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[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR GENERATING CONTROL INFORMATION IN WIRELESS COMMUNICATION SYSTEM

CQI index	CQI index in current table	Modulation	Code rate x 1024	Efficiency
0	0	out of range		
1	2	QPSK	120	0.2344
2	4	QPSK	308	0.6016
3	6	QPSK	602	1.1758
4	7	16QAM	378	1.4766
5	8	16QAM	490	1.9141
6	9	16QAM	616	2.4063
7	10	64QAM	466	2.7305
8	11	64QAM	567	3.3223
9	12	64QAM	666	3.9023
10	13	64QAM	772	4.5234
11	14	64QAM	873	5.1152
12	-	256QAM	x	x
13	-	256QAM	x	x
14	-	256QAM	x	x
15	-	256QAM	x	x

(57) Abstract: A method for generating control information by a terminal in a wireless communication system is provided. The method includes determining whether the terminal supports a high-order modulation scheme, and if the terminal supports the high-order modulation scheme, feeding back control information for supporting the high-order modulation scheme to a base station. The control information includes a first Channel Quality Indicator (CQI) table for supporting the high-order modulation scheme, and the first CQI table is generated by removing a plurality of CQI entries from a second CQI table including a low-order modulation scheme, and replacing a last CQI table index as the high-order modulation scheme.

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Description

Title of Invention: METHOD AND APPARATUS FOR GENERATING CONTROL INFORMATION IN WIRELESS COMMUNICATION SYSTEM

Technical Field

[1] The present disclosure relates to a method and apparatus for generating control information in a wireless communication system.

Background Art

[2] The present disclosure relates to a method and apparatus for generating control information in a wireless communication system.

Disclosure of Invention

Technical Problem

[3] The demand for wireless data traffic is on the rise since the commercialization of the 4th Generation (4G) communication system. In order to satisfy this demand, efforts have been made to develop an improved 5th Generation (5G) communication system or a pre-5G communication system. For this reason, the 5G communication system or pre-5G communication system is sometimes referred to as a Beyond 4G Network communication system or a Post Long Term Evolution (LTE) system. In order to achieve a high data transfer rate, the 5G communication system may be considered to be implemented in a millimeter wave (mmWave) band (e.g., a 60GHz band, etc.). In order to ease the path loss of the radio wave and increase the reach of the radio wave in the millimeter wave band, technologies such as beamforming, massive Multiple Input Multiple Output (MIMO), Full Dimensional MIMO (FD-MIMO), array antenna, analog beamforming, and large scale antenna have been discussed for the 5G communication system. Further, in order to improve the network of the system, technologies such as evolved small cell, advanced small cell, cloud Radio Access Network (cloud RAN), ultra-dense network, Device to Device communication (D2D), wireless backhaul, moving network, cooperative communication, Coordinated Multi-Points (CoMP), and received interference cancellation have been developed for the 5G communication system. In addition, an Advanced Coding Modulation (ACM) scheme such as Hybrid FSK and Quadrature Amplitude Modulation (QAM) and Sliding Window Superposition Coding (SWSC), and an advanced access technology such as Filter Bank Multi Carrier (FBMC), Non Orthogonal Multiple Access (NOMA), and Sparse Code Multiple Access (SCMA) have been developed for the 5G communication system.

[4] On the other hand, the Internet has evolved from the human-centered connection

network in which the humans generate and consume information, into the Internet of Things (IoT) network in which distributed components such as things exchange information with each other to process the information. Even Internet of Everything (IoE) technology has emerged, in which Big Data processing technology and the like is combined with the IoT technology through the connection with a cloud server and the like. In order to implement the IoT, technical components such as sensing technology, wired/wireless communication and network infrastructure, service interface technology and security technology are required, and in recent years, technologies such as sensor network for connection between things, Machine to Machine (M2M), and Machine Type Communication (MTC) have been developed. In the IoT environment, an intelligent Internet Technology (IT) service may be provided to create a new benefit for people by collecting and analyzing the data generated in the connected things. IoT may be used in various fields such as Smart Home, Smart Building, Smart City, Smart Car (or Connected Car), Smart Grid, Healthcare, Smart Appliances, and Advanced Media Service through the convergence and integration between the existing Information Technology (IT) technology and various industries.

[5] Accordingly, various attempts have been made to apply the 5G communication system to the IoT network. For example, the technologies such as sensor network, M2M and MTC may be implemented by 5G communication technology such as beamforming, MIMO and array antenna. Applying the cloud RAN as the above-described Big Data processing technology may be an example of the convergence of the 5G technology and the IoT technology.

[6] FIG. 1 illustrates a basic structure of a time-frequency domain that is a radio resource domain where data or control information is transmitted in a downlink in an LTE system according to the related art.

[7] Referring to FIG. 1, the vertical axis represents the time domain and the horizontal axis represents the frequency domain. The minimum transmission unit in the time domain may be an Orthogonal Frequency Division Multiplexing (OFDM) symbol. N_{symb} OFDM symbols 102 may constitute one slot 106, and two slots may constitute one subframe 105. A length of the slot may be 0.5ms, and a length of the subframe may be 1.0ms. The minimum transmission unit in the frequency domain may be a subcarrier.

[8] In the time-frequency domain, the basic unit of resource may be a Resource Element (RE) 112, which can be represented by an OFDM symbol index and a subcarrier index. A Resource Block (RB) 108 or a Physical Resource Block (PRB) may be defined as N_{symb} consecutive OFDM symbols 102 in the time domain and N^{RB}_{SC} consecutive subcarriers 110 in the frequency domain. Therefore, one RB 108 may include N_{symb} x N^{RB}_{SC} REs 112. Generally, the minimum transmission unit of data may be the RB, and the system transmission band may include a total of N_{RB} RBs. In addition, the entire

system transmission band may include a total of N_{RB} x N^{RB}_{SC} subcarriers 104. Generally, in the LTE system, N_{symb} = 7 and N^{RB}_{SC} =12.

[9] Control information may be transmitted on the first N or fewer OFDM symbols in the subframe. Generally, a control channel transmission period N may be N = {1, 2, 3}. Therefore, the value of N may be changed in each subframe depending on the amount of control information that should be transmitted in the current subframe. The control information may include an indicator indicating the number of OFDM symbols over which the control information is transmitted, scheduling information for uplink (UL) or downlink (DL) data, Hybrid Automatic Repeat reQuest (HARQ) ACK/NACK signal, and the like.

[10] The LTE system may employ the HARQ scheme in which a physical layer re-transmits the data if a decoding failure occurs in the initial transmission. In the HARQ scheme, if a receiver fails to decode data correctly, the receiver may transmit information (e.g., NACK) indicating the decoding failure to a transmitter, so the transmitter may retransmit the data in its physical layer. The receiver may combine the data retransmitted by the transmitter with the existing data that the receiver has failed to decode, to increase the data reception performance. On the other hand, if the receiver has decoded data correctly, the receiver may transmit information (e.g., ACK) indicating the decoding success to the transmitter, so the transmitter may transmit new data.

[11] In a broadband wireless communication system, one of the important things to provide a high-speed wireless data service may be support of a scalable bandwidth. As an example, the system transmission band of the LTE system may have various bandwidths such as 20, 15, 10, 5, 3, and 1.4 MHz. Therefore, service providers may provide a service by selecting a particular bandwidth from among the various bandwidths. In addition, there may be various types of terminals, including a terminal capable of supporting a maximum of a 20 MHz bandwidth and a terminal capable of supporting a minimum of a 1.4 MHz bandwidth.

[12] In the LTE system, scheduling information for uplink or downlink data may be provided by a base station to a terminal through Downlink Control Information (DCI). The uplink means a wireless link via which a terminal transmits data or a control signal to a base station, and the downlink means a wireless link via which a base station transmits data or a control signal to a terminal. For the DCI, several formats may be defined, and a predetermined DCI format may be applied depending on whether the scheduling information is scheduling information (e.g., a UL grant) for uplink data or scheduling information (e.g., a DL grant) for downlink data, whether the size of the control information is a small (compact DCI), whether spatial multiplexing based on multiple antennas is applied, and whether the DCI is a DCI for power control. For

example, DCI format 1, which is scheduling control information (e.g., a DL grant) for downlink data, may be configured to include the following control information.

[13] Resource allocation type 0/1 flag: Resource allocation type 0/1 flag notifies whether the resource allocation scheme is type 0 or type 1. A Type-0 flag is to allocate resources in units of Resource Block Group (RBG) by applying a bitmap scheme. In the LTE system, the basic unit of scheduling may be a Resource Block (RB) that is expressed by time-frequency domain resources, and the RBG may include multiple RBs and may be the basic unit of scheduling in the Type-0 scheme. A Type-1 flag is to allocate a particular RB in an RBG.

[14] Resource block assignment: Resource block assignment notifies an RB allocated for data transmission. The resources may be determined depending on the system bandwidth and the resource allocation scheme.

[15] Modulation and Coding Scheme (MCS): MCS notifies a modulation scheme used for data transmission and a size of a transport block to be transmitted.

[16] HARQ process number: HARQ process number notifies a process number of HARQ.

[17] New data indicator: New data indicator notifies whether the HARQ transmission is an initial transmission or a retransmission.

[18] Redundancy version: Redundancy version notifies a redundancy version of HARQ.

[19] TPC command for PUCCH: Transmit Power Control (TPC) command for Physical Uplink Control Channel (PUCCH) notifies a power control command for a PUCCH that is an uplink control channel.

[20] The DCI may be transmitted over a Physical Downlink Control Channel (PDCCH) after undergoing a channel coding and modulation process.

[21] Generally, the DCI may undergo channel coding for each terminal independently, and then, the channel-coded DCI may be configured with its dependent PDCCH and transmitted. In the time domain, a PDCCH may be mapped and transmitted during the control channel transmission period. The frequency-domain mapping location of the PDCCH may be determined by an ID of each terminal, and may be spread throughout the entire system transmission band.

[22] Downlink data may be transmitted over a Physical Downlink Shared Channel (PDSCH) that is a physical channel for downlink data transmission. A PDSCH may be transmitted since the control channel transmission period, and the scheduling information such as the detailed mapping location in the frequency domain and the modulation scheme may be notified by the DCI that is transmitted over the PDCCH.

[23] Using a 5-bit Modulation and Coding Scheme (MCS) in the control information constituting the DCI, the base station may notify the terminal of the modulation scheme applied to the PDSCH to be transmitted and the size (e.g., a Transport Block Size (TBS)) of the data to be transmitted. The TBS may correspond to the size given before

channel coding for error correction is applied to the data to be transmitted by the base station.

[24] Generally, the modulation scheme supported by the LTE system may include Quadrature Phase Shift Keying (QPSK), 16-ary QAM, 64QAM and the like. However, a Channel Quality Indicator (CQI) and MCS table generation method supporting 256QAM has not been defined for the LTE system.

[25] The above information is presented as background information only to assist with an understanding of the present disclosure. No determination has been made, and no assertion is made, as to whether any of the above might be applicable as prior art with regard to the present disclosure.

Solution to Problem

[26] Aspects of the present disclosure are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the present disclosure is to provide a method and apparatus for generating Channel Quality Indicator (CQI) and Modulation and Coding Scheme (MCS) tables in a communication system supporting 256 Quadrature Amplitude Modulation (QAM).

[27] In accordance with an aspect of the present disclosure, a method for generating control information by a terminal in a wireless communication system is provided. The method includes determining whether the terminal supports a high-order modulation scheme, and if the terminal supports the high-order modulation scheme, feeding back control information for supporting the high-order modulation scheme to a base station. The control information includes a first CQI table for supporting the high-order modulation scheme. The first CQI table is generated by removing a plurality of CQI entries from a second CQI table including a low-order modulation scheme and replacing a last CQI table index as the high-order modulation scheme.

[28] In accordance with another aspect of the present disclosure, a method for generating control information by a base station in a wireless communication system is provided. The method includes determining a first MCS table based on a channel status. The first MCS table is generated by removing a plurality of MCS entries related to a low-order modulation scheme from a second MCS table and setting a last MCS table index as a retransmission mode for a high-order modulation scheme.

[29] In accordance with another aspect of the present disclosure, an apparatus for generating control information in a terminal for a wireless communication system is provided. The apparatus includes a controller configured to determine whether the terminal supports a high-order modulation scheme, and if the terminal supports the high-order modulation scheme, to feed back control information for supporting the

high-order modulation scheme to a base station. The control information includes a first CQI table for supporting the high-order modulation scheme. The first CQI table is generated by removing a plurality of CQI entries from a second CQI table including a low-order modulation scheme and replacing a last CQI table index as the high-order modulation scheme.

[30] In accordance with another aspect of the present disclosure, an apparatus for generating control information in a base station for a wireless communication system is provided. The apparatus includes a controller configured to determine a first MCS table based on a channel status. The first MCS table is generated by removing a plurality of MCS entries related to a low-order modulation scheme from a second MCS table and setting a last MCS table index as a retransmission mode for a high-order modulation scheme.

[31] Other aspects, advantages, and salient features of the disclosure will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses various embodiments of the present disclosure.

Brief Description of Drawings

[32] The above and other aspects, features, and advantages of certain embodiments of the present disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

[33] FIG. 1 illustrates a basic structure of a time-frequency domain in a Long Term Evolution (LTE) system according to the related art;

[34] FIG. 2 is a table illustrating a modulation scheme and a Transport Block Size (TBS) index corresponding to a Modulation and Coding Scheme (MCS) in an LTE system according to an embodiment of the present disclosure;

[35] FIGS. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 illustrate TBS tables defined in an LTE system according to various embodiments of the present disclosure;

[36] FIGS. 14a, 14b, 14c, and 14d are constellations illustrating modulation methods available according to various embodiments of the present disclosure;

[37] FIG. 15 illustrates how a terminal transmits Channel Quality Indicator (CQI), which is one of channel status information, depending on the signal energy and interference strength measured by the terminal according to an embodiment of the present disclosure;

[38] FIGS. 16 and 17 illustrate CQI tables generated according to various embodiments of the present disclosure;

[39] FIG. 18 is a graph illustrating a theoretical capacity curve according to an embodiment of the present disclosure;

[40] FIG. 19 illustrates a CQI table that is obtained from FIG. 16 through the code rate determination method-1 according to an embodiment of the present disclosure;

[41] FIG. 20 illustrates a CQI table that is obtained from FIG. 17 through the code rate determination method-1 according to an embodiment of the present disclosure;

[42] FIG. 21 illustrates a CQI table that is obtained from FIG. 16 through the code rate determination method-2 according to an embodiment of the present disclosure;

[43] FIG. 22 illustrates a CQI table that is obtained from FIG. 17 through the code rate determination method-2 according to an embodiment of the present disclosure;

[44] FIGS. 23 and 24 illustrate MCS tables generated according to various embodiments of the present disclosure;

[45] FIG. 25 is a flowchart illustrating how to use a CQI table according to an embodiment of the present disclosure;

[46] FIG. 26 is a flowchart illustrating how to use an MCS table according to an embodiment of the present disclosure;

[47] FIGS. 27a, 27b, 27c, 27d, and 28 illustrate experimental results using an MCS table generated according to various embodiments of the present disclosure;

[48] FIG. 29 illustrates a structure of a terminal according to an embodiment of the present disclosure; and

[49] FIG. 30 illustrates a structure of a base station according to an embodiment of the present disclosure.

[50] Throughout the drawings, like reference numerals will be understood to refer to like parts, components, and structures.

Mode for the Invention

[51] The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of various embodiments of the present disclosure as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the present disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

[52] The terms and words used in the following description and claims are not limited to the bibliographical meanings, but, are merely used by the inventor to enable a clear and consistent understanding of the present disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of various embodiments of the present disclosure is provided for illustration purpose only and not for the purpose of limiting the present disclosure as defined by the appended claims and their equivalents.

[53] It is to be understood that the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a component surface" includes reference to one or more of such surfaces.

[54] By the term "substantially" it is meant that the recited characteristic, parameter, or value need not be achieved exactly, but that deviations or variations, including for example, tolerances, measurement error, measurement accuracy limitations and other factors known to those of skill in the art, may occur in amounts that do not preclude the effect the characteristic was intended to provide.

[55] In the following description, a Base Station (BS), which is an entity for performing resource allocation for a terminal, may be at least one of an evolved Node B (eNB), a Node B, a BS, a wireless access unit, a BS Controller (BSC), or a node on a network.

[56] A terminal may include a User Equipment (UE), a Mobile Station (MS), a cellular phone, a smart phone, a computer, or a multimedia system with a communication function. Although specific embodiments of the present disclosure will be described in connection with, for example, an Evolved-Universal Terrestrial Radio Access (E-UTRA) (or Long Term Evolution (LTE)) system or an Advanced E-UTRA (or LTE-Advanced (LTE-A)) system, an embodiment of the present disclosure may be applied to any other communication systems having the similar technical backgrounds and/or channel formats. In addition, it will be apparent to those of ordinary skill in the art that an embodiment of the present disclosure may be applied to other communication systems with some modifications without departing from the scope of the present disclosure.

[57] The modulation scheme supported by the LTE system may include Quadrature Phase Shift Keying (QPSK), 16-ary Quadrature Amplitude Modulation (QAM), and 64QAM, a modulation order of which corresponds to $(Q_m) = \{2, 4, 6\}$, respectively. In other words, it is possible to transmit 2 bits per QPSK modulation symbol, 4 bits per 16QAM modulation symbol, and 6 bits per 64QAM modulation symbol.

[58] FIG. 2 is a table illustrating a modulation scheme and a Transport Block Size (TBS) index corresponding to a Modulation and Coding Scheme (MCS) in an LTE system according to an embodiment of the present disclosure.

[59] For example, if MCS is 10 ($I_{MCS} = 10$), it indicates that the modulation scheme is 16QAM and the TBS index I_{TBS} is 9. The size (e.g., TBS) of downlink data transmitted to a terminal may be determined by the number N_{PRB} of Resource Blocks (RBs) allocated to the terminal and the TBS index I_{TBS}.

[60] FIGS. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 illustrate TBS tables defined in an LTE system according to various embodiments of the present disclosure.

[61] Specifically, FIGS. 3 to 13 illustrate TBSs corresponding to TBS indexes I_{TBS} for $N_{PRB} = 1$ to $N_{PRB} = 110$.

[62] For example, if the BS notifies 'N_{PRB} = 10' to the terminal using 'Resource block assignment' control information constituting the DCI, and notifies 'I_{MCS} = 10' to the terminal using the MCS, it indicates that the TBS index I_{TBS} is 9 in FIG. 2 and the TBS is 1544 in FIG. 3.

[63] To increase the transmission efficiency of the LTE system, the introduction of a high-order modulation scheme such as 256QAM has been considered.

[64] FIGS. 14a, 14b, 14c, and 14d illustrate modulation methods according to various embodiments of the present disclosure.

[65] It is possible to consider using 256QAM as shown in FIG. 14d, in addition to the modulation orders of 2, 4, and 6 used in the LTE system as shown in FIGS. 14a to 14c. 256QAM, a modulation order of which is 8, may transmit 8 bits per modulation symbol, so its transmission efficiency (discussed below) is higher than that of 64QAM by 33% or more.

[66] In a mobile communication system, it is necessary to transmit a reference signal in order to measure a downlink channel status. For example, in the case of the 3rd Generation Partnership Project (3GPP) LTE-A system, a terminal may measure a channel status between a BS and the terminal itself, using a Channel Status Information Reference Signal (CSI-RS) transmitted by the BS. For the channel status, several factors should be considered by default, and may include interference in a downlink. The interference in a downlink may include an interference signal, thermal noise and the like, which are generated by an antenna of an adjacent BS, and the interference in a downlink may be important in determining the channel condition of the downlink by the terminal. For example, if a BS with one transmit antenna transmits a reference signal to a terminal with one receive antenna, the terminal should determine a parameter Es/Io indicating the received signal strength by determining the energy per symbol that can be received via a downlink and the interference that is to be received at the same time in the interval where the symbol is received, based on the reference signal received from the BS. The determined Es/Io may be notified to the BS, allowing the BS to determine at which data transfer rate the BS will perform downlink transmission to the terminal.

[67] FIG. 15 illustrates how a terminal transmits CQI, which is one of channel status information, depending on the signal energy and interference strength measured by the terminal according to an embodiment of the present disclosure.

[68] Referring to FIG. 15, a terminal may perform channel estimation by measuring a downlink reference signal such as CSI-RS, and calculate the received signal energy Es for a wireless channel using the channel estimate as shown by reference numeral 1500. In addition, the terminal may calculate the intensity Io of interference and noise using the downlink reference signal or the separate resource for interference or noise mea-

surement, as shown by reference numeral 1510. In the LTE system, a Cell-specific Reference Signal (CRS) that is a downlink reference signal may be used for interference and noise measurement, or the BS may configure an interference measurement resource for the terminal so that the terminal may assume the signal measured in the wireless resource as interference and noise. Using the received signal energy Es and the intensity Io of interference and noise, which are obtained in this way, the terminal may determine the maximum data transfer rate that the terminal can receive data with a predetermined success rate at the signal to interference and noise ratio calculated by the terminal itself, and then notify the determined maximum data transfer rate to the BS. Upon receiving a notification of the maximum data transfer rate that the terminal can support at the calculated signal to interference and noise ratio, the BS may determine the actual data transfer rate for a downlink data signal that the BS will transmit to the terminal at the maximum data transfer rate. The maximum data transfer rate that the terminal has notified to the BS and at which the terminal can receive data with a predetermined success rate will be referred to as CQI in the LTE standard. Since a wireless channel is generally changed over time, the terminal may periodically notify the CQI to the BS as shown by reference numeral 1520, or may report the CQI each time the BS requests CQI from the terminal. The BS may request CQI from the terminal in at least one of a periodic way and an aperiodic way.

[69] A detailed CQI and MCS table generation method for supporting 256QAM according to an embodiment of the present disclosure will be described in detail.

[70] In a first embodiment of the present disclosure, a CQI table generation method to which high-order modulation such as 256QAM is applied is provided.

[71] In a second embodiment of the present disclosure, an MCS table generation method to which high-order modulation such as 256QAM is applied is provided.

[72] With respect to 256QAM support according to the first embodiment of the present disclosure, the CQI table generation method may be as follows:

[73] - In order to prevent an undesired increase of signaling overhead, the amount of CQI information may be maintained at 4 bits as in the prior art.

[74] - CQI index #0 may be maintained as out-of-range.

[75] - In order to newly define 256QAM in the CQI table, 3 CQI entries corresponding to QPSK may be removed from the existing CQI table.

[76] - In order to newly define 256QAM in the CQI table, the last CQI table index #15 may be replaced as 256QAM in the existing CQI table.

[77] - A CQI table index including 256QAM may be rearranged according to the spectral efficiency.

[78] Therefore, the CQI table that can be considered based on the CQI table generation method may be as shown in FIG. 16 or 17.

[79] FIGS. 16 and 17 illustrate CQI tables generated according to the first embodiment of the present disclosure.

[80] FIGS. 16 and 17 may be distinguished according to the method of removing three CQI entries corresponding to QPSK from the existing CQI table. As the method of removing three CQI entries corresponding to QPSK from the existing CQI table, a method of removing CQI entries every other CQI entry without removing consecutive CQI indexes may be advantageous in maintaining a uniform Signal to Noise Ratio (SNR) gap between CQI entries. Since the channel status information is generally determined by the SNR, maintaining the uniform SNR gap between entries in the CQI table may enable the terminal to select a CQI capable of maximizing the transmission efficiency and notify the selected CQI to the BS. Therefore, FIG. 16 represents a case of removing three CQI indexes {#1, #3, #5} corresponding to even numbers from the existing CQI table, and FIG. 17 represents a case of removing three CQI indexes {#2, #4, #6} corresponding to odd numbers from the existing CQI table. By removing 3 CQI entries corresponding to QPSK from the existing CQI table and replacing the last CQI table index #15 as 256QAM, four 256QAM entries may be added as shown in FIGS. 16 and 17. If a code rate corresponding to each 256QAM entry is determined, the efficiency value may be automatically calculated. Generally, the efficiency value may be obtained by multiplying a modulation factor (or a modulation order) by a code rate. For example, in the case of 256QAM, if a code rate is 0.5, an efficiency value may be 4 by multiplying the modulation factor of 8 by the code rate of 0.5. The code rates of the 256QAM entries newly added in FIGS. 16 and 17 and the method of determining the efficiency values calculated from the code rates will be described in detail below.

[81] Next, with respect to 256QAM support according to the second embodiment of the present disclosure, the MCS table generation method may be as follows:

[82] - The amount of MCS information may be maintained at 5 bits as in the prior art.

[83] - 7 explicit entries for 256QAM may be defined in the MCS table.

[84] - A total of 4 implicit entries may be defined in the MCS table, and they may be used as retransmission modes for QPSK, 16QAM, 64QAM and 256QAM, respectively.

[85] Based on the above, a total of 8 MCS entries may be removed from the existing MCS table, for 256QAM support. Generally, it is preferable that the MCS table is designed to ensure the high transmission efficiency in the high-SNR region, and to ensure the good transmission efficiency in the flat or dispersive channel environment in both the mid- and low-SNR regions. Therefore, the method of determining the MCS entries to be removed from the existing MCS table will be described in detail below.

[86] Based on the above discussion, a method of defining the CQI and MCS tables for supporting 256QAM will be proposed through specific embodiments of the present

disclosure.

[87] First Embodiment of Present Disclosure

[88] First, for the four 256QAM entries newly added in FIGS. 16 and 17, efficiency values E12 and E15 corresponding to CQI indexes #12 and #15 may be determined as follows:

[89] - E12: an efficiency value of 5.5547, which corresponds to the existing CQI table index #15, may be reused.

[90] - E15: an efficiency value of 7.4063 (=8x(948/1024)) may be determined based on the code rate that is used for the existing CQI table index #15.

[91] However, the determination of the values for E12 and E15 will not be limited to the above method. For example, the efficiency value for E12 may be newly determined taking into account the SNR gap with 64QAM corresponding to the CQI table index #11 in FIG. 16 or 17. In addition, the efficiency value for E15 may be determined based on the limit value for the code rate. Generally, if the code rate has a value close to 1, there is no effect of channel coding, so the limit value for the code rate may be determined. For example, in the case of the LTE system, an efficiency value for E15 may be determined as 8x0.93=7.44 based on the limit value of 0.93 for the code rate.

[92] In the present disclosure, a method of determining a code rate of a 256QAM entry will be considered in the state where an efficiency value E12 of a CQI index #12 and an efficiency value E15 of a CQI index #15 are determined in FIGS. 16 and 17:

[93] - Code rate determination method-1: an SNR value may be acquired using a theoretical capacity value.

[94] - Code rate determination method-2: efficiency values of CQI indexes #13 and #14 may be acquired with an intermediate value between E12 and E15.

[95] The code rate determination method-1 proposed in the present disclosure may be a method of finding a code rate having a uniform SNR gap using a theoretical capacity value. A theoretical capacity curve is illustrated in FIG. 18.

[96] FIG. 18 is a graph illustrating a theoretical capacity curve according to an embodiment of the present disclosure.

[97] Referring to FIG. 18, the solid line represents an ideal capacity value that can be obtained from a particular SNR without considering a particular modulation method. Other dotted lines represent capacity values that can be obtained from a particular SNR when modulation schemes of QPSK, 16QAM, 64QAM and 256QAM are used, respectively.

[98] The code rate determination method-1 may determine a code rate from the capacity value in FIG. 18 for a case where a particular modulation scheme is used, under the assumption that the LTE system can approach the theoretical capacity in the Additive White Gaussian Noise (AWGN) environment using the Turbo code. For example, if an

efficiency value E12 of the CQI index #12 is determined as 5.5547, it can be found that an SNR value from which the capacity of 5.5547 is acquired in FIG. 18 is 16.54dB, from the capacity curve obtained when the 256QAM modulation scheme is used. After acquiring the SNR value satisfying the efficiency value for the CQI index #12, an efficiency value for the next CQI index #13 may be acquired using the theoretical capacity value by adding a predetermined SNR to the acquired SNR value. In the same way, it is possible to obtain efficiency values for the CQI indexes #14 and #15. In this case, the SNR gap may be adjusted such that the efficiency value for the CQI index #15 may not exceed a pre-considered E15. It is possible to calculate the code rate from the efficiency value of each 256QAM entry, which is determined through the code rate determination method-1.

[99] FIG. 19 illustrates a CQI table that is obtained from FIG. 16 through the code rate determination method-1 according to an embodiment of the present disclosure, and FIG. 20 illustrates a CQI table that is obtained from FIG. 17 through the code rate determination method-1 according to an embodiment of the present disclosure.

[100] Referring to FIGS. 19 and 20, after values of E12 and E15 are determined as 5.5547 and 7.4063, respectively, the efficient values corresponding to the CQI table indexes #13 and #14 may be determined based on the uniform SNR gap of 2.1166dB, using the capacity value of 256QAM in FIG. 18. However, as described above, the values of E12 and E15 may be set differently, and the code rates according thereto may be determined differently from FIGS. 19 and 20. In addition, the code rate determination method-1 may be obtained approximately from the ideal solid-line capacity curve instead of using the capacity curve corresponding to the modulation scheme in FIG. 18.

[101] The code rate determination method-2 proposed in the present disclosure may be a method of acquiring efficiency values of the CQI indexes #13 and #14 from pre-set values of E12 and E15, using an intermediate value between them. This is based on the assumption that if an efficiency region is divided at equal intervals by reflecting the fact that the ideal solid-line capacity value increases linearly in the high-SNR region in FIG. 18, the SNR region may also be divided at equal intervals.

[102] FIG. 21 illustrates a CQI table that is obtained from FIG. 16 through the code rate determination method-2 according to an embodiment of the present disclosure, and FIG. 22 illustrates a CQI table that is obtained from FIG. 17 through the code rate determination method-2 according to an embodiment of the present disclosure.

[103] Noting the fact that a value of a code rate in FIG. 21 or 22 is not greatly different from a value of a code rate corresponding to 256QAM in FIG. 19 or 20, the code rate determination method-2 may have an advantage that it can determine a code rate value more easily without using the theoretical capacity value.

[104] Second Embodiment of Present Disclosure

[105] The second embodiment of the present disclosure proposes an MCS table configuring method for 256QAM support.

[106] FIGS. 23 and 24 illustrate MCS tables generated according to various embodiments of the present disclosure.

[107] The second embodiment of the present disclosure may include a method of determining a total of 8 MCS entries that are removed from the existing MCS table to add seven explicit entries and one implicit entry for 256QAM without changing the amount of 5-bit information of the existing MCS table.

[108] First, seven explicit MCS entries may be determined with an intermediate value of the efficiency for four 256QAM entries and each entry defined in the CQI table. The specific method is illustrated in FIG. 23 based on the CQI tables in FIGS. 21 and 22.

[109] Referring to FIG. 23, MCS indexes #21, #23, #25 and #27 represent four 256QAM entries defined in the CQI table, and MCS indexes #22, #24 and #26 are MCS indexes that are obtained with an intermediate value of the efficiency for each entry. In the second embodiment of the present disclosure, an MCS table is generated on the assumption of the CQI tables in FIGS. 21 and 22. However, assuming the CQI tables in FIG. 19 and 20, which can be generated from the first embodiment of the present disclosure, the code rates and efficiency values for 256QAM, which are calculated in FIG. 23, may vary. Further, in FIG. 23, MCS #31 represents an implicit entry for a retransmission mode for 256QAM.

[110] Since a new MCS table is generally designed in consideration of the small cell environment, a good channel environment may be assumed. Therefore, it is preferable to remove low MCS indexes corresponding to QPSK from the existing MCS table. However, since the channel environment may be suddenly worse, it is necessary to design MCS tables in preparation for the change in the channel environment. Method 1 for this is as follows.

[111] Method 1: in order to ensure the performance of Radio Resource Control (RRC)/Voice over Internet Protocol (VoIP) as in the existing MCS table, TBS #0 may be maintained. To this end, MCS #0 should be maintained in the existing MCS table.

[112] Next, since a correlation between a CQI table and an MCS table is high, it is preferable to design an MCS table in consideration of the correlation. For example, a method may be considered in which CQI entries #1, #3 and #5 or CQI entries #2, #4 and #6 are removed so as to advantageously maintain the uniform SNR gap between CQI entries. Method 2 for this is as follows.

[113] Method 2: when removing low MCS indexes corresponding to QPSK, Method 2 may remove MCS entries every other MCS entry without removing consecutive MCS entries.

[114] In addition, if there is a need for other MCS entries that should be removed in adding eight 256QAM entries, the following Method 3 may be considered in consideration of the small cell environment where a new MCS table has the frequency-flat channel characteristics.

[115] Method 3: MCS entries may be removed from among the duplicate MCS entries (e.g., MCS indexes #9, #10, #16 and #17), which are generated with the same efficiency value for different modulation factors.

[116] In order to make a more accurate and logical decision with respect to the proposed method(s), reference will be made to the experimental results in FIGS. 27a to 27d. This experiment was conducted in consideration of the small cell environment, and for the specific experimental environment, reference may be made to FIG. 28.

[117] FIGS. 27a, 27b, 27c, 27d, and 28 illustrate the experimental results using an MCS table generated according to various embodiments of the present disclosure.

[118] Referring to FIG. 28, the parameters (e.g., system bandwidth, carrier frequency, channel model, and the like) and their values used in the experiment are listed. Based on the experimental results in FIGS. 27a to 27d, it is possible to obtain the following observation results:

[119] Observation result 1: it can be found from FIG. 27a that Method 2 makes it possible to maintain an SNR gap of about 2dB between MCS entries in a low-SNR region.

[120] Observation result 2: it can be found from FIGS. 27b and 27c that MCS #10 and MCS #17 corresponding to a high modulation factor among the duplicate MCS entries generated with the same efficiency value for different modulation factors show the Block Error Rate (BLER) performance which is duplicate with that of other MCS entities. Therefore, it is preferable to remove MCS #10 and MCS #17 by applying Method 3.

[121] Observation result 3: it can be found from FIG. 27d that BLER of MCS #28 is 1. This is because as a result of rate matching, the code rate is 1. Actually, since CQI entry #15 corresponding to MCS #28 is removed even from the CQI table, it is preferable to remove MCS #28 from the MCS table.

[122] Observation result 4: it can be found from FIG. 27d that if MCS #28 is removed, there is an SNR difference of 2dB or more between MCS #27 and a new 256QAM entry, so it is preferable to maintain MCS #27 at interpolation points of 64QAM and 256QAM.

[123] Based on the above observation results, the following MCS index removing method proposal is determined:

[124] Proposal 1: MCS #0 may be maintained according to Method 1.

[125] Proposal 2: when removing low MCS indexes corresponding to QPSK, this proposal may remove MCS entries every other MCS entry without removing consecutive MCS

entries according to the observation result 2 above.

[126] Proposal 3: this proposal may remove MCS #10 and MCS #17 corresponding to a high modulation factor among the duplicate MCS entries generated with the same efficiency value for different modulation factors according to the observation result 3 above.

[127] Proposal 4: MCS #28 may be removed by the observation result 4 above.

[128] Proposal 5: MCS #27 may be maintained according to the observation result 5 above.

[129] According to the above proposals, MCS indexes #1, #3, #5, #7, #9, #10, #17 and #28 may be removed from the existing MCS table on the basis of the existing MCS table, and the explicit and implicit entries for 256QAM may be added. A table for this case is illustrated in FIG. 23. However, the MCS table generation method according to the present disclosure will not be limited only to the method of removing MCS indexes #1, #3, #5, #7, #9, #10, #17 and #28 based on the existing MCS table. For example, it is possible to maintain the MCS index #9 and additionally remove other MCS indexes based on the existing MCS table. In addition, it is possible to maintain all the MCS indexes #9, #10, #16 and #17 whose modulation schemes are changed, and to additionally remove other MCS indexes, in the existing MCS table.

[130] In FIG. 23, TBS indexes #0 ~ #26 corresponding to MCS indexes are illustrated based on the existing MCS table. In addition, TBS indexes corresponding to newly added 256QAM entries are illustrated as TBS indexes #27 ~ #33 that are additional to the existing TBS indexes. However, if TBS indexes are newly defined in consideration of the MCS entries removed from the existing MCS table, the mapping between MCS indexes and TBS indexes may be newly defined as shown in FIG. 23.

[131] As shown in FIG. 23, the MCS entries newly added for 256QAM support may be arranged in the size of the efficiency and defined as a new table, and the MCS entries for 256QAM may be added in positions of the MCS entries #1, #3, #5, #7, #9, #10, #17, and #28 removed from the existing MCS table as shown in FIG. 24, in consideration of the operation of the existing legacy terminal.

[132] FIG. 25 is a flowchart illustrating how to use a CQI table according to an embodiment of the present disclosure.

[133] Referring to FIG. 25, first, a BS may signal RRC to a terminal, considering whether to support 25QAM. The terminal may perform RRC configuration in operation 2500, and determine in operation 2510 whether the current terminal is a terminal supporting 256QAM. If the terminal is not a terminal supporting 256QAM, the terminal may feed the channel status back to the BS using the existing CQI table in operation 2520. On the other hand, if it is determined in operation 2510 that the current terminal is a terminal supporting 256QAM, the terminal may feed the channel status back to the BS using the new CQI table (e.g., tables in FIGS. 16, 17, and 19 to 22) according to an

embodiment of the present disclosure, in operation 2530. A definition of the specific CQI table will follow the above-described embodiments.

[134] FIG. 26 is a flowchart illustrating how to use an MCS table according to an embodiment of the present disclosure.

[135] Referring to FIG. 26, first, a BS may determine in operation 2600 whether the current terminal supports 256QAM. If the current terminal does not support 256QAM, the BS may determine MCS by using the existing MCS table in operation 2610. However, if it is determined in operation 2600 that the current terminal supports 256QAM, the BS may determine MCS by using a new MCS table (e.g., tables in FIGS. 23 and 24) according to an embodiment of the present disclosure, in operation 2620. A definition of the specific CQI table will follow the above-described embodiments.

[136] FIGS. 27a to 27d and FIG. 28 have been described when FIGS. 23 and 24 were described above, so further detailed description thereof will be omitted.

[137] FIG. 29 illustrates a structure of a terminal according to an embodiment of the present disclosure.

[138] A terminal 2900 may include a transmitter 2910, a receiver 2920, a controller 2930, and a storage 2940.

[139] The transmitter 2910 and the receiver 2920 may include a transmission module and a reception module, respectively, for transmitting and receiving data to/from a BS in a communication system according to an embodiment of the present disclosure.

[140] The controller 2930 may generate a CQI table according to the procedures described in FIGS. 16 to 24. A definition of the specific CQI table will follow the above-described embodiments (e.g., tables in FIGS. 16, 17, and 19 to 22).

[141] The storage 2940 may store the information that is transmitted and received through the transmitter 2910 and the receiver 2920. In addition, the storage 2940 may store a variety of information generated in the controller 2930.

[142] FIG. 30 illustrates a structure of a BS according to an embodiment of the present disclosure.

[143] Referring to FIG. 30, a BS 3000 may include a transmitter 3010, a receiver 3020, a controller 3030, and a storage 3040.

[144] The transmitter 3010 and the receiver 3020 may include a transmission module and a reception module, respectively, for transmitting and receiving data to/from a terminal in a communication system according to an embodiment of the present disclosure.

[145] The controller 3030 may perform scheduling based on the channel status information (e.g., a CQI table) received from the terminal. In addition, the controller 3030 may determine MCS by using a new MCS table according to an embodiment of the present disclosure. A definition of the specific CQI table will follow the above-described embodiments (e.g., tables in FIGS. 23 and 24).

[146] The storage 3040 may store the information that is transmitted and received through the transmitter 3010 and the receiver 3020. In addition, the storage 3040 may store a variety of information generated in the controller 3030.

[147] It will be appreciated that the method and apparatus for generating control information in a wireless communication system according to an embodiment of the present disclosure may be implemented in the form of hardware, software, or a combination thereof. The software may be stored in a volatile or nonvolatile storage device (e.g., erasable/rewritable Read Only Memory (ROM)), a memory (e.g., Random Access Memory (RAM), memory chip, memory device, or memory Integrated Circuit (IC)), or an optically/magnetically recordable machine (e.g., computer)-readable storage medium (e.g., Compact Disc (CD), Digital Versatile Disc (DVD), magnetic disk, or magnetic tape). The method for generating control information in a wireless communication system according to an embodiment of the present disclosure may be implemented by a computer or a mobile terminal that includes a controller and a memory. It will be appreciated that the memory is an example of a non-transitory machine-readable storage medium suitable to store a program or programs including instructions for implementing various embodiments of the present disclosure.

[148] Therefore, the present disclosure may include a program including a code for implementing the apparatus and method as set forth in any claims of the specification, and a non-transitory machine (or computer)-readable storage medium storing the program.

[149] In addition, the apparatus for generating control information in a wireless communication system according to an embodiment of the present disclosure may receive the program from a program server to which the apparatus is connected by wire or wirelessly, and store the received program. The program server may include a memory for storing a program including instructions for performing the control information generation method in the wireless communication system, and storing information necessary for the control information generation method in the wireless communication system, a communication unit for performing wired/wireless communication with the control information generation apparatus, and a controller for transmitting the program to the control information generation apparatus automatically or at the request of the control information generation apparatus.

[150] As is apparent from the foregoing description, the present disclosure may increase the system transmission efficiency by using CQI and MCS tables for supporting 256QAM in a wireless communication system.

[151] While the present disclosure has been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and

scope of the present disclosure as defined by the appended claims and their equivalents.

Claims

[Claim 1] A method for generating control information by a terminal in a wireless communication system, the method comprising:
determining whether the terminal supports a high-order modulation scheme; and
if the terminal supports the high-order modulation scheme, feeding back control information for supporting the high-order modulation scheme to a base station,
wherein the control information includes a first channel quality indicator (CQI) table for supporting the high-order modulation scheme, and
wherein the first CQI table is generated by removing a plurality of CQI entries from a second CQI table including a low-order modulation scheme, and replacing a last CQI table index as the high-order modulation scheme.

[Claim 2] A method for generating control information by a base station in a wireless communication system, the method comprising:
determining a first modulation and coding scheme (MCS) table based on a channel status,
wherein the first MCS table is generated by removing a plurality of MCS entries related to a low-order modulation scheme from a second MCS table, and setting a last MCS table index as a retransmission mode for a high-order modulation scheme.

[Claim 3] The method of claim 1 or the method of claim 2, wherein the high-order modulation scheme includes 256-ary quadrature amplitude modulation (QAM) and the low-order modulation scheme includes at least one of quadrature phase shift keying (QPSK), 16QAM, or 64QAM.

[Claim 4] The method of claim 1 or the method of claim 2, wherein the first CQI table is generated by maintaining a substantially uniform signal to noise ratio (SNR) gap between entries of the first CQI table.

[Claim 5] The method of claim 1 or the method of claim 2,
wherein a CQI index #0 is maintained as out-of-range in the first CQI table, and
wherein a CQI table index including the high-order modulation scheme is arranged in the first CQI table according to a spectral efficiency.

[Claim 6] The method of claim 1 or the method of claim 2, further comprising configuring radio resource control (RRC).

[Claim 7] An apparatus for generating control information in a terminal for a wireless communication system, the apparatus comprising:
a controller configured to determine whether the terminal supports a high-order modulation scheme, and to, if the terminal supports the high-order modulation scheme, feed back control information for supporting the high-order modulation scheme to a base station,
wherein the control information includes a first channel quality indicator (CQI) table for supporting the high-order modulation scheme, and
wherein the first CQI table is generated by removing a plurality of CQI entries from a second CQI table including a low-order modulation scheme and replacing a last CQI table index as the high-order modulation scheme.

[Claim 8] An apparatus for generating control information in a base station for a wireless communication system, the apparatus comprising:
a controller configured to determine a first modulation and coding scheme (MCS) table based on a channel status,
wherein the first MCS table is generated by removing a plurality of MCS entries related to a low-order modulation scheme from a second MCS table, and setting a last MCS table index as a retransmission mode for a high-order modulation scheme.

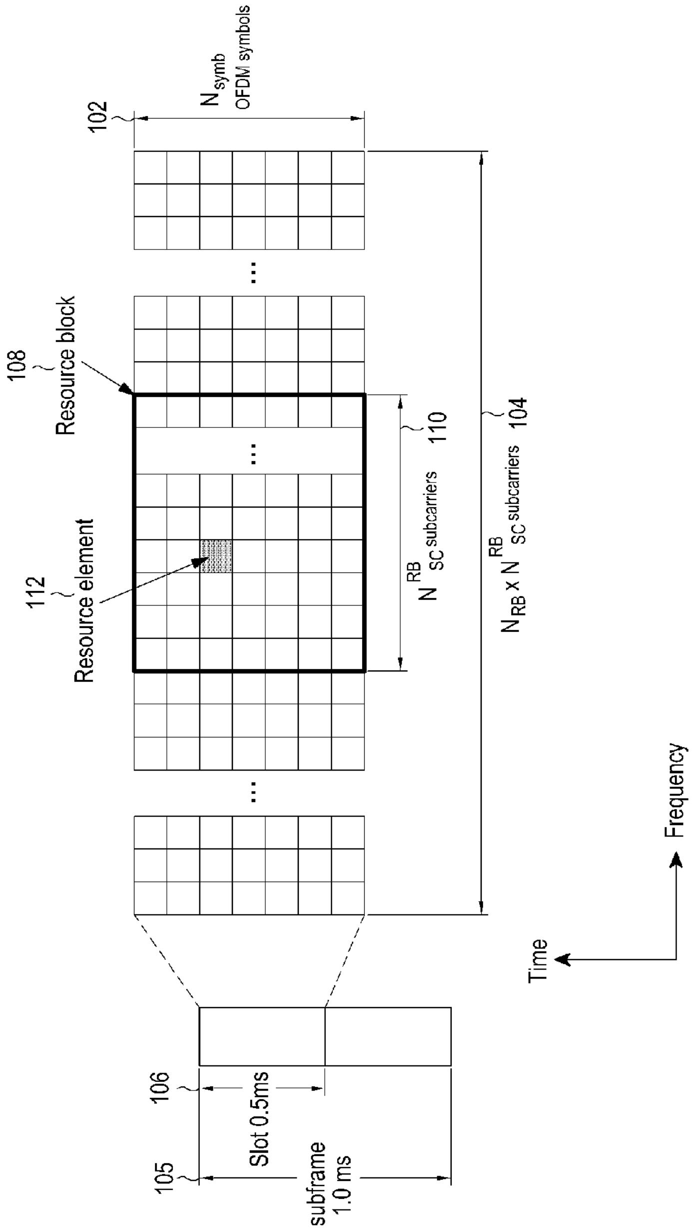
[Claim 9] The apparatus of claim 7 or the apparatus of claim 8, wherein the high-order modulation scheme includes 256-ary quadrature amplitude modulation (QAM) and the low-order modulation scheme includes at least one of quadrature phase shift keying (QPSK), 16QAM, or 64QAM.

[Claim 10] The apparatus of claim 7 or the apparatus of claim 8, wherein the first CQI table is generated by maintaining a substantially uniform signal to noise ratio (SNR) gap between entries of the first CQI table.

[Claim 11] The apparatus of claim 7 or the apparatus of claim 8,
wherein a CQI index #0 is maintained as out-of-range in the first CQI table, and
wherein a CQI table index including the high-order modulation scheme is arranged in the first CQI table according to a spectral efficiency.

[Claim 12] The apparatus of claim 7 or the apparatus of claim 8, wherein the controller is configured to configure radio resource control (RRC).

[Fig. 1]


102
N symb OFDM symbols
108
Resource block
112
Resource element
110
N RB SC subcarriers
104
N RB x N RB SC subcarriers
Frequency
Time
106
Slot 0.5ms
105
subframe 1.0 ms

[Fig. 2]

MCS Index I_{MCS}	Modulation Order Q_m	TBS Index I_{TBS}
0	2	0
1	2	1
2	2	2
3	2	3
4	2	4
5	2	5
6	2	6
7	2	7
8	2	8
9	2	9
10	4	9
11	4	10
12	4	11
13	4	12
14	4	13
15	4	14
16	4	15
17	6	15
18	6	16
19	6	17
20	6	18
21	6	19
22	6	20
23	6	21
24	6	22
25	6	23
26	6	24
27	6	25
28	6	26
29	2	reserved
30	4	
31	6	

[Fig. 3]

I_{TBS}	N_{PRB}									
	1	2	3	4	5	6	7	8	9	10
0	16	32	56	88	120	152	176	208	224	256
1	24	56	88	144	176	208	224	256	328	344
2	32	72	144	176	208	256	296	328	376	424
3	40	104	176	208	256	328	392	440	504	568
4	56	120	208	256	328	408	488	552	632	696
5	72	144	224	328	424	504	600	680	776	872
6	328	176	256	392	504	600	712	808	936	1032
7	104	224	328	472	584	712	840	968	1096	1224
8	120	256	392	536	680	808	968	1096	1256	1384
9	136	296	456	616	776	936	1096	1256	1416	1544
10	144	328	504	680	872	1032	1224	1384	1544	1736
11	176	376	584	776	1000	1192	1384	1608	1800	2024
12	208	440	680	904	1128	1352	1608	1800	2024	2280
13	224	488	744	1000	1256	1544	1800	2024	2280	2536
14	256	552	840	1128	1416	1736	1992	2280	2600	2856
15	280	600	904	1224	1544	1800	2152	2472	2728	3112
16	328	632	968	1288	1608	1928	2280	2600	2984	3240
17	336	696	1064	1416	1800	2152	2536	2856	3240	3624
18	376	776	1160	1544	1992	2344	2792	3112	3624	4008
19	408	840	1288	1736	2152	2600	2984	3496	3880	4264
20	440	904	1384	1864	2344	2792	3240	3752	4136	4584
21	488	1000	1480	1992	2472	2984	3496	4008	4584	4968
22	520	1064	1608	2152	2664	3240	3752	4264	4776	5352
23	552	1128	1736	2280	2856	3496	4008	4584	5160	5736
24	584	1192	1800	2408	2984	3624	4264	4968	5544	5992
25	616	1256	1864	2536	3112	3752	4392	5160	5736	6200
26	712	1480	2216	2984	3752	4392	5160	5992	6712	7480

[Fig. 4]

I_{TBS}	N_{PRB}									
	11	12	13	14	15	16	17	18	19	20
0	288	328	344	376	392	424	456	488	504	536
1	376	424	456	488	520	568	600	632	680	712
2	472	520	568	616	648	696	744	776	840	872
3	616	680	744	808	872	904	968	1032	1096	1160
4	776	840	904	1000	1064	1128	1192	1288	1352	1416
5	968	1032	1128	1224	1320	1384	1480	1544	1672	1736
6	1128	1224	1352	1480	1544	1672	1736	1864	1992	2088
7	1320	1480	1608	1672	1800	1928	2088	2216	2344	2472
8	1544	1672	1800	1928	2088	2216	2344	2536	2664	2792
9	1736	1864	2024	2216	2344	2536	2664	2856	2984	3112
10	1928	2088	2280	2472	2664	2792	2984	3112	3368	3496
11	2216	2408	2600	2792	2984	3240	3496	3624	3880	4008
12	2472	2728	2984	3240	3368	3624	3880	4136	4392	4584
13	2856	3112	3368	3624	3880	4136	4392	4584	4968	5160
14	3112	3496	3752	4008	4264	4584	4968	5160	5544	5736
15	3368	3624	4008	4264	4584	4968	5160	5544	5736	6200
16	3624	3880	4264	4584	4968	5160	5544	5992	6200	6456
17	4008	4392	4776	5160	5352	5736	6200	6456	6712	7224
18	4392	4776	5160	5544	5992	6200	6712	7224	7480	7992
19	4776	5160	5544	5992	6456	6968	7224	7736	8248	8504
20	5160	5544	5992	6456	6968	7480	7992	8248	8760	9144
21	5544	5992	6456	6968	7480	7992	8504	9144	9528	9912
22	5992	6456	6968	7480	7992	8504	9144	9528	10296	10680
23	6200	6968	7480	7992	8504	9144	9912	10296	11064	11448
24	6712	7224	7992	8504	9144	9912	10296	11064	11448	12216
25	6968	7480	8248	8760	9528	10296	10680	11448	12216	12576
26	8248	8760	9528	10296	11064	11832	12576	13536	14112	14688

[Fig. 5]

I_{TBS}	N_{PRB}									
	21	22	23	24	25	26	27	28	29	30
0	568	600	616	648	680	712	744	776	776	808
1	744	776	808	872	904	936	968	1000	1032	1064
2	936	968	1000	1064	1096	1160	1192	1256	1288	1320
3	1224	1256	1320	1384	1416	1480	1544	1608	1672	1736
4	1480	1544	1608	1736	1800	1864	1928	1992	2088	2152
5	1864	1928	2024	2088	2216	2280	2344	2472	2536	2664
6	2216	2280	2408	2472	2600	2728	2792	2984	2984	3112
7	2536	2664	2792	2984	3112	3240	3368	3368	3496	3624
8	2984	3112	3240	3368	3496	3624	3752	3880	4008	4264
9	3368	3496	3624	3752	4008	4136	4264	4392	4584	4776
10	3752	3880	4008	4264	4392	4584	4776	4968	5160	5352
11	4264	4392	4584	4776	4968	5352	5544	5736	5992	5992
12	4776	4968	5352	5544	5736	5992	6200	6456	6712	6712
13	5352	5736	5992	6200	6456	6712	6968	7224	7480	7736
14	5992	6200	6456	6968	7224	7480	7736	7992	8248	8504
15	6456	6712	6968	7224	7736	7992	8248	8504	8760	9144
16	6712	7224	7480	7736	7992	8504	8760	9144	9528	9912
17	7480	7992	8248	8760	9144	9528	9912	10296	10296	10680
18	8248	8760	9144	9528	9912	10296	10680	11064	11448	11832
19	9144	9528	9912	10296	10680	11064	11448	12216	12576	12960
20	9912	10296	10680	11064	11448	12216	12576	12960	13536	14112
21	10680	11064	11448	12216	12576	12960	13536	14112	14688	15264
22	11448	11832	12576	12960	13536	14112	14688	15264	15840	16416
23	12216	12576	12960	13536	14112	14688	15264	15840	16416	16992
24	12960	13536	14112	14688	15264	15840	16416	16992	17568	18336
25	13536	14112	14688	15264	15840	16416	16992	17568	18336	19080
26	15264	16416	16992	17568	18336	19080	19848	20616	21384	22152

[Fig. 6]

I_{TBS}	N_{PRB}									
	31	32	33	34	35	36	37	38	39	40
0	840	872	904	936	968	1000	1032	1032	1064	1096
1	1128	1160	1192	1224	1256	1288	1352	1384	1416	1416
2	1384	1416	1480	1544	1544	1608	1672	1672	1736	1800
3	1800	1864	1928	1992	2024	2088	2152	2216	2280	2344
4	2216	2280	2344	2408	2472	2600	2664	2728	2792	2856
5	2728	2792	2856	2984	3112	3112	3240	3368	3496	3496
6	3240	3368	3496	3496	3624	3752	3880	4008	4136	4136
7	3752	3880	4008	4136	4264	4392	4584	4584	4776	4968
8	4392	4584	4584	4776	4968	4968	5160	5352	5544	5544
9	4968	5160	5160	5352	5544	5736	5736	5992	6200	6200
10	5544	5736	5736	5992	6200	6200	6456	6712	6712	6968
11	6200	6456	6712	6968	6968	7224	7480	7736	7736	7992
12	6968	7224	7480	7736	7992	8248	8504	8760	8760	9144
13	7992	8248	8504	8760	9144	9144	9528	9912	9912	10296
14	8760	9144	9528	9912	9912	10296	10680	11064	11064	11448
15	9528	9912	10296	10296	10680	11064	11448	11832	11832	12216
16	9912	10296	10680	11064	11448	11832	12216	12216	12576	12960
17	11064	11448	11832	12216	12576	12960	13536	13536	14112	14688
18	12216	12576	12960	13536	14112	14112	14688	15264	15264	15840
19	13536	13536	14112	14688	15264	15264	15840	16416	16992	16992
20	14688	14688	15264	15840	16416	16992	16992	17568	18336	18336
21	15840	15840	16416	16992	17568	18336	18336	19080	19848	19848
22	16992	16992	17568	18336	19080	19080	19848	20616	21384	21384
23	17568	18336	19080	19848	19848	20616	21384	22152	22152	22920
24	19080	19848	19848	20616	21384	22152	22920	22920	23688	24496
25	19848	20616	20616	21384	22152	22920	23688	24496	24496	25456
26	22920	23688	24496	25456	25456	26416	27376	28336	29296	29296

[Fig. 7]

I_{TBS}	N_{PRB}									
	41	42	43	44	45	46	47	48	49	50
0	1128	1160	1192	1224	1256	1256	1288	1320	1352	1384
1	1480	1544	1544	1608	1608	1672	1736	1736	1800	1800
2	1800	1864	1928	1992	2024	2088	2088	2152	2216	2216
3	2408	2472	2536	2536	2600	2664	2728	2792	2856	2856
4	2984	2984	3112	3112	3240	3240	3368	3496	3496	3624
5	3624	3752	3752	3880	4008	4008	4136	4264	4392	4392
6	4264	4392	4584	4584	4776	4776	4968	4968	5160	5160
7	4968	5160	5352	5352	5544	5736	5736	5992	5992	6200
8	5736	5992	5992	6200	6200	6456	6456	6712	6968	6968
9	6456	6712	6712	6968	6968	7224	7480	7480	7736	7992
10	7224	7480	7480	7736	7992	7992	8248	8504	8504	8760
11	8248	8504	8760	8760	9144	9144	9528	9528	9912	9912
12	9528	9528	9912	9912	10296	10680	10680	11064	11064	11448
13	10680	10680	11064	11448	11448	11832	12216	12216	12576	12960
14	11832	12216	12216	12576	12960	12960	13536	13536	14112	14112
15	12576	12960	12960	13536	13536	14112	14688	14688	15264	15264
16	13536	13536	14112	14112	14688	14688	15264	15840	15840	16416
17	14688	15264	15264	15840	16416	16416	16992	17568	17568	18336
18	16416	16416	16992	17568	17568	18336	18336	19080	19080	19848
19	17568	18336	18336	19080	19080	19848	20616	20616	21384	21384
20	19080	19848	19848	20616	20616	21384	22152	22152	22920	22920
21	20616	21384	21384	22152	22920	22920	23688	24496	24496	25456
22	22152	22920	22920	23688	24496	24496	25456	25456	26416	27376
23	23688	24496	24496	25456	25456	26416	27376	27376	28336	28336
24	25456	25456	26416	26416	27376	28336	28336	29296	29296	30576
25	26416	26416	27376	28336	28336	29296	29296	30576	31704	31704
26	30576	30576	31704	32856	32856	34008	35160	35160	36696	36696

[Fig. 8]

I_{TBS}	N_{PRB}									
	51	52	53	54	55	56	57	58	59	60
0	1416	1416	1480	1480	1544	1544	1608	1608	1608	1672
1	1864	1864	1928	1992	1992	2024	2088	2088	2152	2152
2	2280	2344	2344	2408	2472	2536	2536	2600	2664	2664
3	2984	2984	3112	3112	3240	3240	3368	3368	3496	3496
4	3624	3752	3752	3880	4008	4008	4136	4136	4264	4264
5	4584	4584	4776	4776	4776	4968	4968	5160	5160	5352
6	5352	5352	5544	5736	5736	5992	5992	5992	6200	6200
7	6200	6456	6456	6712	6712	6712	6968	6968	7224	7224
8	7224	7224	7480	7480	7736	7736	7992	7992	8248	8504
9	7992	8248	8248	8504	8760	8760	9144	9144	9144	9528
10	9144	9144	9144	9528	9528	9912	9912	10296	10296	10680
11	10296	10680	10680	11064	11064	11448	11448	11832	11832	12216
12	11832	11832	12216	12216	12576	12576	12960	12960	13536	13536
13	12960	13536	13536	14112	14112	14688	14688	14688	15264	15264
14	14688	14688	15264	15264	15840	15840	16416	16416	16992	16992
15	15840	15840	16416	16416	16992	16992	17568	17568	18336	18336
16	16416	16992	16992	17568	17568	18336	18336	19080	19080	19848
17	18336	19080	19080	19848	19848	20616	20616	20616	21384	21384
18	19848	20616	21384	21384	22152	22152	22920	22920	23688	23688
19	22152	22152	22920	22920	23688	24496	24496	25456	25456	25456
20	23688	24496	24496	25456	25456	26416	26416	27376	27376	28336
21	25456	26416	26416	27376	27376	28336	28336	29296	29296	30576
22	27376	28336	28336	29296	29296	30576	30576	31704	31704	32856
23	29296	29296	30576	30576	31704	31704	32856	32856	34008	34008
24	31704	31704	32856	32856	34008	34008	35160	35160	36696	36696
25	32856	32856	34008	34008	35160	35160	36696	36696	37888	37888
26	37888	37888	39232	40576	40576	40576	42368	42368	43816	43816

[Fig. 9]

I_{TBS}	N_{PRB}									
	61	62	63	64	65	66	67	68	69	70
0	1672	1736	1736	1800	1800	1800	1864	1864	1928	1928
1	2216	2280	2280	2344	2344	2408	2472	2472	2536	2536
2	2728	2792	2856	2856	2856	2984	2984	3112	3112	3112
3	3624	3624	3624	3752	3752	3880	3880	4008	4008	4136
4	4392	4392	4584	4584	4584	4776	4776	4968	4968	4968
5	5352	5544	5544	5736	5736	5736	5992	5992	5992	6200
6	6456	6456	6456	6712	6712	6968	6968	6968	7224	7224
7	7480	7480	7736	7736	7992	7992	8248	8248	8504	8504
8	8504	8760	8760	9144	9144	9144	9528	9528	9528	9912
9	9528	9912	9912	10296	10296	10296	10680	10680	11064	11064
10	10680	11064	11064	11448	11448	11448	11832	11832	12216	12216
11	12216	12576	12576	12960	12960	13536	13536	13536	14112	14112
12	14112	14112	14112	14688	14688	15264	15264	15264	15840	15840
13	15840	15840	16416	16416	16992	16992	16992	17568	17568	18336
14	17568	17568	18336	18336	18336	19080	19080	19848	19848	19848
15	18336	19080	19080	19848	19848	20616	20616	20616	21384	21384
16	19848	19848	20616	20616	21384	21384	22152	22152	22152	22920
17	22152	22152	22920	22920	23688	23688	24496	24496	24496	25456
18	24496	24496	24496	25456	25456	26416	26416	27376	27376	27376
19	26416	26416	27376	27376	28336	28336	29296	29296	29296	30576
20	28336	29296	29296	29296	30576	30576	31704	31704	31704	32856
21	30576	31704	31704	31704	32856	32856	34008	34008	35160	35160
22	32856	34008	34008	34008	35160	35160	36696	36696	36696	37888
23	35160	35160	36696	36696	37888	37888	37888	39232	39232	40576
24	36696	37888	37888	39232	39232	40576	40576	42368	42368	42368
25	39232	39232	40576	40576	40576	42368	42368	43816	43816	43816
26	45352	45352	46888	46888	48936	48936	48936	51024	51024	52752

[Fig. 10]

I_{TBS}	N_{PRB}									
	71	72	73	74	75	76	77	78	79	80
0	1992	1992	2024	2088	2088	2088	2152	2152	2216	2216
1	2600	2600	2664	2728	2728	2792	2792	2856	2856	2856
2	3240	3240	3240	3368	3368	3368	3496	3496	3496	3624
3	4136	4264	4264	4392	4392	4392	4584	4584	4584	4776
4	5160	5160	5160	5352	5352	5544	5544	5544	5736	5736
5	6200	6200	6456	6456	6712	6712	6712	6968	6968	6968
6	7480	7480	7736	7736	7736	7992	7992	8248	8248	8248
7	8760	8760	8760	9144	9144	9144	9528	9528	9528	9912
8	9912	9912	10296	10296	10680	10680	10680	11064	11064	11064
9	11064	11448	11448	11832	11832	11832	12216	12216	12576	12576
10	12576	12576	12960	12960	12960	13536	13536	13536	14112	14112
11	14112	14688	14688	14688	15264	15264	15840	15840	15840	16416
12	16416	16416	16416	16992	16992	17568	17568	17568	18336	18336
13	18336	18336	19080	19080	19080	19848	19848	19848	20616	20616
14	20616	20616	20616	21384	21384	22152	22152	22152	22920	22920
15	22152	22152	22152	22920	22920	23688	23688	23688	24496	24496
16	22920	23688	23688	24496	24496	24496	25456	25456	25456	26416
17	25456	26416	26416	26416	27376	27376	27376	28336	28336	29296
18	28336	28336	29296	29296	29296	30576	30576	30576	31704	31704
19	30576	30576	31704	31704	32856	32856	32856	34008	34008	34008
20	32856	34008	34008	34008	35160	35160	35160	36696	36696	36696
21	35160	36696	36696	36696	37888	37888	39232	39232	39232	40576
22	37888	39232	39232	40576	40576	40576	42368	42368	42368	43816
23	40576	40576	42368	42368	43816	43816	43816	45352	45352	45352
24	43816	43816	45352	45352	45352	46888	46888	46888	48936	48936
25	45352	45352	46888	46888	46888	48936	48936	48936	51024	51024
26	52752	52752	55056	55056	55056	55056	57336	57336	57336	59256

[Fig. 11]

I_{TBS}	N_{PRB}									
	81	82	83	84	85	86	87	88	89	90
0	2280	2280	2280	2344	2344	2408	2408	2472	2472	2536
1	2984	2984	2984	3112	3112	3112	3240	3240	3240	3240
2	3624	3624	3752	3752	3880	3880	3880	4008	4008	4008
3	4776	4776	4776	4968	4968	4968	5160	5160	5160	5352
4	5736	5992	5992	5992	5992	6200	6200	6200	6456	6456
5	7224	7224	7224	7480	7480	7480	7736	7736	7736	7992
6	8504	8504	8760	8760	8760	9144	9144	9144	9144	9528
7	9912	9912	10296	10296	10296	10680	10680	10680	11064	11064
8	11448	11448	11448	11832	11832	12216	12216	12216	12576	12576
9	12960	12960	12960	13536	13536	13536	13536	14112	14112	14112
10	14112	14688	14688	14688	14688	15264	15264	15264	15840	15840
11	16416	16416	16992	16992	16992	17568	17568	17568	18336	18336
12	18336	19080	19080	19080	19080	19848	19848	19848	20616	20616
13	20616	21384	21384	21384	22152	22152	22152	22920	22920	22920
14	22920	23688	23688	24496	24496	24496	25456	25456	25456	25456
15	24496	25456	25456	25456	26416	26416	26416	27376	27376	27376
16	26416	26416	27376	27376	27376	28336	28336	28336	29296	29296
17	29296	29296	30576	30576	30576	30576	31704	31704	31704	32856
18	31704	32856	32856	32856	34008	34008	34008	35160	35160	35160
19	35160	35160	35160	36696	36696	36696	37888	37888	37888	39232
20	37888	37888	39232	39232	39232	40576	40576	40576	42368	42368
21	40576	40576	42368	42368	42368	43816	43816	43816	45352	45352
22	43816	43816	45352	45352	45352	46888	46888	46888	48936	48936
23	46888	46888	46888	48936	48936	48936	51024	51024	51024	51024
24	48936	51024	51024	51024	52752	52752	52752	52752	55056	55056
25	51024	52752	52752	52752	55056	55056	55056	55056	57336	57336
26	59256	59256	61664	61664	61664	63776	63776	63776	66592	66592

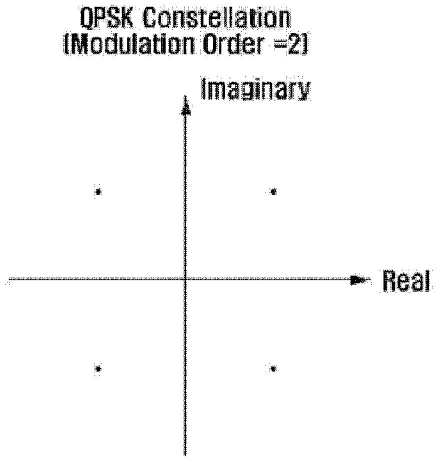
[Fig. 12]

I_{TBS}	N_{PRB}									
	91	92	93	94	95	96	97	98	99	100
0	2536	2536	2600	2600	2664	2664	2728	2728	2728	2792
1	3368	3368	3368	3496	3496	3496	3496	3624	3624	3624
2	4136	4136	4136	4264	4264	4264	4392	4392	4392	4584
3	5352	5352	5352	5544	5544	5544	5736	5736	5736	5736
4	6456	6456	6712	6712	6712	6968	6968	6968	6968	7224
5	7992	7992	8248	8248	8248	8504	8504	8760	8760	8760
6	9528	9528	9528	9912	9912	9912	10296	10296	10296	10296
7	11064	11448	11448	11448	11448	11832	11832	11832	12216	12216
8	12576	12960	12960	12960	13536	13536	13536	13536	14112	14112
9	14112	14688	14688	14688	15264	15264	15264	15264	15840	15840
10	15840	16416	16416	16416	16992	16992	16992	16992	17568	17568
11	18336	18336	19080	19080	19080	19080	19848	19848	19848	19848
12	20616	21384	21384	21384	21384	22152	22152	22152	22920	22920
13	23688	23688	23688	24496	24496	24496	25456	25456	25456	25456
14	26416	26416	26416	27376	27376	27376	28336	28336	28336	28336
15	28336	28336	28336	29296	29296	29296	29296	30576	30576	30576
16	29296	30576	30576	30576	30576	31704	31704	31704	31704	32856
17	32856	32856	34008	34008	34008	35160	35160	35160	35160	36696
18	36696	36696	36696	37888	37888	37888	37888	39232	39232	39232
19	39232	39232	40576	40576	40576	40576	42368	42368	42368	43816
20	42368	42368	43816	43816	43816	45352	45352	45352	46888	46888
21	45352	46888	46888	46888	46888	48936	48936	48936	48936	51024
22	48936	48936	51024	51024	51024	51024	52752	52752	52752	55056
23	52752	52752	52752	55056	55056	55056	55056	57336	57336	57336
24	55056	57336	57336	57336	57336	59256	59256	59256	61664	61664
25	57336	59256	59256	59256	61664	61664	61664	61664	63776	63776
26	66592	68808	68808	68808	71112	71112	71112	73712	73712	75376

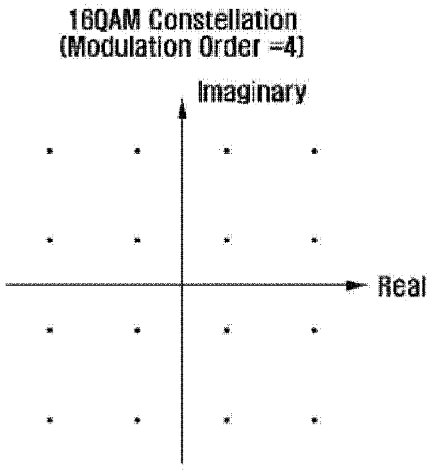
[Fig. 13]

I_{TBS}	N_{PRB}									
	101	102	103	104	105	106	107	108	109	110
0	2792	2856	2856	2856	2984	2984	2984	2984	2984	3112
1	3752	3752	3752	3752	3880	3880	3880	4008	4008	4008
2	4584	4584	4584	4584	4776	4776	4776	4776	4968	4968
3	5992	5992	5992	5992	6200	6200	6200	6200	6456	6456
4	7224	7224	7480	7480	7480	7480	7736	7736	7736	7992
5	8760	9144	9144	9144	9144	9528	9528	9528	9528	9528
6	10680	10680	10680	10680	11064	11064	11064	11448	11448	11448
7	12216	12576	12576	12576	12960	12960	12960	12960	13536	13536
8	14112	14112	14688	14688	14688	14688	15264	15264	15264	15264
9	15840	16416	16416	16416	16416	16992	16992	16992	16992	17568
10	17568	18336	18336	18336	18336	18336	19080	19080	19080	19080
11	20616	20616	20616	21384	21384	21384	21384	22152	22152	22152
12	22920	23688	23688	23688	23688	24496	24496	24496	24496	25456
13	26416	26416	26416	26416	27376	27376	27376	27376	28336	28336
14	29296	29296	29296	29296	30576	30576	30576	30576	31704	31704
15	30576	31704	31704	31704	31704	32856	32856	32856	34008	34008
16	32856	32856	34008	34008	34008	34008	35160	35160	35160	35160
17	36696	36696	36696	37888	37888	37888	39232	39232	39232	39232
18	40576	40576	40576	40576	42368	42368	42368	42368	43816	43816
19	43816	43816	43816	45352	45352	45352	46888	46888	46888	46888
20	46888	46888	48936	48936	48936	48936	48936	51024	51024	51024
21	51024	51024	51024	52752	52752	52752	52752	55056	55056	55056
22	55056	55056	55056	57336	57336	57336	57336	59256	59256	59256
23	57336	59256	59256	59256	59256	61664	61664	61664	61664	63776
24	61664	61664	63776	63776	63776	63776	66592	66592	66592	66592
25	63776	63776	66592	66592	66592	66592	68808	68808	68808	71112
26	75376	75376	75376	75376	75376	75376	75376	75376	75376	75376

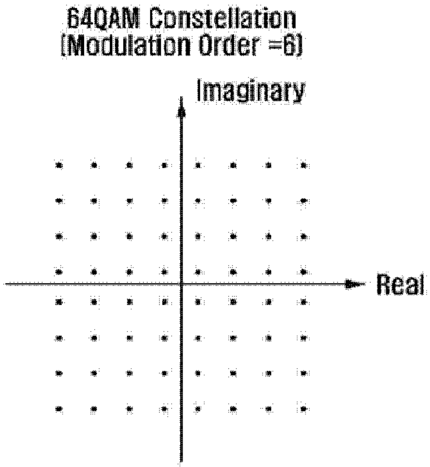
[Fig. 14a]



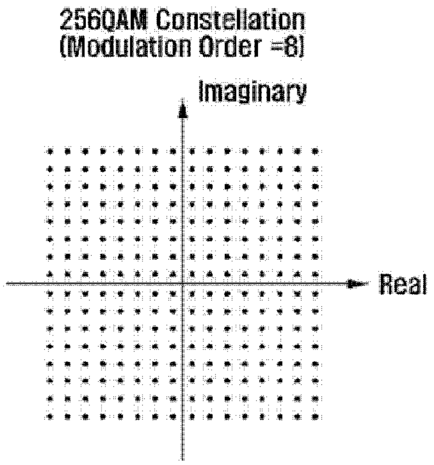
[Fig. 14b]



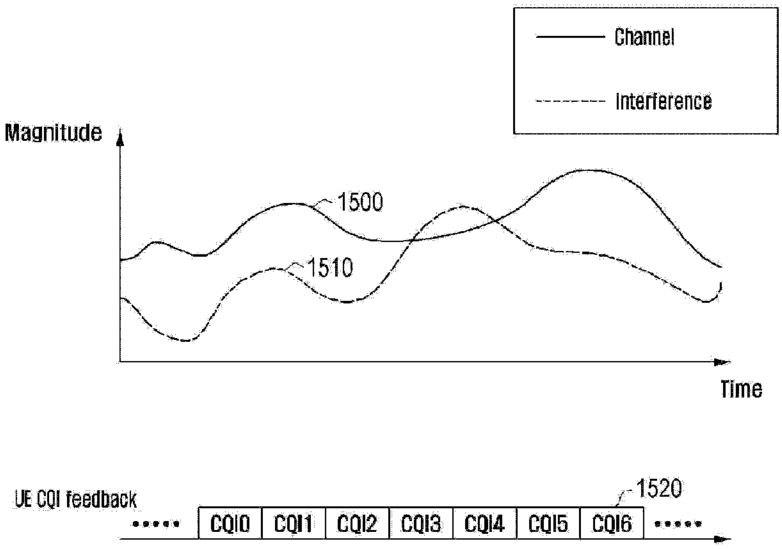
[Fig. 14c]



[Fig. 14d]



[Fig. 15]



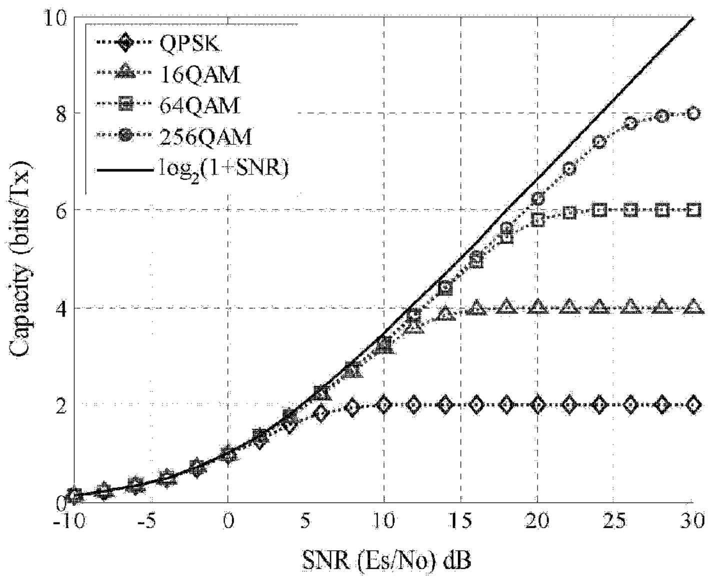
[Fig. 16]

CQI index	CQI index in current table	Modulation	Code rate x 1024	Efficiency
0	0	out of range		
1	2	QPSK	120	0.2344
2	4	QPSK	308	0.6016
3	6	QPSK	602	1.1758
4	7	16QAM	378	1.4766
5	8	16QAM	490	1.9141
6	9	16QAM	616	2.4063
7	10	64QAM	466	2.7305
8	11	64QAM	567	3.3223
9	12	64QAM	666	3.9023
10	13	64QAM	772	4.5234
11	14	64QAM	873	5.1152
12	-	256QAM	x	x
13	-	256QAM	x	x
14	-	256QAM	x	x
15	-	256QAM	x	x

[Fig. 17]

CQI index	CQI index in current table	Modulation	Code rate x 1024	Efficiency
0	0	out of range		
1	1	QPSK	78	0.1523
2	3	QPSK	193	0.3770
3	5	QPSK	449	0.8770
4	7	16QAM	378	1.4766
5	8	16QAM	490	1.9141
6	9	16QAM	616	2.4063
7	10	64QAM	466	2.7305
8	11	64QAM	567	3.3223
9	12	64QAM	666	3.9023
10	13	64QAM	772	4.5234
11	14	64QAM	873	5.1152
12	-	256QAM	x	x
13	-	256QAM	x	x
14	-	256QAM	x	x
15	-	256QAM	x	x

[Fig. 18]



[Fig. 19]

CQI index	SNR [dB]	Modulation	Code rate x 1024	Efficiency
0		out of range		
1		QPSK	120	0.2344
2		QPSK	308	0.6016
3		QPSK	602	1.1758
4		16QAM	378	1.4766
5		16QAM	490	1.9141
6		16QAM	616	2.4063
7		64QAM	466	2.7305
8		64QAM	567	3.3223
9		64QAM	666	3.9023
10		64QAM	772	4.5234
11		64QAM	873	5.1152
12	17.65	256QAM	711	5.5547
13	19.76	256QAM	792	6.1905
14	21.88	256QAM	877	6.8571
15	24.00	256QAM	948	7.4063

[Fig. 20]

CQI index	SNR [dB]	Modulation	Code rate x 1024	Efficiency
0		out of range		
1		QPSK	78	0.1523
2		QPSK	193	0.3770
3		QPSK	449	0.8770
4		16QAM	378	1.4766
5		16QAM	490	1.9141
6		16QAM	616	2.4063
7		64QAM	466	2.7305
8		64QAM	567	3.3223
9		64QAM	666	3.9023
10		64QAM	772	4.5234
11		64QAM	873	5.1152
12	17.65	256QAM	711	5.5547
13	19.76	256QAM	792	6.1905
14	21.88	256QAM	877	6.8571
15	24.00	256QAM	948	7.4063

[Fig. 21]

CQI index	Modulation	Code rate x 1024	Efficiency
0	out of range		
1	QPSK	120	0.2344
2	QPSK	308	0.6016
3	QPSK	602	1.1758
4	16QAM	378	1.4766
5	16QAM	490	1.9141
6	16QAM	616	2.4063
7	64QAM	466	2.7305
8	64QAM	567	3.3223
9	64QAM	666	3.9023
10	64QAM	772	4.5234
11	64QAM	873	5.1152
12	256QAM	711	5.5547
13	256QAM	790	6.1719
14	256QAM	869	6.7891
15	256QAM	948	7.4063

[Fig. 22]

CQI index	Modulation	Code rate x 1024	Efficiency
0	out of range		
1	QPSK	78	0.1523
2	QPSK	193	0.3770
3	QPSK	449	0.8770
4	16QAM	378	1.4766
5	16QAM	490	1.9141
6	16QAM	616	2.4063
7	64QAM	466	2.7305
8	64QAM	567	3.3223
9	64QAM	666	3.9023
10	64QAM	772	4.5234
11	64QAM	873	5.1152
12	256QAM	711	5.5547
13	256QAM	790	6.1719
14	256QAM	869	6.7891
15	256QAM	948	7.4063

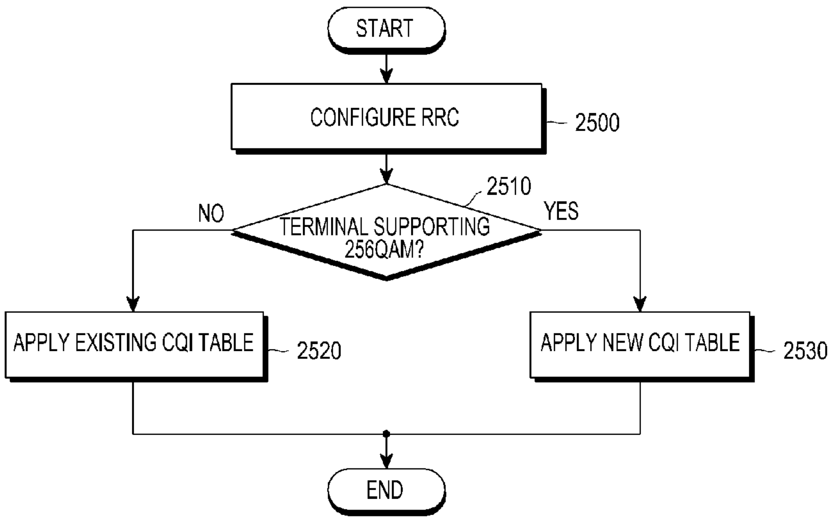
[Fig. 23]

MCS index	MCS Index in current table	Modulation Order	TBS index in current table	Code rate x 1024	Efficiency
0	0	2	0	120	0.2344
1	2	2	2	193	0.3770
2	4	2	4	308	0.6016
3	6	2	6	449	0.8770
4	8	2	8	602	1.1758
5	11	4	10	378	1.4766
6	12	4	11	434	1.69535
7	13	4	12	490	1.9141
8	14	4	13	553	2.1602
9	15	4	14	616	2.4063
10	16	4	15	658	2.5684
11	18	6	16	466	2.7305
12	19	6	17	517	3.0264
13	20	6	18	567	3.3223
14	21	6	19	616	3.6123
15	22	6	20	666	3.9023
16	23	6	21	719	4.21285
17	24	6	22	772	4.5234
18	25	6	23	822	4.8193
19	26	6	24	873	5.1152
20	27	6	25	910	5.5547
21	-	8	27	711	5.5547
22	-	8	28	752	5.8726
23	-	8	29	790	6.1905
24	-	8	30	835	6.5238
25	-	8	31	869	6.8571
26	-	8	32	913	7.1317
27	-	8	33	948	7.4063
28	29	2	Reserved for implicit TBS signaling		
29	30	4	Reserved for implicit TBS signaling		
30	31	6	Reserved for implicit TBS signaling		
31	-	8	Reserved for implicit TBS signaling		

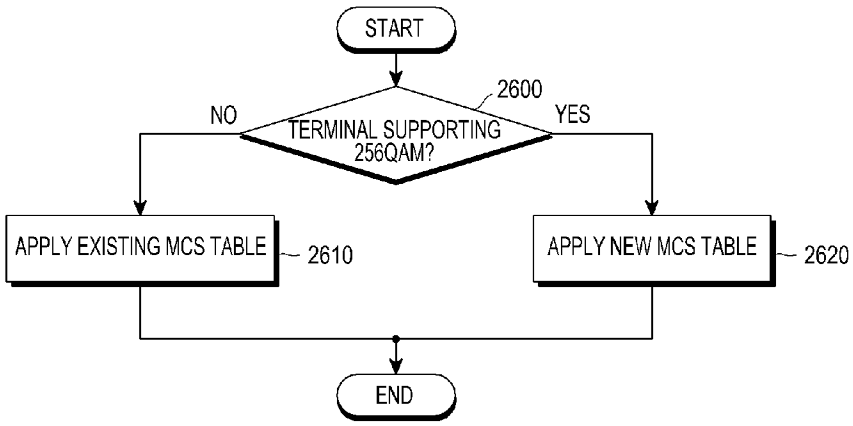
[Fig. 24]

MCS index	Modulation Order	TBS Index in current table
0	2	0
1	8	27
2	2	2
3	8	28
4	2	4
5	8	29
6	2	6
7	8	30
8	2	8
9	8	31
10	8	32
11	4	10
12	4	11
13	4	12
14	4	13
15	4	14
16	4	15
17	8	33
18	6	16
19	6	17
20	6	18
21	6	19
22	6	20
23	6	21
24	6	22
25	6	23
26	6	24
27	6	25
28	8	reserved
29	2	
30	4	
31	6	

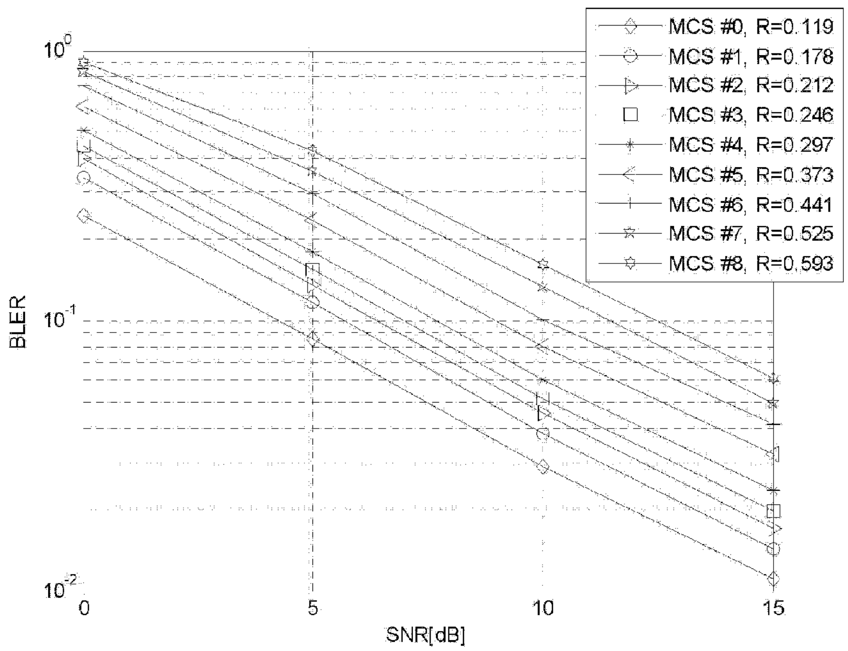
[Fig. 25]



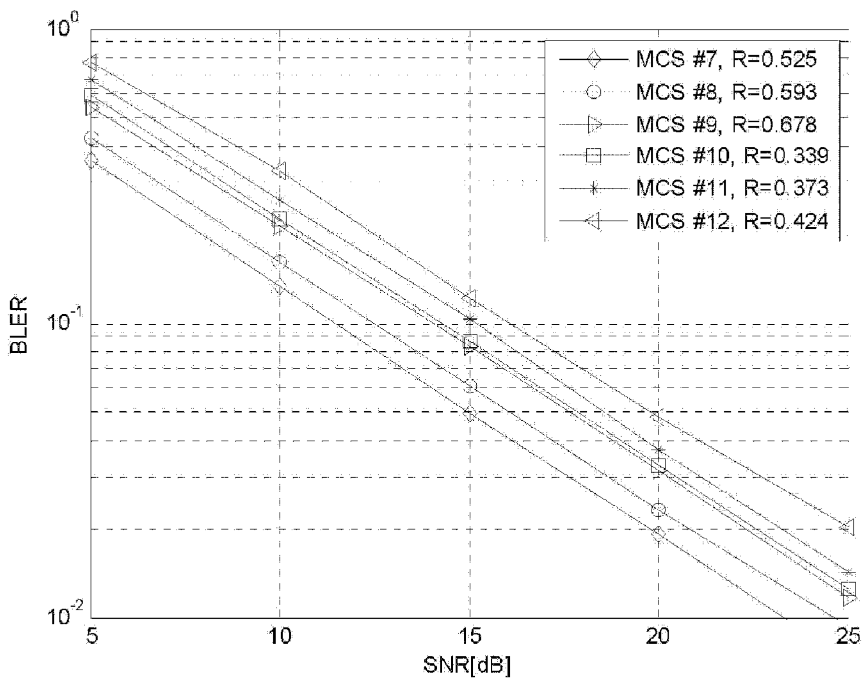
[Fig. 26]



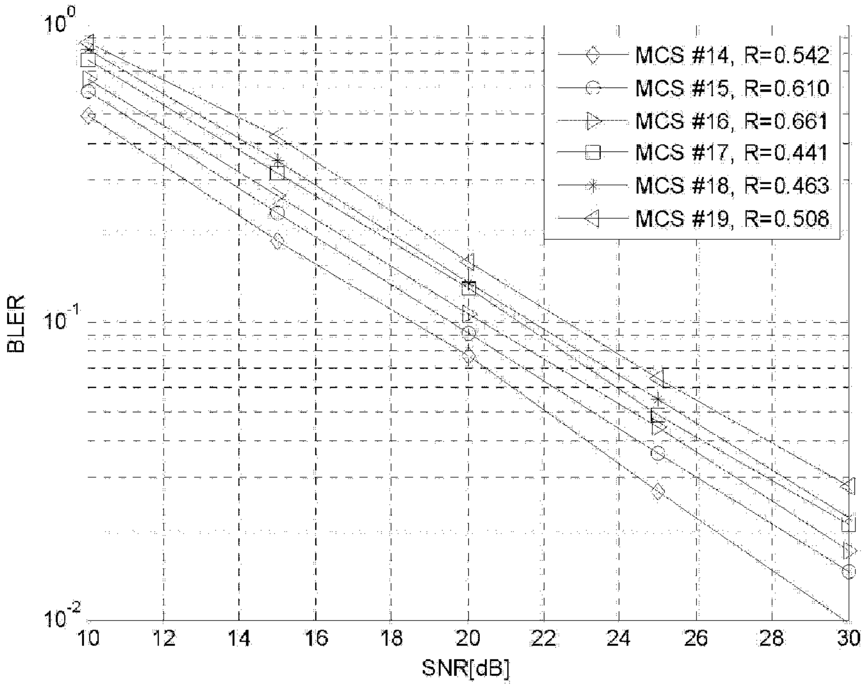
[Fig. 27a]



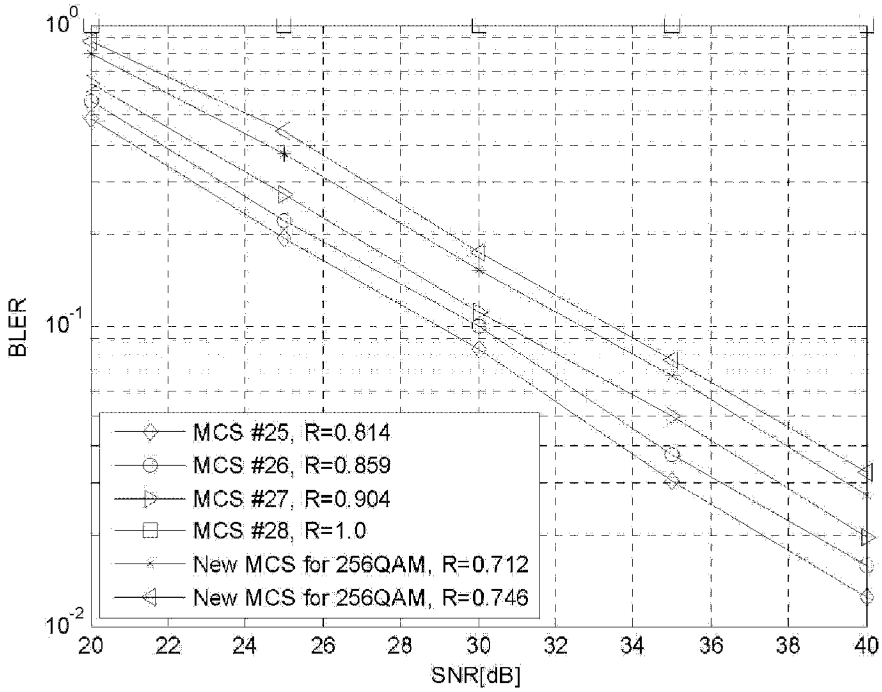
[Fig. 27b]



[Fig. 27c]



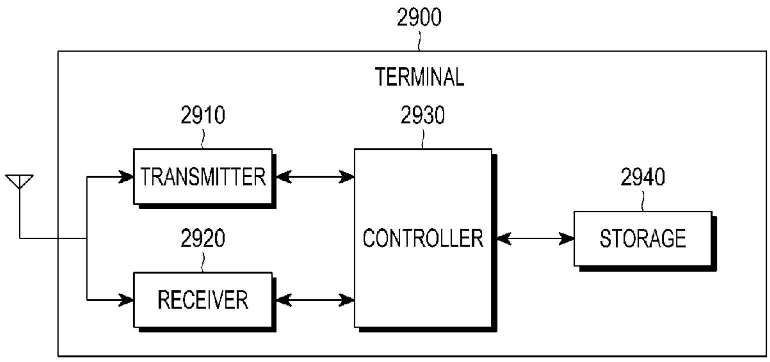
[Fig. 27d]



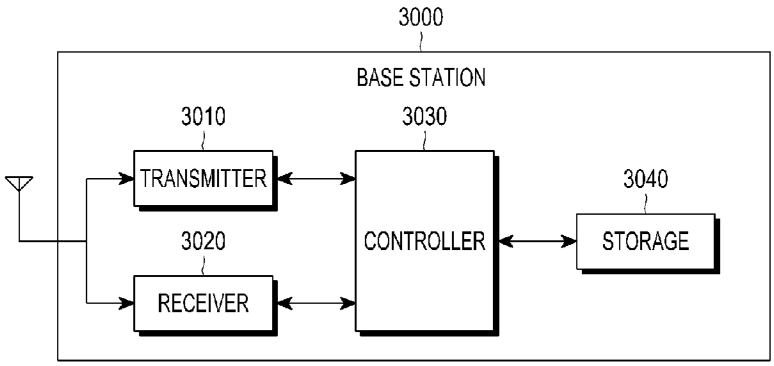
[Fig. 28]

Parameter	Value
System Bandwidth	10MHz
Carrier frequency	3.5GHz
Channel model	EPA
Transmission mode	TM9
MIMO configuration	2x2
DMRS configuration	Antenna ports 7,8 for 2x2
Rank adaptation	Fixed as 2
Link adaptation	Off
HARQ	Off
UE receiver	MMSE
Channel estimation	2D-MMSE
PDP estimation	ideal
Received timing delay (us)	0
Frequency offset (Hz)	0
UE speed	3km/h
Data Allocation	4 RBs
Channel coding	Turbo
Overhead assumption	3 PDCCH symbols; 2-port DMRS for 2x2 CSI-RS for 2x2

[Fig. 29]



[Fig. 30]



INTERNATIONAL SEARCH REPORT	International application No. **PCT/KR2015/004301**

A. CLASSIFICATION OF SUBJECT MATTER

H04L 27/34(2006.01)i, H04L 27/26(2006.01)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)
H04L 27/34; H04W 72/04; H04L 27/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: MCS, CQI, high-order moduation, 256QAM

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0092823 A1 (RESEARCH IN MOTION LIMITED) 03 April 2014 See paragraphs [0036], [0060]-[0063]; and figures 1, 5a-7b.	1-12
Y	QUALCOMM INCORPORATED, `Higher order modulation`, R1-140451, 3GPP TSG RAN WG1 #76, Prague, Czech Republic, 10-14 February 2014, (http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_76/Docs/) See pages 1-6.	1-12
A	INTEL CORPORATION, `CQI/MCS/TBS Tables for 256QAM and Relevant Signaling`, R1-140118, 3GPP TSG RAN WG1 #76, Prague, Czech Republic, 10-14 February 2014, (http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_76/Docs/) See pages 1-5.	1-12
A	INTEL CORPORATION, `Discussion on configuration aspects for 256QAM`, R1-141153, 3GPP TSG RAN WG1 #76bis, Shenzhen, China, 31 March - 04 April 2014 , (http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_76b/Docs/) See pages 1, 2.	1-12
A	ZTE, `On standard impacts of 256QAM in downlink`, R1-140258, 3GPP TSG RAN WG1 #76, Prague, Czech Republic, 10-14 February 2014, (http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_76/Docs/) See pages 1-7.	1-12

☒ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 July 2015 (29.07.2015)	**30 July 2015 (30.07.2015)**

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014-0092823 A1	03/04/2014	CA 2886028 A1	03/04/2014
		CA 2886214 A1	03/04/2014
		US 2014-092785 A1	03/04/2014
		WO 2014-051697 A1	03/04/2014
		WO 2014-051699 A1	03/04/2014