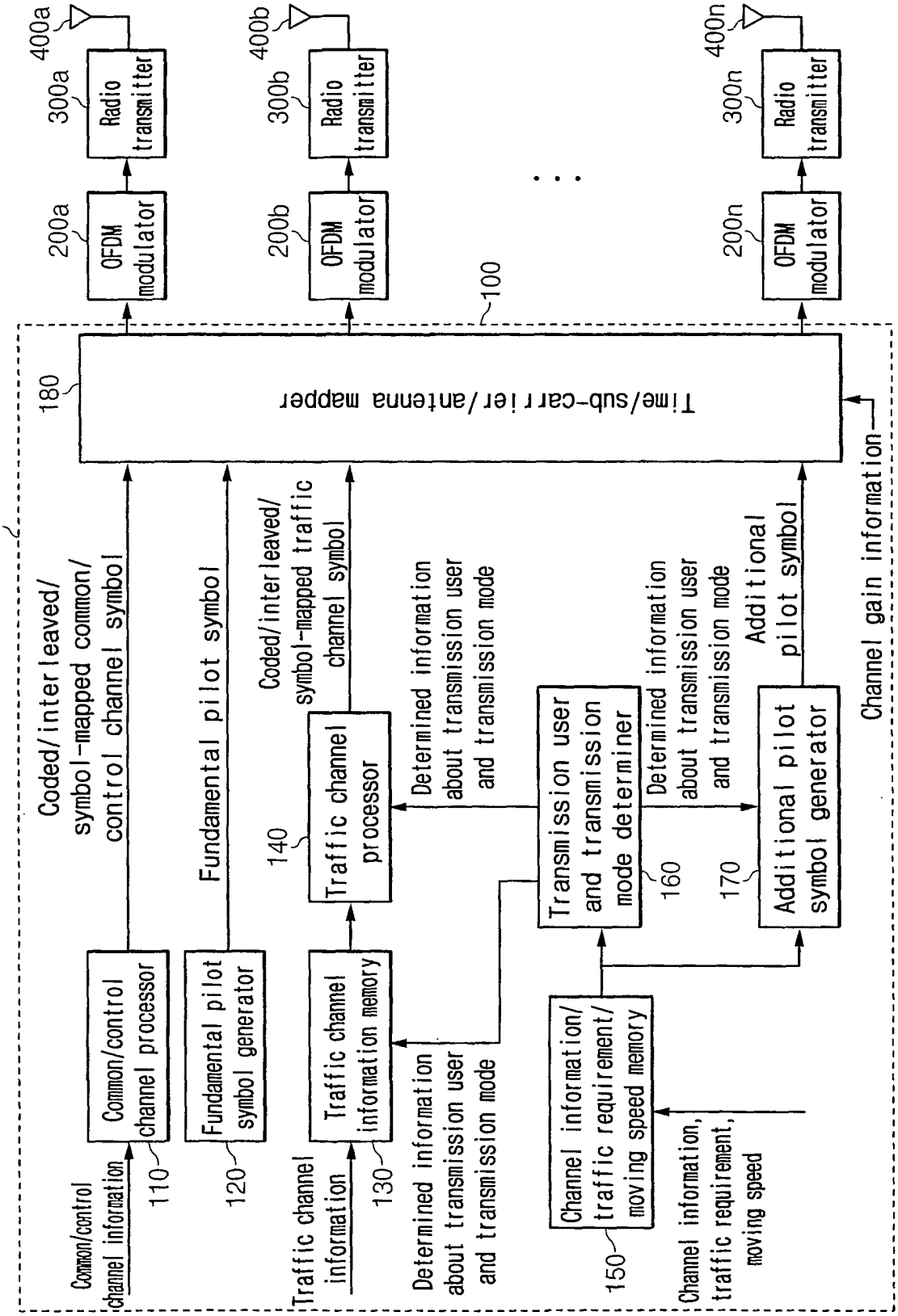

100
Common/control channel information
Common/control channel processor
110
Fundamental pilot symbol generator
120
Traffic channel information
Traffic channel information memory
130
Traffic channel processor
140
Channel information/ traffic requirement/ moving speed memory
150
Channel information, traffic requirement, moving speed
Transmission user and transmission mode determiner
160
Determined information about transmission user and transmission mode
Determined information about transmission user and transmission mode
Additional pilot symbol generator
170
Additional pilot symbol
Coded/interleaved/ symbol-mapped common/ control channel symbol
Fundamental pilot symbol
Coded/interleaved/ symbol-mapped traffic channel symbol
Channel gain information
Time/sub-carrier/antenna mapper
180
200a
OFDM modulator
200b
OFDM modulator
200n
OFDM modulator
300a
Radio transmitter
300b
Radio transmitter
300n
Radio transmitter
400a
400b
400n

Fig. 11

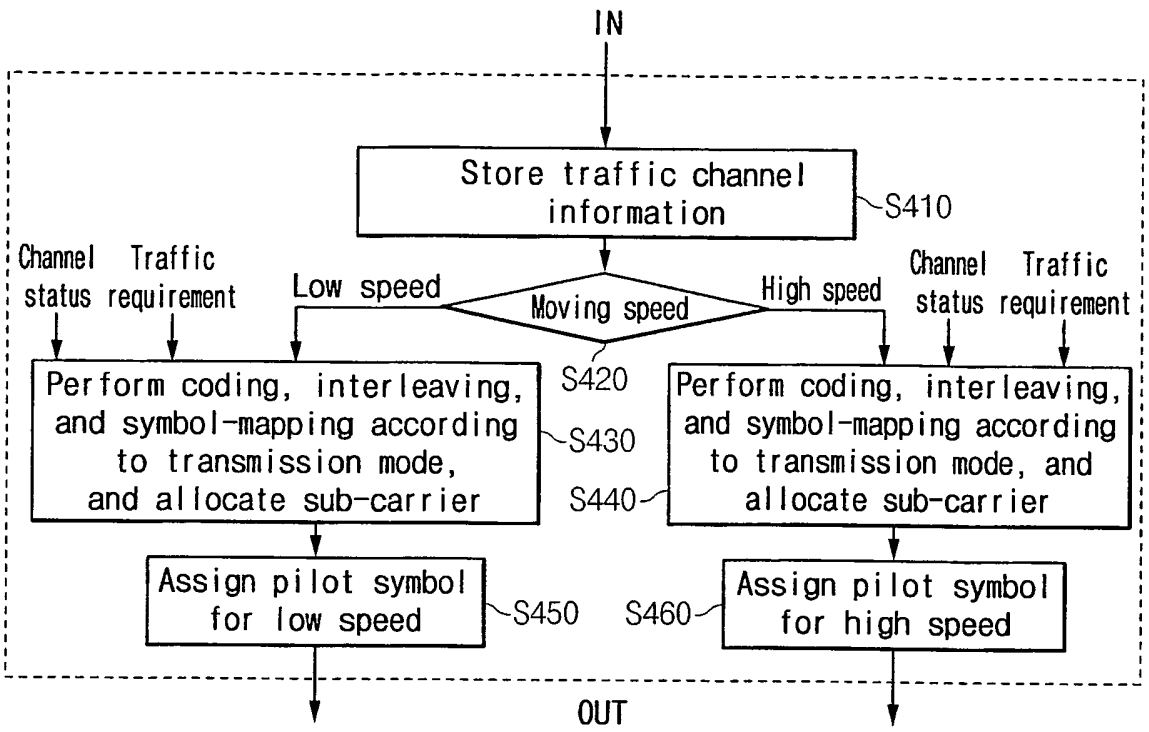
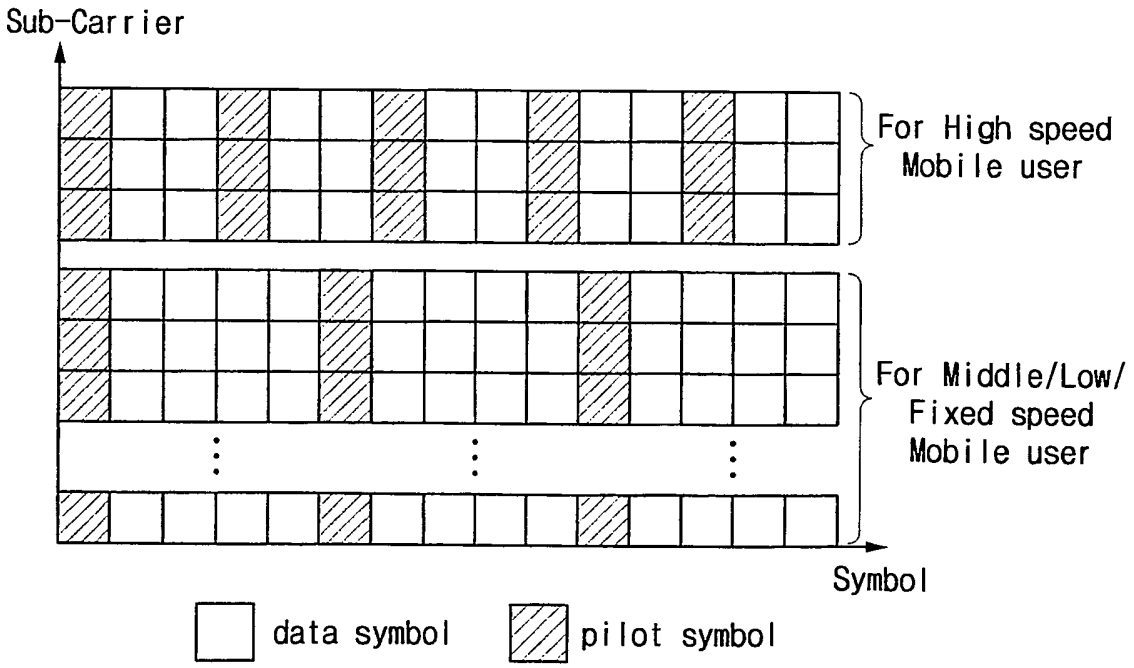

IN
Store traffic channel information
S410
Channel status
Traffic requirement
Low speed
Moving speed
High speed
Channel status
Traffic requirement
S420
Perform coding, interleaving, and symbol-mapping according to transmission mode, and allocate sub-carrier
S430
S440
Perform coding, interleaving, and symbol-mapping according to transmission mode, and allocate sub-carrier
Assign pilot symbol for low speed
S450
S460
Assign pilot symbol for high speed
OUT

Fig. 12


Sub-Carrier
For High speed Mobile user
For Middle/Low/ Fixed speed Mobile user
Symbol
data symbol
pilot symbol

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 938208 A1 **[0010]**

Non-patent literature cited in the description

- **F. CLASSEN ; M. SPETH ; H. MEYR.** Channel estimation units for an OFDM system suitable for mobile communication. *ITG Conference on Mobile Radio,* September 1995 **[0004]**
- Pilot-symbol-aided channel estimation in time and frequency. **P. HOEHER et al.** Multi-carrier Spread-Spectrum. Kluwer Academic Publishers, 1997 **[0006]**
- **M. J. FERNANDEZ-GETINO GARCIA et al.** Efficient pilot patterns for channel estimation in OFDM systems over HF channels. *Proc IEEE VTC,* 1999 **[0006]**