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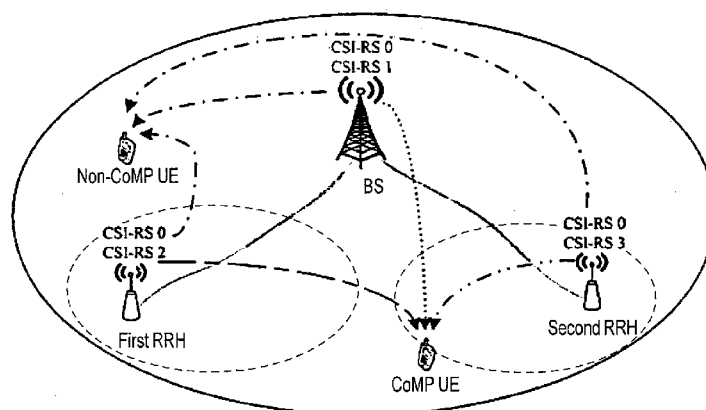
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(54) Title: RRH ENHANCED CoMP TRANSMISSION SYSTEM AND CSI-RS CONFIGURATION METHOD THEREOF

FIG. 2



(57) Abstract: The present invention proposes an RRH enhanced CoMP transmission system comprising a Base Station (BS) for transmitting to all UEs in the present cell resource configuration parameters of Channel State Information Reference Signaling (CSI-RS) of BS and each RRH in the cell via a broadcast channel, transmitting to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs of a set of transmission points that are subject to be measured via an RRC signaling, non-CoMP UEs for performing channel state measurement by means of the resource configuration parameters of the common CSI-RS transmitted from BS, and feeding back the measurement to BS via an uplink channel; and CoMP UEs for performing channel state measurement on the transmission points listed in the set of transmission points by means of the resource configuration parameters of CSI-RSs of respective transmission points transmitted from BS via the broadcast channel, and feed back the measurement to BS via an uplink channel. With the systems and methods according to the present invention, the CoMP transmission scenarios in an LTE-Advanced system can be matched well by effectively configuring CSI-RS modes in the system.

DESCRIPTION

TITLE OF INVENTION:

RRH ENHANCED COMP TRANSMISSION SYSTEM AND CSI-RS
CONFIGURATION METHOD THEREOF

5 TECHNICAL FIELD

The present invention relates to a mobile communication technique, and more particularly, to an RRH enhanced Cooperative Multiple Points (CoMP) transmission system and Channel State Information Reference Signal (CSI-RS)
10 configuration method thereof, which method is used for a mobile communication system that uses a CoMP transmission mode.

BACKGROUND ART

15 In April 2008, the third Generation Partnership Project (3GPP) organization held a conference in Shenzhen, China to discuss the next generation International Mobile Telecommunication (IMT)-Advanced. In this conference, various companies analyzed the demand for 4G mobile
20 communication system, and discussed possible key techniques. Among the various proposals, a technique called "Cooperative Multiple Points (CoMP) Transmission" draw intense attention and got support from the participants. The basic concept of

this technique is to use a plurality of Base Stations (BSs) to serve one or more User Equipments (UEs) to provide a communication service thereto, thereby improving the data transmission rate for UEs at the edge of the cell. In the subsequent conferences held by 3GPP Wireless Access Network 1 (RAN1), process of the CoMP transmission and related feedback process were discussed. In the newest 3GPP technical report, TR 36.814 (3GPP TSG RAN E-UTRA Further advancements for E-UTRA physical layer aspects (Release 9)), the CoMP transmission is divided into two types. One is called Joint Processing in which a UE may receive respective data transmissions from any point (i.e., any BS) that participates in the CoMP transmission. This type can be categorized as Joint Transmission and Dynamic Cell Selection. Joint Transmission is that a plurality of cooperative BSs transmit data for a certain UE at a time, while Dynamic Cell Selection is that one of BSs is selected to transmit data for a UE at a time. The second type is called cooperative scheduling/beam forming, in which data is transmitted to a UE from a serving BS who performs cooperative scheduling/beam forming with other cooperative BSs. Moreover, 3GPP TR 36.814 classes the feedback process that supports CoMP transmission into a first one called explicit channel state information feedback, a second one called implicit channel state information feedback, and a third one in which channel state information is estimated

through Sounding Reference Signal (SRS) by means of channel reciprocity. All three classes can be combined freely to provide an effective channel state information feedback for CoMP transmission.

5 One possible problem in CoMP transmission among a plurality of BSs is the delay of backend data transmission among BSs. CoMP transmission needs rather quick and substantive backend data switching, which cannot be provided by the backend interface defined in the existing LTE-Advanced
10 system. Various companies are paying attention to Remote Radio Head (RRH) enhanced network architecture in order to place the CoMP transmission technique into practice in a real mobile communication system while further speeding the LTE-Advanced standardization.

15 RRH or RRE (Remote Radio Equipment) usually is also referred as Remote Base Station, distributed antenna and etc. For example, as said in R1-084254 ("NTT DoCoMo, Application of Remote Radio Equipment to LTE-Advanced, 3GPP TSG RAN1 Meeting #55") RRH is a wireless radio frequency transceiver
20 located remotely from the central control station. RRH is generally capable of radio frequency transmission and reception, digital-to-analog and analog-to-digital conversion, and optical modulation and demodulation only, while all baseband signal processing function and scheduling function
25 are positioned at the central control station. RRH is

connected to the central control station via a high speed optical fiber to guard interaction of a low delay and a large amount of data. Currently, the four scenarios listed in "R1-110603, NTT DoCoMo, CoMP Simulation Assumption, 3GPP TSG RAN1 Meeting #63bis", are agreed as the base scenarios for CoMP transmission in an LTE-Advanced system. Scenario 1 is an intra-site CoMP transmission where three different cells located within one and the same site perform CoMP transmission. Scenario 2 is a high power RRH cooperative CoMP transmission where each RRH has the same transmission power and coverage region as BS. Scenarios 3 and 4 both are low power RRH cooperative CoMP transmissions where each RRH has a lower transmission power and a smaller coverage region while being within the coverage region of BS to which it belongs. The difference between Scenario 3 and Scenario 4 is in that each RRH has a single cell ID different from BS in Scenario 3, whereas each RRH has the same cell ID as BS in Scenario 4. Three scenarios except scenario 1 among the four scenarios are RRH-enhanced-based CoMP transmission scenarios.

Another problem existing in the CoMP transmission technique is how to perform an effective channel state information feedback. In the most recent 3GPP technical report 3GPP TR 36.814, some conclusions were preliminarily made on the channel state information feedback. In the report, the basic CoMP transmission feedback manner is a

single cell based separate feedback on uplink resource of a serving BS, i.e., UE feeds back channel state information of adjacent cooperative cells by uplink resource of the serving cell. However, topology of a network changes due to the introduction
5 of RRHs, which causes that further research and expansion are needed on the above-mentioned conclusions. For example, CoMP transmissions are performed among RRHs or among RRHs and BS since RRHs have different sites from BS. According to the above-mentioned conclusion, it is expected to
10 be determined whether respective channel state information measurements should be performed on wireless channels between respective cooperative RRHs and UE or between BS and UE, and if so, how to.

In "R1-110649, Ericsson, Aspects on Distributed RRUs
15 with Shared Cell-ID for Heterogeneous Deployments, 3GPP TSG RAN1 Meeting #64", Ericsson proposed a method in which different Channel State Information Reference Signaling (CSI-RS) resources were configured at different Transmission Points (including BS and RRHs connected thereto), and CSI-RS
20 resource for channel state information measurement of UE was semi-statically based on the UE's position or uplink measurement. The proposal utilizes the existed mechanism in the current standard as much as possible, thereby achieving the channel state information feedback in the RRH enhanced
25 network topology. One problem of such proposal, however, is

that a new configuration of CSI-RS resource is triggered if an LTE-Advanced UE moves from an RRH coverage region to another RRH coverage region within the present cell. In the proposal, data are transmitted from only one transmission point by default, and thus the LTE-Advanced UE cannot obtain the transmission combination gain brought forth by the RRHs.

In view of such problems, the present invention deals with how to configure CSI-RS resource in an RRH enhanced CoMP transmission network structure so as to enable both a legacy UE (i.e., LTE-Advanced UE) and a LTE-Advanced Beyond UE to perform effective channel state information feedback.

SUMMARY OF INVENTION

In view of above-mentioned disadvantages in the prior arts, the present invention proposes an RRH enhanced CoMP transmission system and a CSI-RS configuration method.

An RRH enhanced CoMP transmission system according to the present invention comprises a BS, one or more RRHs, and one or more CoMP UEs and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein BS transmits to all UEs in the present cell resource configuration parameters of Channel State Information Reference Signaling (CSI-RS) of BS and each RRH in the cell via a broadcast channel, transmits to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present

cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of a set of transmission points that are subject to be measured via an RRC signaling; the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS; the non-CoMP UEs perform channel state measurement on the resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS transmitted from BS, and feed back the measurement to BS via an uplink channel; the CoMP UEs perform channel state measurement on the transmission points listed in the set of transmission points by means of the resource configuration parameters of CSI-RSs of respective transmission points transmitted from BS via the broadcast channel, and feed back the measurement to BS via an uplink channel.

Another RRH enhanced CoMP transmission system according to the present invention comprises a BS, one or more RRHs, and one or more CoMP UEs and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein BS transmits to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of a set of transmission points that are subject to be measured via an RRC signaling; the RRHs are connected to BS via a optical fiber for performing data switching of a large

capacity at a high speed with BS; the non-CoMP UEs perform channel state measurement on the resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feed back the measurement to BS via an uplink channel; the CoMP UEs perform channel state measurement on channels between a respective transmission point and the CoMP UE by means of the resource configuration parameters of CSI-RS of the transmission point of the set of transmission points that are subject to be measured informed from BS via an RRC signaling, and feed back the measurement to BS via an uplink channel.

Still another RRH enhanced CoMP transmission system according to the present invention comprises a BS, one or more RRHs, and one or more CoMP UEs and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein BS transmits to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of information on serial numbers of transmission points that are subject to be measured via an RRC signaling, the transmission points in the cell each having a unique serial number; the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS; the non-CoMP UEs perform channel state measurement on the resource corresponding to the common

CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feed back the measurement to BS via an uplink channel; the CoMP UEs perform channel state measurement on the transmission points that are subject to be
5 measured on the common CSI-RS resource by means of reference signaling sequences associated with the serial numbers of the transmission points, and feed back the measurement to BS via an uplink channel.

Yet another RRH enhanced CoMP transmission system
10 according to the present invention comprises a BS, one or more RRHs, and one or more CoMP UEs and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein BS transmits to all UEs in the present cell resource configuration parameters of Channel State
15 Information Reference Signaling (CSI-RS) of each RRH in the present cell via a broadcast channel, transmits to the CoMP or non-CoMP UEs resource configuration parameters of CSI-RS of BS via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of a set of transmission points that are subject to
20 be measured via an RRC signaling; the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS; the non-CoMP UEs perform channel state measurement on channel between BS and the non-CoMP UE on the resource corresponding to the CSI-RS by
25 means of the resource configuration parameters of the CSI-RS

transmitted from BS, and feed back the measurement to BS via an uplink channel; the CoMP UEs perform channel state measurement on channels between a respective transmission point and the CoMP UE by means of information on the set of
5 transmission points and the received resource configuration parameters of CSI-RS of BS and each RRH, and feed back the measurement to BS via an uplink channel.

Further another RRH enhanced CoMP transmission system according to the present invention comprises a BS, one
10 or more RRHs, and one or more UEs, the BS and the RRHs being transmission points in a cell, wherein BS informs the UEs of information on resource configuration parameters of CSI-RSs of transmission points that are subject to be measured via a Radio Resource Control (RRC) signaling; the RRHs are connected to
15 BS via a optical fiber for performing data switching of a large capacity at a high speed with BS; UEs perform channel state measurement on channel between the UE and a respective transmission point for each transmission point on the respective resources configured by the resource configuration
20 parameters of CSI-RSs, and feed back the measurement to BS via an uplink channel.

Still another RRH enhanced CoMP transmission system according to the present invention comprises a BS, one or more RRHs, one or more CoMP UEs and one or more non-CoMP UEs,
25 the BS and the RRHs being transmission points in a cell,

wherein BS transmits to the non-CoMP UEs or the CoMP UEs resource configuration parameters of CSI-RS of BS via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of information on serial numbers of transmission points that are
5 subject to be measured via an RRC signaling, the transmission points in the cell each having a unique serial number; the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS; the non-CoMP UEs perform channel state measurement on the
10 resource corresponding to the CSI-RS resource by means of the resource configuration parameters of CSI-RS, and feed back the measurement to BS via an uplink channel; the CoMP UEs perform channel state measurement on a respective transmission point that are subject to be measured on the
15 resource of CSI-RS by means of a reference signaling sequence associated with the serial number of the transmission point, and feed back the measurement to BS via an uplink channel.

Still another RRH enhanced CoMP transmission system according to the present invention comprises a BS, one or more
20 RRHs and one or more UEs, the BS and the RRHs being transmission points in a cell, wherein BS and each RRH transmit to the UE(s) different channel state information reference signaling for channel state information measurement, each CoMP UE receives data from only one transmission point
25 at a time, and BS scrambles data transmitted from different

transmission points by different methods.

A reference signaling configuration method in an RRH enhanced CoMP transmission system according to the present invention comprises steps of transmitting by BS, to all UEs in
5 the present cell resource configuration parameters of Channel State Information Reference Signaling (CSI-RS) of BS and each RRH in the cell via a broadcast channel, transmitting to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control
10 (RRC) signaling, and informing the CoMP UEs of a set of transmission points that are subject to be measured via an RRC signaling; performing, by the non-CoMP UEs, channel state measurement on the resource corresponding to the common CSI-RS by means of the resource configuration parameters of
15 the common CSI-RS transmitted from BS, and feeding back the measurement to BS via an uplink channel; performing, by the CoMP UEs, channel state measurement on the transmission points listed in the set of transmission points by means of the resource configuration parameters of CSI-RSs of respective
20 transmission points transmitted from BS via the broadcast channel, and feeding back the measurement to BS via an uplink channel.

Another reference signaling configuration method in an RRH enhanced CoMP transmission system according to the
25 present invention comprises steps of transmitting, by BS, to the

non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs of a set of transmission points that are subject to be measured via an RRC signaling; performing, by the non-CoMP UEs, channel state measurement on the resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feeding back the measurement to BS via an uplink channel; performing, by the CoMP UEs, channel state measurement on channels between a respective transmission point and the CoMP UE by means of the resource configuration parameters of CSI-RS of the transmission point of the set of transmission points that are subject to be measured informed from BS via an RRC signaling, and feeding back the measurement to BS via an uplink channel.

Yet another reference signaling configuration method in an RRH enhanced CoMP transmission system according to the present invention comprises steps of transmitting, by BS, to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs of information on serial numbers of transmission points that are subject to be measured via an RRC signaling, the transmission points in the cell each having a unique serial number; performing, by the non-CoMP UEs, channel state measurement on the resource

corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feeding back the measurement to BS via an uplink channel; performing, by the CoMP UEs, channel state measurement on the transmission points that are subject to be measured on the common CSI-RS resource by means of reference signaling sequences associated with the serial numbers of the transmission points, and feeding back the measurement to BS via an uplink channel.

According to the systems and methods of the present invention, the CoMP transmission scenarios in an LTE-Advanced system can be matched well by effectively configuring CSI-RS modes in the system in a CoMP transmission mode.

The present invention can be embodied as an RRH enhanced CoMP transmission system and a CSI-RS configuration method in such system, as specially and generally illustrated herein.

BRIEF DESCRIPTION OF DRAWINGS

The above and other objects, features and advantages of the present invention will be clearer from the embodiments of the present invention taken in conjunction with the accompanying drawings below, in which:

Fig. 1 is a block diagram showing a first RRH enhanced

CoMP transmission system according to the present invention;

Fig. 2 is a block diagram showing a second RRH enhanced CoMP transmission system according to the present invention;

Figs. 3 is a signaling flow chart of CSI-RS configuration of
5 the first and second RRH enhanced CoMP transmission systems according to the present invention;

Figs. 4 is a signaling flow chart of CSI-RS configuration of the first and second RRH enhanced CoMP transmission systems according to the present invention;

10 Figs. 5 is a signaling flow chart of CSI-RS configuration of the first and second RRH enhanced CoMP transmission systems according to the present invention;

Fig. 6 is a block diagram showing a third RRH enhanced CoMP transmission system according to the present invention;

15 Figs. 7 is a signaling flow chart of CSI-RS configuration of the third RRH enhanced CoMP transmission system according to the present invention;

Figs. 8 is a signaling flow chart of CSI-RS configuration of the third RRH enhanced CoMP transmission system according
20 to the present invention;

Figs. 9 is a signaling flow chart of CSI-RS configuration of the third RRH enhanced CoMP transmission system according to the present invention; and

Fig. 10 is a block diagram showing a fourth RRH enhanced
25 CoMP transmission system according to the present invention.

DESCRIPTION OF EMBODIMENTS

Preferred embodiments of the present invention will be described in details below with reference to the drawings.

5 Some details and functions that are not necessary for a skilled person in the art to understand the invention will be omitted in the description below while they may blur the understanding of the present invention.

The implementation of the present invention is described
10 by describing below a specific embodiment of the present invention which is applied to an RRH enhanced mobile communication system, especially an LTE-Advanced cellular mobile communication system and its future system of evolution. It should be noted that the present invention is not
15 limited to the applications that have been described herein and can be applied to other relevant communication system, such as a prospective 5G cellular communication system.

Before describing the embodiments of the present invention, related contents about CSI-RS defined in an
20 LTE-Advanced system are described briefly. In an LTE-Advanced system, a Base Station (BS) device configures CSI-RS resource parameter for a designated User Equipment (UE) semi-statically by a Radio Resource Control (RRC) signaling. The parameter includes the following essential
25 fields as given in, for example, "3GPP TS 36.331 v10.0.0, 3GPP

TSG RAN E-UTRA RRC Protocol specification”:

- CSI-RS mapping location, which describes which Resource Element (RE) in a sub-frame the CSI-RS maps to. In the standardization document, “3GPP TS 36.211 V10.0.0, 3GPP
5 TSG RAN E-UTRA Physical channels and modulation”, 32 different mapping modes are defined for a sub-frame that uses a normal Cyclic Prefix (CP), where the first 20 modes are applicable to an FDD system.

- CSI-RS sub-frame configuration, which describes on
10 which sub-frames the CSI-RS for the designated UE are transmitted. In the standardization document, 3GPP TS 36.211, 155 types of different configuration modes are defined. Different CSI-RS sub-frame configurations have different configuration periods or offsets.

15 The CSI-RS resource configuration parameter is composed of a CSI-RS mapping location field and a CSI-RS sub-frame configuration field. According to the definition in the standardization document, the available configurations can be up to 3100 for an FDD system with a normal CP if one or two
20 antennas are provided since, up to 1500 if four antennas are provided, and up to 775 if eight antennas are provided. Accordingly, the resource configuration parameters of CSI-RSs defined in an LTE-Advanced system are sufficient.

Different CSI-RSs can also be differentiated by the
25 transmitted Reference-signaling Sequence in addition to the

CSI-RS resource configuration parameters. In the standardization document 3GPP TS 36.211, it is defined a procedure for generating a CSI-RS Reference signaling Sequence which is a pseudorandom sequence and determined by an initial value associated with a cell ID. For a system with a normal cyclic prefix, the initial value is $c_{\text{init}} = 2^{10} \cdot (7 \cdot (n_s + 1) + l + 1) \cdot (2 \cdot N_{\text{ID}}^{\text{cell}} + 1) + 2 \cdot N_{\text{ID}}^{\text{cell}} + 1$, where n_s is the number of the slot, l is the serial number of the OFDM symbol, and $N_{\text{ID}}^{\text{cell}}$ is the cell ID. The reference signaling sequence is associated with the cell ID, and can effectively restrain inter-cell CSI-RS interference.

By informing a UE of the CSI-RS resource configuration parameter, UE can perform channel state information measurement on the designated CSI-RS resource by means of the known reference signaling sequence which is based on the cell ID.

Fig. 1 is a block diagram showing a first RRH enhanced CoMP transmission system according to the present invention. As shown in Fig. 1, the RRH enhanced CoMP transmission system comprises a BS, a first RRH, a second RRH, a non-CoMP UE and a CoMP UE. Fig. 1 is only for illustration, and the numbers of RRHs and UEs are not limited to those as shown in the drawing, and may be one or more. This also applies to the system of the present invention described below with reference

to other drawings.

The first and second RRHs are connected to BS via optical fibers, so that data switching of a large capacity can be performed at a high speed. An RRH has relatively simple functions, including radio frequency data transmission and reception, digital-to-analog and analog-to-digital conversion, and optical modulation and demodulation. An RRH has no separate cell ID, but share one cell ID with BS. Baseband signal processing and resource scheduling are performed at BS.

10 In the system, the RRHs have the same transmission power as BS, and the signal coverage of BS is equivalent to that of the first and second RRHs.

Fig. 2 is a block diagram showing a second RRH enhanced CoMP transmission system according to the present invention.

15

As shown in Fig. 2, the RRH enhanced CoMP transmission system comprises a BS, a first RRH, a second RRH, a non-CoMP UE and a CoMP UE.

The first and second RRHs are connected to BS via optical fibers, so that data switching of a large capacity can be performed at a high speed. An RRH has only simple functions, including radio frequency data transmission and reception, digital-to-analog and analog-to-digital conversion, and optical modulation and demodulation. An RRH has no separate cell ID, but share one cell ID with BS. Baseband

20

25

signal processing and resource scheduling are performed at BS. In the system, the RRHs have lower transmission power, and the signal from BS can reach the whole cell, including the regions that are covered by the first and second RRHs.

5 In the first and second RRH enhanced CoMP transmission systems described above, BS and each RRH (including the first RRH and the second RRH) within the cell transmit a common channel state information reference signaling to a non-CoMP UE for performing channel state information measurement in
10 mode 9 as defined in LTE-Advanced. BS and each RRH within the cell transmit different channel state information reference signaling to a CoMP UE for performing channel state information measurement (the CoMP UE is a UE that receives data from a plurality of transmission points by using a CoMP
15 transmission mode). For example, BS, the first RRH and the second RRH transmit a common reference signaling CSI-RS 0 to a non-CoMP UE for channel state information measurement, while BS, the first RRH and the second RRH transmit channel state information reference signaling CSI-RS 1, CSI-RS 2 and
20 CSI-RS 3 respectively to a CoMP UE in the cell for channel state information measurement. If the non-CoMP UE (the Non-CoMP UE is a UE that receives data from a single transmission point in a conventional way) is configured by BS to operate in mode 9 as defined in LTE-Advanced, it performs channel state
25 measurement by using the channel state information reference

signaling CSI-RS 0 transmitted from a plurality of transmission points in the cell, with the measured channel state being that of a combined channel from the plurality of transmission points to the non-CoMP UE. On the other hand, the CoMP UE performs measurement on a plurality of surrounding transmission points (including BS and RRHs) to obtain channel states of channels from the respective transmission points to the CoMP UE by means of the received different resource configuration parameters of CSI-RSs. For example, as shown in Fig. 1, the CoMP UE may measure the state of a channel from BS to the CoMP UE by means of CSI-RS 1, measure the state of a channel from the first RRH to the CoMP UE by means of CSI-RS 2, and measure the state of a channel from the second RRH to the CoMP UE by means of CSI-RS 3.

15

Fig. 3 is a first signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the first and second RRH enhanced CoMP transmission systems as described above.

With regard to Figs. 1-3, in the above-mentioned first and second transmission systems, BS transmits resource configuration parameters of channel state information reference signaling of each transmission point (including BS and each RRH) within the present cell to UEs in the cell (including the CoMP UE(s) and the non-CoMP UE(s)) via a broadcast channel (such as, Dynamic Broadcast Channel

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(D-BCH) as defined in LTE-Advanced). For example, BS informs all LTE-Advanced Beyond UEs in the cell via a D-BCH that there are 3 transmission points in the cell, i.e., BS and two RRHs. The BS uses the resource configuration parameter of CSI-RS 1. The first RRH uses the resource configuration parameter of CSI-RS 2. And the second RRH uses the resource configuration parameter of CSI-RS 3.

BS transmits to a designated UE the resource configuration parameter of a common CSI-RS in the present cell via an RRC signaling. In the above-mentioned first and second transmission systems, BS transmits to the non-CoMP UE the resource configuration parameter of common CSI-RS 0 in the cell via an RRC signaling. If the non-CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

BS informs the CoMP UE of information on a set of

transmission points that are subject to be measured via an RRC signaling. The transmission points included in the set are RRHs specified by BS and to be CSI measured by the CoMP UE. For example, if BS informs the CoMP UE of a set of transmission
5 points including BS, the first RRH and the second RRH, the CoMP UE performs channel state measurements on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 1, CSI-RS 2 and CSI-RS 3
10 respectively according to the information on the set of transmission points and the received resource configuration parameters of CSI-RSs of respective transmission points.

UEs (including the CoMP UE and the non-CoMP UE) feed the channel state information back to BS via an uplink channel
15 in the feedback manners corresponding to their specific operation modes.

Fig. 4 is a second signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the first and second RRH
20 enhanced CoMP transmission systems as described above.

With regard to Figs. 1, 2 and 4, BS transmits the resource configuration parameter of the common CSI-RS in the present cell to a designated UE via an RRC signaling. For example, BS transmits the resource configuration parameter of common
25 CSI-RS 0 in the cell to the non-CoMP UE via an RRC signaling.

If the non-CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

BS informs the CoMP UE of resource configuration parameters of CSI-RSs of a set of transmission points that are subject to be measured via an RRC signaling. In the above-mentioned first and second transmission systems, BS informs the CoMP UE to perform channel state measurements on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 1, CSI-RS 2 and CSI-RS 3. In such a case, the CoMP UE performs channel state measurements on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 1, CSI-RS 2 and CSI-RS 3 respectively according to the received resource configuration parameters of CSI-RSs of

respective transmission points.

UEs (including the CoMP UE and the non-CoMP UE) feed the channel state information back to BS via an uplink channel in the feedback manners corresponding to their specific
5 operation modes.

Fig. 5 is a third signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the first and second RRH enhanced CoMP transmission systems as described above.

10 With regard to Figs. 1, 2 and 5, BS transmits the resource configuration parameter of the common CSI-RS in the present cell to a designated UE via an RRC signaling. For example, BS transmits the resource configuration parameter of a common CSI-RS 0 in the cell to the non-CoMP UE via an RRC signaling.
15 If the non-CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to
20 the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a
25 CoMP mode and a non CoMP mode.

BS informs the CoMP UE of the serial numbers of the transmission points that are subject to be measured via an RRC signaling. Each transmission point in the cell has a unique serial number. If it is assumed that the upper limit for the numbers of transmission points in a single cell is 32, the transmission points in the cell can be numbered from 0 to 31 serially. For example, BS is numbered as 0, the first RRH is numbered as 1, and the second RRH is numbered as 2. BS may inform the CoMP UE via an RRC signaling that the transmission points that are subject to be measured have serial numbers of 0, 1, and 2. In such a case, the CoMP UE uses reference signaling sequences associated with the serial numbers of the transmission points to perform channel measurements on the transmission points to be measured on resource of the common CSI-RS 0. The channel measurement is a well known technique, such as what is given in LTE-Advanced. In the embodiment, CSI-RSs are differentiated by different serial numbers instead of the resource configurations of CSI-RS 1, 2 and 3.

As defined in the standardization document 3GPP TS 36.211, an initial value of a reference signaling sequence of CSI-RS on respective transmission points is defined as $c_{\text{init}} = 2^{15} \cdot (7 \cdot (n_s + 1) + l + 1) \cdot (2 \cdot N_{\text{ID}}^{\text{cell}} + 1) + 2^5 \cdot N_{\text{ID}}^{\text{cell}} + N_{\text{ID}}^{\text{TP}} + 1$, where n_s is the number of the slot, l is the serial number of the OFDM symbol, $N_{\text{ID}}^{\text{cell}}$ is the cell ID and $N_{\text{ID}}^{\text{TP}}$ is the serial number of the

transmission point. On the same CSI-RS resource, the channels from different transmission points to UE can be differentiated by different reference signaling sequences.

UEs (including the CoMP UE and the non-CoMP UE) feed
5 the channel state information back to BS via an uplink channel in the feedback manners corresponding to their specific operation modes.

Fig. 6 is a block diagram showing the third RRH enhanced
10 CoMP transmission system according to the present invention.

As shown in Fig. 6, the RRH enhance CoMP transmission system comprises a BS, a first RRH, a second RRH, a non-CoMP UE and a CoMP UE.

The first and second RRHs are connected to BS via optical
15 fibers, so that data switching of a large capacity can be performed at a high speed. An RRH has only simple functions, including radio frequency data transmission and reception, digital-to-analog and analog-to-digital conversion, and optical modulation and demodulation. An RRH has no
20 separate cell ID, but share one cell ID with BS. Baseband signal processing and resource scheduling are performed at BS. In the system, the RRHs have lower transmission power, and signal from BS can reach the whole cell, including the regions that are covered by the first and second RRHs.

25 BS and each RRH (including the first RRH and the second

RRH) transmit different channel state information reference signaling to UEs for channel state information measurement. For example, BS, the first RRH and the second RRH transmit channel state information reference signaling CSI-RS 0, CSI-RS 1 and CSI-RS 2 to UEs in the cell for channel state information measurement respectively. BS has a higher transmission power so that it covers the whole cell. All UEs (including the non-CoMP UE and the CoMP UE) in the cell are capable of receiving signals transmitted from BS, including data signal and reference signaling. RRHs have lower transmission power so that their wireless singals cover a smaller region only.

In the system, RRHs are only used for cooperative transmission in a CoMP transmission mode. RRHs do not participate in data transmission to the non-CoMP UE. The non-CoMP UE performs point-to-point data transmission with BS according to the transmission mode configured by BS. For example, the non-CoMP UE needs the channel state information reference signal CSI-RS 0 transmitted from BS to perform the channel state measurement if it is configured to transmit data in mode 9 as defined in LTE-Advanced. According to the configuration, the CoMP UE measures a plurality of surrounding transmission points (including BS and RRHs) respectively by means of different channel state information reference signalings to obtain the channel state information. As shown in Fig. 6, the CoMP UE may measure the state

information on channel from BS to the CoMP UE by means of CSI-RS 0, measure the state information on channel from the first RRH to the CoMP UE by means of CSI-RS 1, and measure the state information on channel from the second RRH to the CoMP UE by means of CSI-RS 2.

Fig. 7 is a signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the third RRH enhanced CoMP transmission system according to the present invention.

With regard to Figs. 6 and 7, BS transmits resource configuration parameters of the channel state information reference signaling of each RRH in the present cell to UEs (including the CoMP UE and the non-CoMP UE) in the present cell via a broadcast channel (such as, Dynamic Broadcast Channel (D-BCH) as defined in LTE-Advanced). For example, BS informs all LTE-Advanced Beyond UEs (including the CoMP UE and the non-CoMP UE) in the cell that there are two RRHs in the cell, the first RRH uses configuration parameter of CSI-RS 1, and the second RRH uses configuration parameter of CSI-RS 2.

BS transmits resource configuration parameter of CSI-RS of BS to a designated UE via an RRC signaling. For example, BS transmits configuration parameter of CSI-RS 0 of BS to the non-CoMP UE via an RRC signaling. If the non-CoMP UE has received the resource configuration parameter of CSI-RS 0, it

performs channel information measurement on the wireless channel between BS and UE on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

BS informs the CoMP UE of information on a set of transmission points that are subject to be measured via an RRC signaling. For example, if BS informs the CoMP UE that the set of transmission points that are subject to be measured includes BS, the first RRH and the second RRH, the CoMP UE performs channel state measurement on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 0, CSI-RS 1 and CSI-RS 2 respectively, based on the information on the set of transmission points and the received resource configuration parameters of the channel state information reference signaling of BS and each RRH.

UE feeds the channel state information back to BS via an uplink channel in feedback manner corresponding to its specific operation mode.

Fig. 8 is another signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the third RRH enhanced CoMP transmission system according to the present invention.

5 With regard to Figs. 6 and 8, BS informs UEs of resource configuration parameters of CSI-RSs of transmission points that are subject to be measured via an RRC signaling. For example, BS informs the CoMP UE to perform channel state measurements on channels between the BS and the CoMP UE,
10 between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 0, CSI-RS 1 and CSI-RS 2 respectively. UE feeds the channel state information back to BS via an uplink channel in feedback manner corresponding to its specific operation mode.

15

Fig. 9 is another signaling flow chart for configuring CSI-RS parameters of the CoMP UE in the third RRH enhanced CoMP transmission system according to the present invention.

With regard to Figs. 6 and 9, BS transmits resource
20 configuration parameter of CSI-RS of BS to a designated UE via an RRC signaling. For example, BS transmits the configuration parameter of CSI-RS 0 of BS to the non-CoMP UE via an RRC signaling. If the non-CoMP UE has received the resource configuration parameter of CSI-RS 0, it performs
25 channel state information measurement on the wireless

channel between BS and the UE on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP
5 UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

10 BS informs UE (the CoMP UE) of information on serial numbers of transmission points that are subject to be measured via an RRC signaling. Each transmission point has a unique serial number. If it is assumed that the upper limit for the numbers of transmission points in a single cell is 32, the
15 transmission points in the cell can be numbered from 0 to 31 serially. For example, BS is numbered as 0, the first RRH is numbered as 1, and the second RRH is numbered as 2. BS may inform the CoMP UE via an RRC signaling that the transmission points that are subject to be measured have serial
20 numbers of 0, 1, and 2. In such a case, the CoMP UE uses reference signaling sequences associated with the serial numbers of the transmission points to perform channel measurement on the transmission points to be measured on the resource of the common CSI-RS 0. As defined in the
25 standardization document 3GPP TS 36.211, an initial value of

the reference signaling sequence of CSI-RS on respective transmission points is defined as

$$c_{\text{init}} = 2^{15} \cdot (7 \cdot (n_s + 1) + l + 1) \cdot (2 \cdot N_{\text{ID}}^{\text{cell}} + 1) + 2^5 \cdot N_{\text{ID}}^{\text{cell}} + N_{\text{ID}}^{\text{TP}} + 1,$$

where n_s is the number of the slot, l is the serial number of the OFDM symbol,

5 $N_{\text{ID}}^{\text{cell}}$ is the cell ID and $N_{\text{ID}}^{\text{TP}}$ is the serial number of the transmission point. On the same CSI-RS resource, the channels from different transmission points to UE can be differentiated by different reference signaling sequences. UE feeds the channel state information back to BS via an uplink

10 channel in feedback manner corresponding to its specific operation mode.

Fig. 10 is a block diagram showing the fourth RRH enhanced CoMP transmission system according to the present

15 invention.

With regard to Fig. 10, the first and second RRHs are connected to BS via optical fibers, so that data switching of a large capacity can be performed at a high speed. An RRH has relatively simple functions, including radio frequency data

20 transmission and reception, digital-to-analog and analog-to-digital conversion, and optical modulation and demodulation. An RRH has no separate cell ID, but share one cell ID with BS. Baseband signal processing and resource scheduling are performed at BS.

25 BS and each RRH (including the first RRH and the second

RRH) transmit different channel state information reference signaling to UE for performing channel state information measurement. For example, BS, the first RRH and the second RRH respectively transmit the channel state information reference signaling CSI-RS 0, CSI-RS 1 and CSI-RS 2 to UE in the cell for channel state information measurement.

The CoMP UE in the cell is configured in a transmission mode of cooperative scheduling/beamforming or dynamic cell selection. In either mode, the CoMP UE only receives data from one transmission points at a time.

Each of all transmission points in the cell is provided with a unique serial number. If it is assumed that the upper limit for the numbers of transmission points in a single cell is 32, the transmission points in the cell can be numbered from 0 to 31 serially. In the system as shown in Fig. 10, BS is numbered as 0, the first RRH is numbered as 1, and the second RRH is numbered as 2. BS scrambles the data transmitted from different transmission points. As shown, the data transmitted from BS can be scrambled with the cell ID as defined in LTE-Advanced, while the data transmitted from the first RRH is scrambled with the serial number of the transmission point. More particularly, as defined in the standardization document 3GPP TS 36.211, the initial value of the scrambling sequence may be designed by $c_{\text{init}} = n_{\text{RNTI}} \cdot 2^{19} + q \cdot 2^{18} + \lfloor n_s/2 \rfloor \cdot 2^{14} + N_{\text{ID}}^{\text{cell}} \cdot 2^5 + N_{\text{ID}}^{\text{TP}}$, where n_{RNTI} is the Cell Radio Network Temporary Identifier

(RNTI) number of UE, n_s is the number of the slot, q is the serial number of the code word, N_{ID}^{cell} is the cell ID and N_{ID}^{TP} is the serial number of the transmission point.

With such a method, data transmitted from different
5 transmission points in the cell are scrambled with different sequences, so that interference among the transmission points can be reduced more or less, and thus the capacity of the system is improved.

The channel state information measurements as described
10 in conjunction with Figs. 7-9 are applicable in the system.

Furthermore, the present invention also proposes a CSI-RS configuration method that is applied to the RRH enhanced CoMP transmission system. Six embodiments of the
15 method are given as follows.

(Embodiment 1)

With regard to Fig. 3, the embodiment of the method can be applied to the RRH enhanced CoMP transmission system of
20 the present invention described with reference to Figs. 1-2. The CSI-RS configuration method comprises the following steps.

Step 1, BS transmits resource configuration parameters of channel state information reference signaling of each
25 transmission point (including BS and each RRH) within the

present cell to UEs in the cell (including the CoMP UE(s) and the non-CoMP UE(s)) via a broadcast channel (such as, Dynamic Broadcast Channel (D-BCH) as defined in LTE-Advanced). For example, BS informs all LTE-Advanced Beyond UEs in the cell
5 via a D-BCH that there are 3 transmission points in the cell, i.e., BS and two RRHs, BS uses the resource configuration parameter of CSI-RS 1, the first RRH uses the resource configuration parameter of CSI-RS2 and the second RRH uses the resource configuration parameter of CSI-RS 3.

10 Step 2, BS transmits to a designated UE (the non-CoMP UE) the resource configuration parameter of a common CSI-RS in the present cell via an RRC signaling. For example, BS transmits to the non-CoMP UE the resource configuration parameter of a common CSI-RS 0 in the cell via an RRC
15 signaling. If the non-CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0
20 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS
25 switching between a CoMP mode and a non-CoMP mode.

Step 3, BS informs the CoMP UE of information on a set of transmission points that are subject to be measured via an RRC signaling. For example, if BS informs the CoMP UE of a set of transmission points including BS, the first RRH and the second
5 RRH, the CoMP UE performs channel state measurements on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 1, CSI-RS 2 and CSI-RS 3 respectively according to the information on the set
10 and the received resource configuration parameters of channel state information reference signaling of respective transmission points.

Step 4, UEs (including the CoMP UE and the non-CoMP UE) feed the channel state information back to BS via an uplink
15 channel in the feedback manners corresponding to their specific operation modes.

(Embodiment 2)

With regard to Fig. 4, the embodiment of the method can
20 be applied to the RRH enhanced CoMP transmission system of the present invention described with reference to Figs. 1-2. The CSI-RS configuration method comprises the following steps.

Step 1, BS transmits the resource configuration
25 parameter of the common CSI-RS in the present cell to a

designated UE via an RRC signaling.

For example, BS transmits the resource configuration parameter of a common CSI-RS 0 in the cell to the non-CoMP UE via an RRC signaling. If the non-CoMP UE has received the
5 resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In
10 such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non-CoMP
15 mode.

Step 2, BS informs the CoMP UE of resource configuration parameters of CSI-RSs of a set of transmission points that are subject to be measured via an RRC signaling. For example, BS informs the CoMP UE to perform channel state measurements
20 on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 1, CSI-RS 2 and CSI-RS 3.

Step 3, UEs (including the CoMP UE and the non-CoMP
25 UE) feed the channel state information back to BS via an uplink

channel in the feedback manners corresponding to their specific operation modes.

(Embodiment 3)

5 With regard to Fig. 5, the embodiment of the method can be applied to the RRH enhanced CoMP transmission system of the present invention described with reference to Figs. 1-2. The CSI-RS configuration method comprises the following steps.

10 Step 1, BS transmits the resource configuration parameter of a common CSI-RS in the present cell to a designated UE via an RRC signaling.

For example, BS transmits the resource configuration parameter of a common CSI-RS 0 in the cell to the non-CoMP UE
15 via an RRC signaling. If the non-CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common
20 CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a
25 basis for BS switching between a CoMP mode and a non CoMP

mode.

Step 2, BS informs the CoMP UE of the serial numbers of the transmission points that are subject to be measured via an RRC signaling. Each transmission point in the cell has a unique serial number. If it is assumed that the upper limit for the numbers of transmission points in a single cell is 32, the transmission points in the cell can be numbered from 0 to 31 serially. For example, BS is numbered as 0, the first RRH is numbered as 1, and the second RRH is numbered as 2. BS may inform the CoMP UE via an RRC signaling that the transmission points that are subject to be measured have serial numbers of 0, 1, and 2. In such a case, the CoMP UE uses reference signaling sequences associated with the serial numbers of the transmission points to perform channel measurements on the transmission points to be measured on the resource of the common CSI-RS 0. As defined in the standardization document 3GPP TS 36.211, an initial value of the reference signaling sequence of CSI-RS on respective transmission points is defined as

$$c_{\text{init}} = 2^{15} \cdot (7 \cdot (n_s + 1) + l + 1) \cdot (2 \cdot N_{\text{ID}}^{\text{cell}} + 1) + 2^5 \cdot N_{\text{ID}}^{\text{cell}} + N_{\text{ID}}^{\text{TP}} + 1,$$

where n_s is the number of the slot, l is the serial number of the OFDM symbol, $N_{\text{ID}}^{\text{cell}}$ is the cell ID and $N_{\text{ID}}^{\text{TP}}$ is the serial number of the transmission point. On the same CSI-RS resource, the channels from different transmission points to UE can be differentiated by different reference signaling sequences.

Step 3, UEs (including the CoMP UE and the non-CoMP UE) feed the channel state information back to BS via an uplink channel in the feedback manners corresponding to their specific operation modes.

5

(Embodiment 4)

With regard to Fig. 7, the embodiment of the method can be applied to the RRH enhanced CoMP transmission system of the present invention described with reference to Fig. 6. The
10 CSI-RS configuration method comprises the following steps.

Step 1, BS transmits resource configuration parameters of the channel state information reference signaling of each RRH in the present cell to UEs (including the CoMP UE and the non-CoMP UE) in the present cell via a broadcast channel (such
15 as, Dynamic Broadcast Channel (D-BCH) as defined in LTE-Advanced). For example, BS informs all LTE-Advanced Beyond UEs (including the CoMP UE and the non-CoMP UE) in the cell that there are two RRHs in the cell, the first RRH uses configuration parameter of CSI-RS1, and the second RRH uses
20 configuration parameter of CSI-RS2.

Step 2, BS transmits resource configuration parameter of CSI-RS of BS to a designated UE via an RRC signaling. For example, BS transmits configuration parameter of CSI-RS 0 of BS to the non-CoMP UE via an RRC signaling. If the UE has
25 received the resource configuration parameter of CSI-RS 0, it

performs channel information measurement on the wireless channel between BS and UE on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

Step 3, BS informs the CoMP UE of information on a set of transmission points that are subject to be measured via an RRC signaling. For example, if BS informs the CoMP UE that the set of transmission points that are subject to be measured includes BS, the first RRH and the second RRH, the CoMP UE performs channel state measurement on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 0, CSI-RS 1 and CSI-RS 2 respectively, based on the information on the set of transmission points and the received resource configuration parameters of the channel state information reference signaling of BS and each RRH.

Step 4, UE feeds the channel state information back to BS via an uplink channel in feedback manner corresponding to its specific operation mode.

(Embodiment 5)

With regard to Fig. 8, the embodiment of the method can be applied to the RRH enhanced CoMP transmission system of the present invention described with reference to Fig. 6. The CSI-RS configuration method comprises the following steps.

Step 1, BS informs UEs of resource configuration parameters of CSI-RSs of transmission points that are subject to be measured via an RRC signaling. For example, BS informs the CoMP UE to perform channel state measurements on channels between the BS and the CoMP UE, between the first RRH and the CoMP UE, between the second RRH and the CoMP UE on the configured resources of CSI-RS 0, CSI-RS 1 and CSI-RS 2 respectively.

Step 2, UE feeds the channel state information back to BS via an uplink channel in feedback manner corresponding to its specific operation mode.

(Embodiment 6)

With regard to Fig. 9, the embodiment of the method can be applied to the RRH enhanced CoMP transmission system of the present invention described with reference to Fig. 6. The CSI-RS configuration method comprises the following steps.

Step 1, BS transmits resource configuration parameter of CSI-RS of BS to a designated UE via an RRC signaling. For

example, BS transmits the configuration parameter of CSI-RS 0 of BS to the non-CoMP UE via an RRC signaling. If the non-CoMP UE has received the resource configuration parameter of CSI-RS 0, it performs channel state information measurement on the wireless channel between BS and the UE on the resource corresponding to CSI-RS 0. It is understood that BS may transmit the configuration parameter of the common CSI-RS 0 in the cell to the CoMP UE via an RRC signaling. In such a case, if the CoMP UE has received the resource configuration parameter of the common CSI-RS 0, it performs channel state information measurement on the resource corresponding to CSI-RS 0, and the measurement may form a basis for BS switching between a CoMP mode and a non CoMP mode.

Step 2, BS informs UEs (the CoMP UEs) of information on serial numbers of transmission points that are subject to be measured via an RRC signaling. Each transmission point has a unique serial number. If it is assumed that the upper limit for the numbers of transmission points in a single cell is 32, the transmission points in the cell can be numbered from 0 to 31 serially. For example, BS is numbered as 0, the first RRH is numbered as 1, and the second RRH is numbered as 2. BS may inform the CoMP UEs via an RRC signaling that the transmission points that are subject to be measured have serial numbers of 0, 1, and 2. In such a case, the CoMP UEs use

reference signaling sequences associated with the serial numbers of the transmission points to perform channel measurements on the transmission points to be measured on the resource of the common CSI-RS 0. As defined in the standardization document 3GPP TS 36.211, an initial value of the reference signaling sequence of CSI-RS on respective transmission points is defined as

$$c_{\text{init}} = 2^{15} \cdot (7 \cdot (n_s + 1) + l + 1) \cdot (2 \cdot N_{\text{ID}}^{\text{cell}} + 1) + 2^5 \cdot N_{\text{ID}}^{\text{cell}} + N_{\text{ID}}^{\text{TP}} + 1,$$

where n_s is the number of the slot, l is the serial number of the OFDM symbol, $N_{\text{ID}}^{\text{cell}}$ is the cell ID and $N_{\text{ID}}^{\text{TP}}$ is the serial number of the transmission point. On the same CSI-RS resource, the channels from different transmission points to UE can be differentiated by different reference signaling sequences.

Step 3, UEs feed the channel state information back to BS via an uplink channel in feedback manner corresponding to its specific operation mode.

With the RRH enhanced CoMP transmission system and its CSI-RS configuration method as proposed above, both the CoMP UE and the non-CoMP UE can effectively perform CSI measurement and feedback, provide sound basis for BS to allocate resource and perform scheduling, thereby improving throughput of the whole system. The method is simple but effective, while the system is of low complexity, which satisfies the design requirements of a real system, LTE-Advanced system

and its system of evolution.

The present invention is described with reference to the preferred embodiments of the present invention. It is obvious that, any modification, substitution, improvement or like can
5 be made without departing from the spirit and principle of the present invention. The scope of the present invention is not limited to the embodiments, and should be encompassed by the attached claims.

CLAIMS

1. A Remote Radio Head (RRH) enhanced Cooperative Multiple Points (CoMP) transmission system comprising a Base
5 Station (BS), one or more RRHs, and one or more CoMP User Equipments (UEs) and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein

BS transmits to all UEs in the present cell resource configuration parameters of Channel State Information
10 Reference Signaling (CSI-RS) of BS and each RRH in the cell via a broadcast channel, transmits to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of a set of transmission points that are subject to
15 be measured via an RRC signaling;

the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS;

the non-CoMP UEs perform channel state measurement on
20 resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS transmitted from BS, and feed back the measurement to BS via an uplink channel; and

the CoMP UEs perform channel state measurement on the
25 transmission points listed in the set of transmission points by

means of the resource configuration parameters of CSI-RSs of respective transmission points transmitted from BS via the broadcast channel, and feed back the measurement to BS via an uplink channel.

5

2. The system according to claim 1, wherein BS and each RRH in the cell transmit a common CSI-RS to the non-CoMP UE for channel state information measurement, and BS and each RRH transmit different CSI-RSs to the CoMP UE for respective
10 channel state information measurements.

3. The system according to claim 2, wherein the common CSI-RS and the different CSI-RSs have different resource configuration parameters.

15

4. The system according to claim 1, wherein the non-CoMP UE performs channel state measurement by using the common CSI-RS transmitted from a plurality of transmission points in the cell, with the measured channel state being that of a
20 combined channel from the plurality of transmission points to the non-CoMP UE.

5. The system according to claim 4, wherein the CoMP UE performs measurement on a plurality of surrounding
25 transmission points to obtain channel states of channels from

the respective transmission points to the CoMP UE by means of the received different CSI-RSs.

6. The system according to claim 5, wherein the non-CoMP
5 UE performs channel state information measurement in mode 9 as defined in LTE-Advanced.

7. The system according to any of claims 1 to 6, wherein
the one or more RRHs have no separate cell ID, and share one
10 cell ID with BS.

8. The system according to claim 7, wherein each of the
one or more RRHs has the same transmission power as BS.

15 9. The system according to claim 7, wherein each of the
one or more RRHs has lower transmission power compared with
BS, and wherein the signal from BS can reach the whole cell,
including the regions that are covered by the RRHs.

20 10. A Remote Radio Head (RRH) enhanced Cooperative
Multiple Points (CoMP) transmission system comprising a
Base Station (BS), one or more RRHs, and one or more CoMP
User Equipments (UEs) and/or one or more non-CoMP UEs, the
BS and the RRHs being transmission points in a cell, wherein
25 BS transmits to the non-CoMP UEs resource configuration

parameters of common Channel State Information Reference Signaling (CSI-RS) in the present cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of the resource configuration parameters of CSI-RSs of a set of
5 transmission points that are subject to be measured via an RRC signaling;

the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS;

10 the non-CoMP UEs perform channel state measurement on resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feed back the measurement to BS via an uplink channel; and

the CoMP UEs perform channel state measurement on
15 channels between a respective transmission point and the CoMP UE by means of the resource configuration parameters of CSI-RS of the transmission point of the set of transmission points that are subject to be measured informed from BS via an RRC signaling, and feed back the measurement to BS via an
20 uplink channel.

11. The system according to claim 10, wherein BS and each RRH in the cell transmit a common CSI-RS to the non-CoMP UE for channel state information measurement, and
25 BS and each RRH transmit different CSI-RSs to the CoMP UE for

respective channel state information measurements.

12. The system according to claim 11, wherein the common CSI-RS and the different CSI-RSs have different
5 resource configuration parameters.

13. The system according to claim 12, wherein the non-CoMP UE performs channel state measurement by using the common CSI-RS transmitted from a plurality of
10 transmission points in the cell, with the measured channel state being that of a combined channel from the plurality of transmission points to the non-CoMP UE.

14. The system according to claim 12, wherein the CoMP
15 UE performs measurement on a plurality of surrounding transmission points to obtain channel states of channels from the respective transmission points to the CoMP UE by means of the received different CSI-RSs.

20 15. The system according to claim 14, wherein the non-CoMP UE performs channel state information measurement in mode 9 as defined in LTE-Advanced.

16. The system according to any of claims 10 to 15,
25 wherein the one or more RRHs have no separate cell ID, and

share one cell ID with BS.

17. The system according to claim 16, wherein each of the one or more RRHs has the same transmission power as BS.

5

18. The system according to claim 16, wherein each of the one or more RRHs has lower transmission power compared with BS, and wherein the signal from BS can reach the whole cell, including the regions that are covered by the RRHs.

10

19. A Remote Radio Head (RRH) enhanced Cooperative Multiple Points (CoMP) transmission system comprising a Base Station (BS), one or more RRHs, and one or more CoMP User Equipments (UEs) and/or one or more non-CoMP UEs, the BS and the RRHs being transmission points in a cell, wherein

BS transmits to the non-CoMP UEs resource configuration parameters of a common Channel State Information Reference Signaling (CSI-RS) in the present cell via a Radio Resource Control (RRC) signaling, and informs the CoMP UEs of information on serial numbers of transmission points that are subject to be measured via an RRC signaling, the transmission points in the cell each having a unique serial number;

the RRHs are connected to BS via a optical fiber for performing data switching of a large capacity at a high speed with BS;

25

the non-CoMP UEs perform channel state measurement on resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feed back the measurement to BS via an uplink channel; and

5 the CoMP UEs perform channel state measurement on the transmission points that are subject to be measured on the common CSI-RS resource by means of reference signaling sequences associated with the serial numbers of the transmission points, and feed back the measurement to BS via
10 an uplink channel.

20. The system according to claim 19, wherein BS and each RRH in the cell transmit a common CSI-RS to the non-CoMP UE for channel state information measurement.

15

21. The system according to claim 20, wherein the non-CoMP UE performs channel state measurement by using the common CSI-RS transmitted from a plurality of transmission points in the cell, with the measured channel
20 state being that of a combined channel from the plurality of transmission points to the non-CoMP UE.

22. The system according to claim 21, wherein the non-CoMP UE performs channel state information
25 measurement in mode 9 as defined in LTE-Advanced.

23. The system according to any of claims 19 to 22, wherein the one or more RRHs have no separate cell ID, and share one cell ID with BS.

5

24. The system according to claim 23, wherein each of the one or more RRHs has the same transmission power as BS.

25. The system according to claim 23, wherein each of the
10 one or more RRHs has lower transmission power compared with BS, and wherein the signal from BS can reach the whole cell, including the regions that are covered by the RRHs.

26. A Remote Radio Head (RRH) enhanced Cooperative
15 Multiple Points (CoMP) transmission system comprising a Base Station (BS), one or more RRHs, and one or more User Equipments (UEs), the BS and the RRHs being transmission points in a cell, wherein

BS and each RRH transmit to the UE(s) different Channel
20 State Information Reference Signaling (CSI-RS) for channel state information measurement, each CoMP UE receiving data from only one transmission point at a time, and

wherein BS scrambles data transmitted from different transmission points by different methods.

27. The system according to claim 26, wherein the transmission points in the cell each is provided with a unique serial number.

5 28. The system according to claim 27, wherein the CoMP UE in the cell is configured in a transmission mode of cooperative scheduling/beamforming or dynamic cell selection.

29. The system according to claim 28, wherein the data
10 transmitted from BS is scrambled with the cell ID as defined in LTE-Advanced, while the data transmitted from the RRH is scrambled with the serial number of the transmission point.

30. A reference signaling configuration method in a
15 Remote Radio Head (RRH) enhanced Cooperative Multiple Points (CoMP) transmission system according to any of claims 1 to 9, comprising steps of

transmitting, by BS, to all UEs in the present cell resource configuration parameters of Channel State Information
20 Reference Signaling (CSI-RS) of BS and each RRH in the cell via a broadcast channel, transmitting to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs of a set of transmission points that are
25 subject to be measured via an RRC signaling;

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performing, by the non-CoMP UEs, channel state measurement on resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS transmitted from BS, and feeding back the measurement to BS via an uplink channel; and

performing, by the CoMP UEs, channel state measurement on the transmission points listed in the set of transmission points by means of the resource configuration parameters of CSI-RSs of respective transmission points transmitted from BS via the broadcast channel, and feeding back the measurement to BS via an uplink channel.

31. A reference signaling configuration method in a Remote Radio Head (RRH) enhanced Cooperative Multiple Points (CoMP) transmission system according to any of claims 10 to 18, comprising steps of

transmitting, by BS, to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs the resource configuration parameters of CSI-RSs of a set of transmission points that are subject to be measured via an RRC signaling;

performing, by the non-CoMP UEs, channel state measurement on resource corresponding to the common CSI-RS by means of the resource configuration parameters of the

common CSI-RS, and feeding back the measurement to BS via an uplink channel; and

performing, by the CoMP UEs, channel state measurement on channels between a respective transmission point and the CoMP UE by means of the resource configuration parameters of CSI-RS of the transmission point of the set of transmission points that are subject to be measured informed from BS via an RRC signaling, and feeding back the measurement to BS via an uplink channel.

10

32. A reference signaling configuration method in a Remote Radio Head (RRH) enhanced Cooperative Multiple Points (CoMP) transmission system according to any of claims 19 to 25, comprising steps of:

transmitting, by BS, to the non-CoMP UEs resource configuration parameters of the common CSI-RS in the present cell via a Radio Resource Control (RRC) signaling, and informing the CoMP UEs of information on serial numbers of transmission points that are subject to be measured via an RRC signaling, the transmission points in the cell each having a unique serial number;

performing, by the non-CoMP UEs, channel state measurement on resource corresponding to the common CSI-RS by means of the resource configuration parameters of the common CSI-RS, and feeding back the measurement to BS via

25

an uplink channel; and

performing, by the CoMP UEs, channel state measurement on the transmission points that are subject to be measured on the common CSI-RS resource by means of reference signaling sequences associated with the serial numbers of the transmission points, and feeding back the measurement to BS via an uplink channel.

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FIG. 1

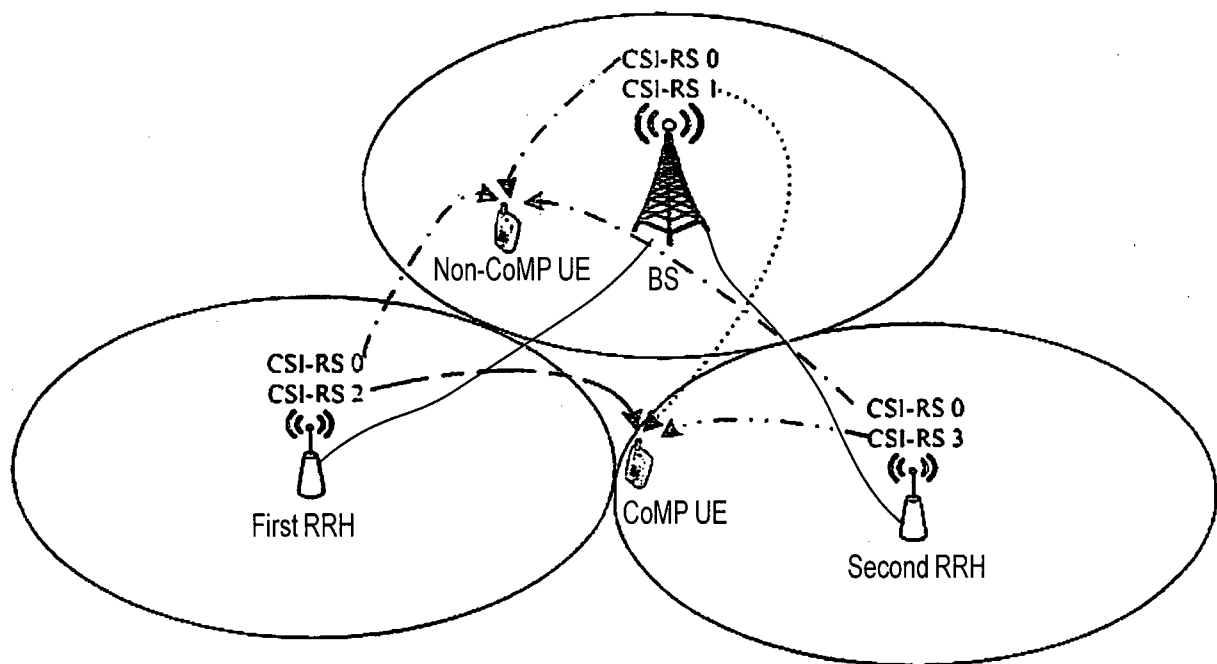
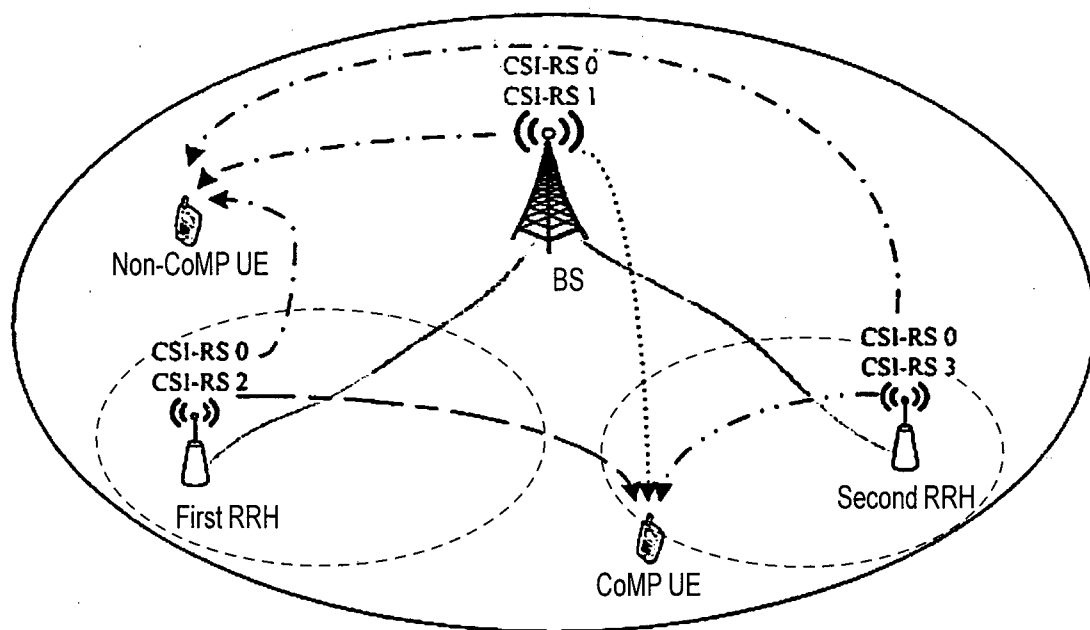


FIG. 2



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FIG. 3

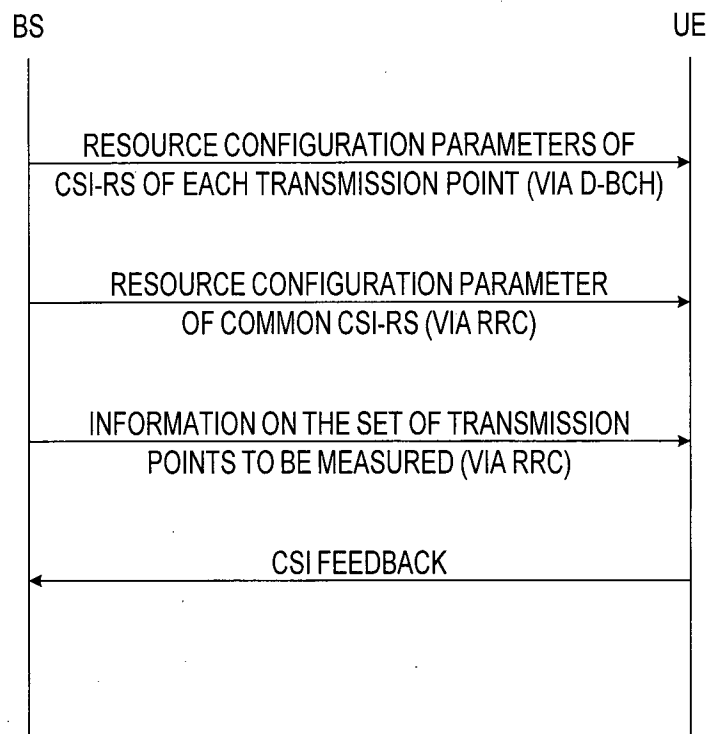
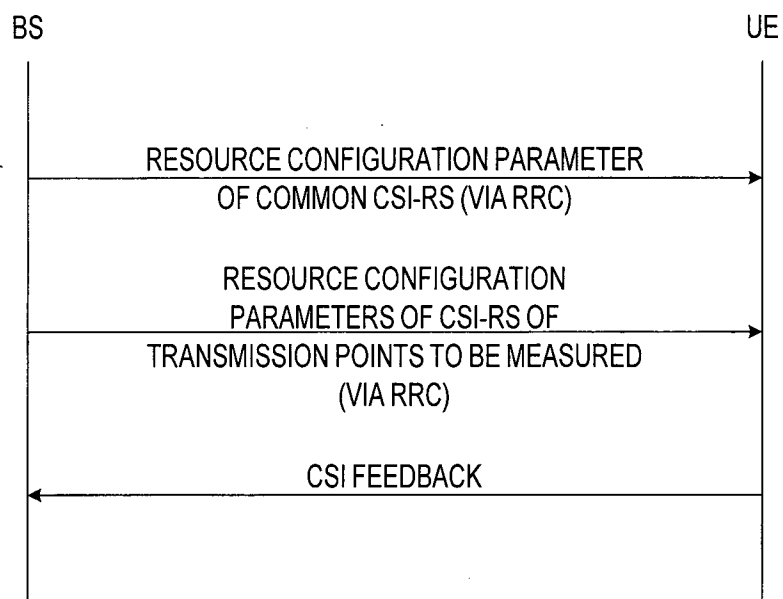


FIG. 4



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FIG. 5

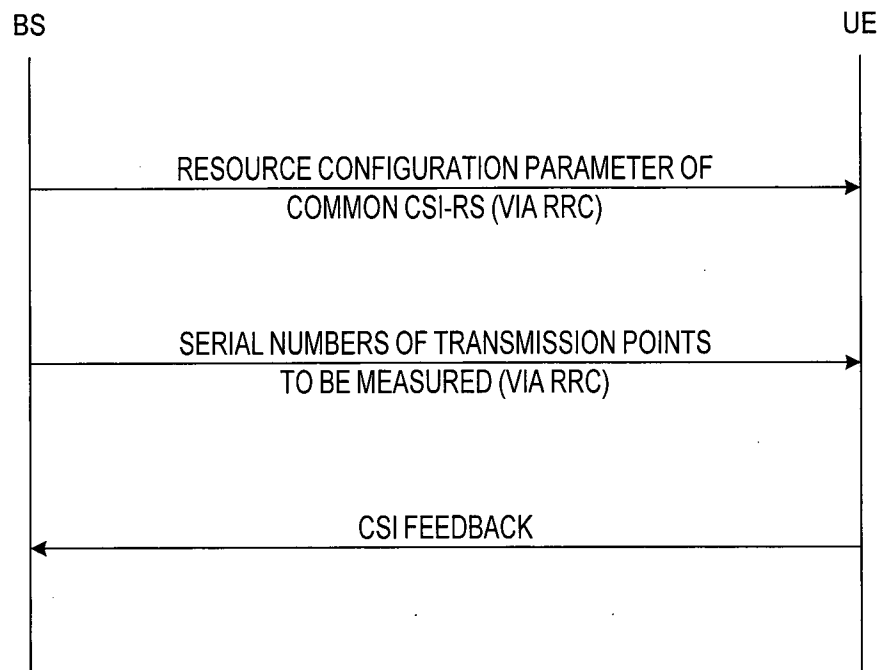
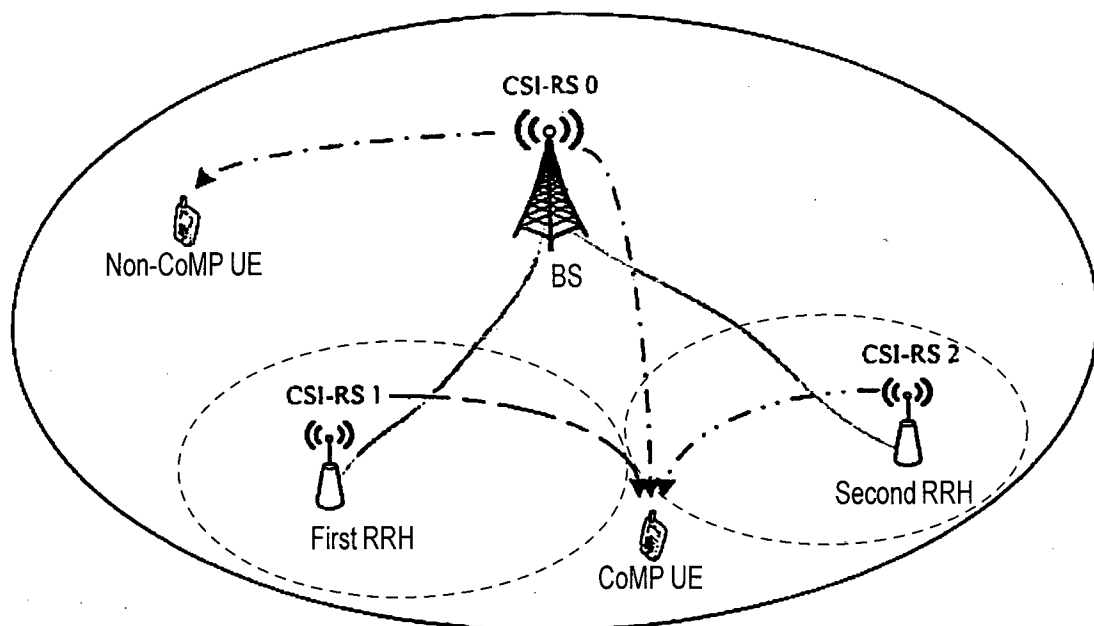


FIG. 6



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FIG. 7

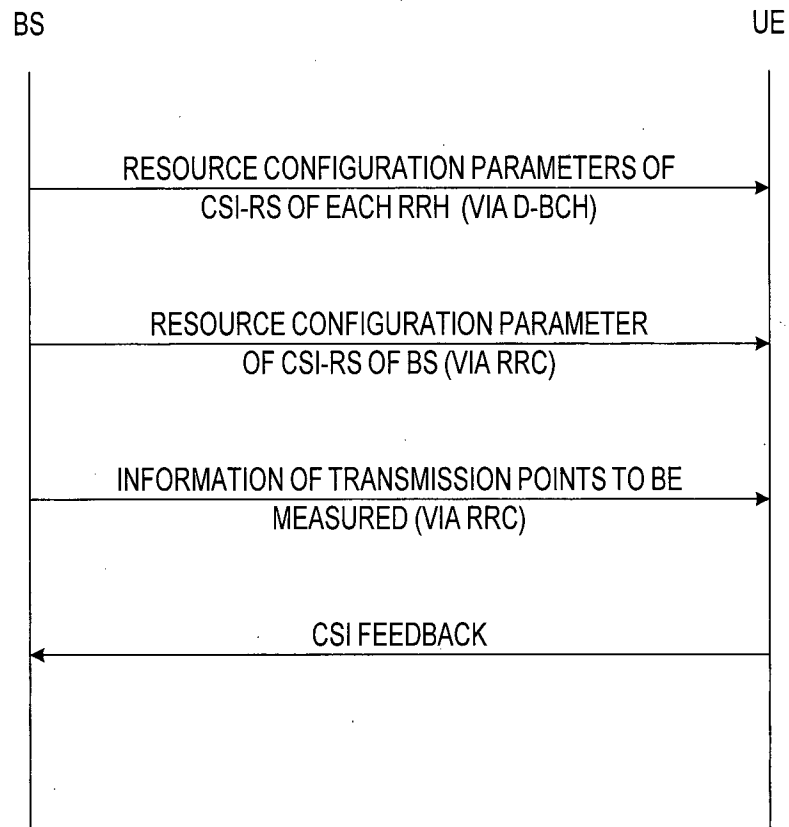
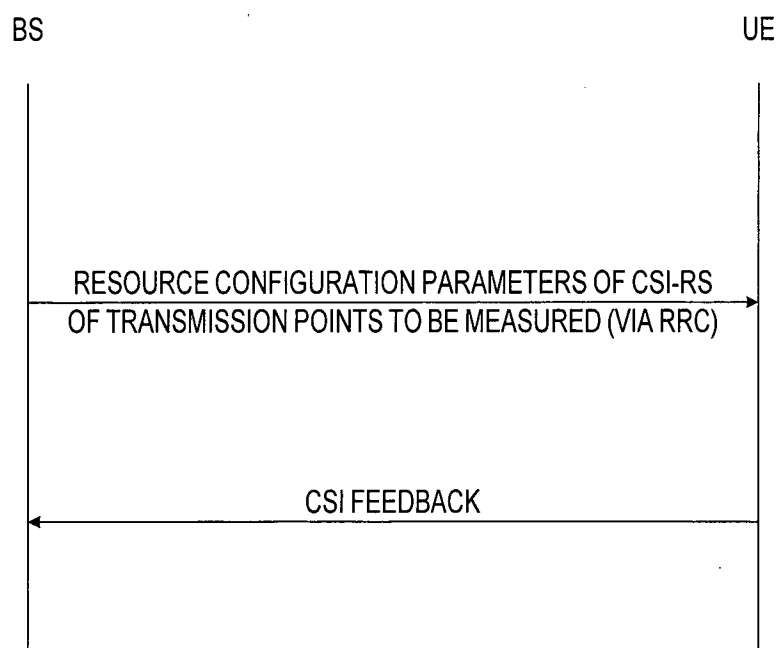


FIG. 8



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FIG. 9

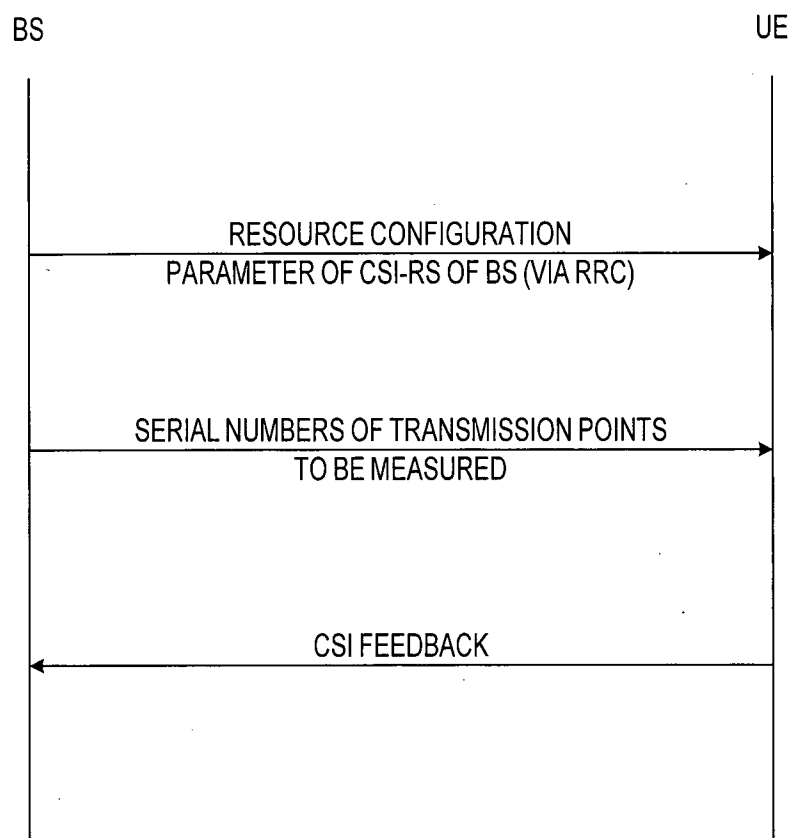
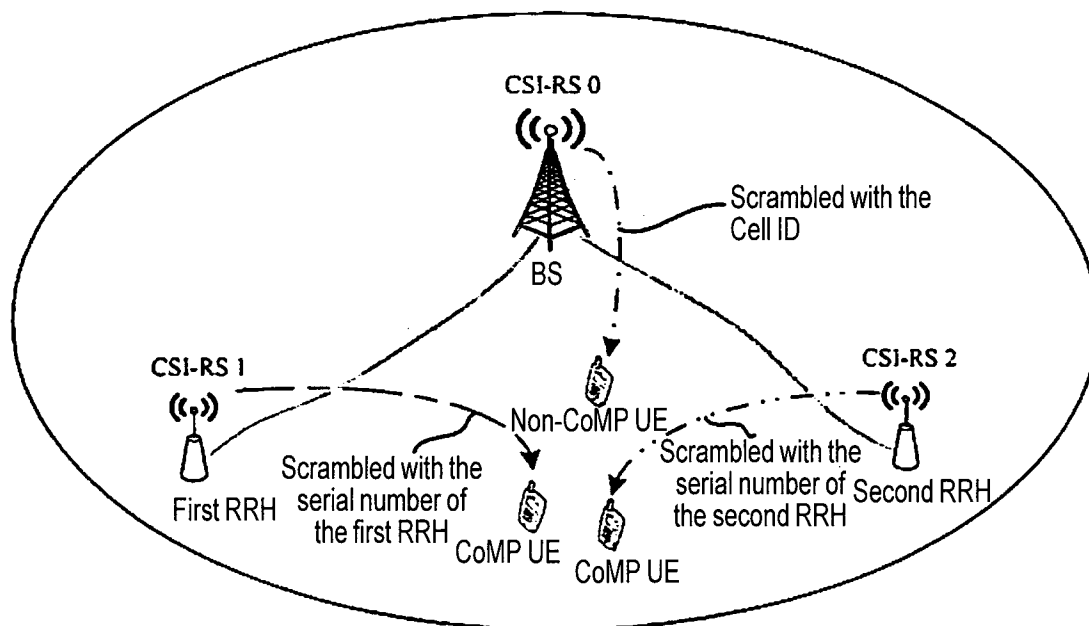


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/055731

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H04W28/16 (2009.01) i, H04W24/10 (2009.01) i, H04W88/08 (2009.01) i,
H04W92/20 (2009.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H04W4/00-99/00, H04B7/24-7/26

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2012
Registered utility model specifications of Japan 1996-2012
Published registered utility model applications of Japan 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010/146781 A1 (Sharp Kabushiki Kaisha) 2010.12.23, Abstract, Claims 1-11 (family: none)	1-25, 30-32
A	Ericsson, ST-Ericsson, Aspects on Distributed RRUs with Shared Cell-ID for Heterogeneous Deployments, 3GPP TSG-RAN WG1 #64 R1-110649, 2011.02.25	1-25, 30-32
A	Intel Corporation (UK), Proposal on CoMP evaluation methodology, 3GPP TSG-RAN WG1 #63bis R1-110250, 2011.01.22	1-25, 30-32

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

* Special categories of cited documents:

“A” document defining the general state of the art which is not
considered to be of particular relevance“E” earlier application or patent but published on or after the inter-
national filing date“L” document which may throw doubts on priority claim(s) or which
is cited to establish the publication date of another citation or other
special reason (as specified)“O” document referring to an oral disclosure, use, exhibition or other
means“P” document published prior to the international filing date but later
than the priority date claimed“T” later document published after the international filing date or
priority date and not in conflict with the application but cited to
understand the principle or theory underlying the invention“X” document of particular relevance; the claimed invention cannot
be considered novel or cannot be considered to involve an
inventive step when the document is taken alone“Y” document of particular relevance; the claimed invention cannot
be considered to involve an inventive step when the document is
combined with one or more other such documents, such
combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

24.05.2012

Date of mailing of the international search report

05.06.2012

Name and mailing address of the ISA/JP

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5J 9571

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/055731

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1-32 involve neither the same nor corresponding special technical features. Thus, there are 2 inventions in the claims of this application.

(Invention 1) claims 1-25, 30-32 A RRH enhanced CoMP transmission system, wherein non-CoMP UEs perform channel state measurement on resource corresponding to common CSI-RS and CoMP UEs perform channel state measurement on the transmission points listed in the set of transmission points by means of the resource configuration parameters of CSI-RSs of respective transmission points.

(Invention 2) claims 26-29 A RRH enhanced CoMP transmission system, wherein BS and each RRH transmit to UE(s) different CSI-RS for channel state information measurement, each CoMP UE receiving data from only one transmission point at a time, and wherein BS scrambles data transmitted from different transmission points by different methods.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-25, 30-32

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.