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[Continued on next page]

(54) **Title**: Cooperative Multi-Point Modulation (CoMP-M): Method and Apparatus using Base Station Modulation with Cooperative Multi-point Transmitting and Receiving in a Cellular System

(57) **Abstract**: A Cooperative Multi-point transmitting and receiving apparatuses using base station modulation method in a wireless system are provided.

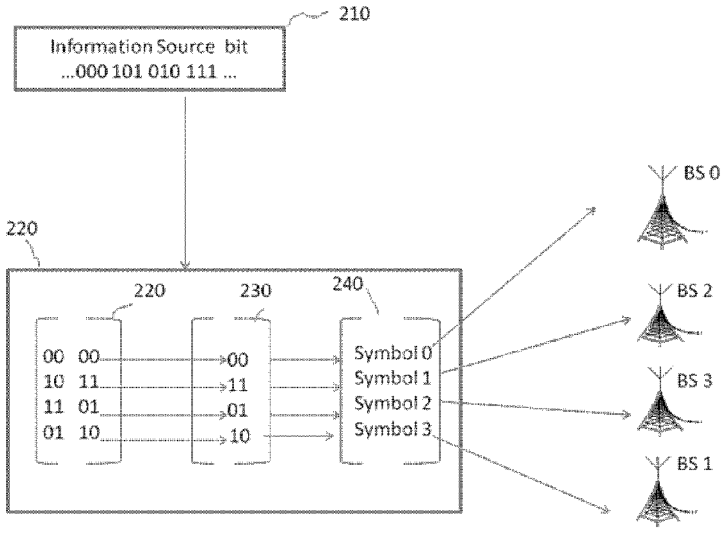

Figure 2

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Cooperative Multi-Point Modulation (CoMP-M): Method and Apparatus using Base Station Modulation with Cooperative Multi-point Transmitting and Receiving in a Cellular System

Background of the Invention:

Field of the Invention

The present invention relates generally to a modulation method of cooperative transmitting point. Example of cooperative transmitting point can be eNB cell, pico, Femto, or RRH.

Description of the Related Art

In order to increase the capacity of the modern radio access systems, Cooperative Multipoint (CoMP) transmission and reception has been proposed. Traditionally, in cellular systems each user is assigned to a base station on the basis of criteria such as down link signal strength. At the terminal side, all the signals coming from the other base stations are deemed as interference, which ultimately limit the capacity. In the uplink, the user terminal (UE) only communicates with only one single serving base station while causing interference to the neighboring base station. Also, each base station processes in-cell users independently, and the rest of the users are seen as inter-cell interference.

With CoMP, several geographically distributed base stations cooperate in the transmission and reception with the aim of reducing interference. Cooperation among these base stations are enabled by the high speed link, such as optical fiber links, between them.

For DL-CoMP, multiple base stations in a CoMP set simultaneous transmitting to the same UE. Multiple-input and Multiple –output antenna technologies, such as spatial multiplexing or space time block coding, could be employed.

Usually at terminal side, UE is expected to receive multiple data streams from different base station. There are two scenarios. First, when space time blocking coding is employed, as the rank of the data is 1, relatively simple receiver structure is required thus leading to reduced implementation complexity at the UE side. Admittedly, there is a penalty in the aspect of spectrum efficiency.

To achieve higher spectrum efficiency as compare to spatial time blocking coding, open loop spatial multiplexing is employed. In this case, more complex receiver, such as MMSE receiver is needed at UE side, consequently increasing UE implementation complexity.

There is a need to achieve higher spectrum efficiency in the CoMP system, at the same time keeping a relative low terminal implementation cost. This is especially useful for Machine-to-Machine application where the terminal cost is a major issue.

Summary of the Invention:

To achieve a trade of between spectrum efficiency and UE implementation complexity and terminal cost in cooperative multi-point transmitting and receiving system, base station modulation is introduced. CoMP-M is defined as a CoMP system with base station modulation.

The basic idea of base station modulation is to map a block of information bits into a constellation which has two parts:

1) A symbol that is chosen from a signal-constellation diagram, like QPSK, BPSK, and
2) A unique base station index that is carefully chosen from a set of cooperative multi-point transmission set.

In Figure 1, an exemplary signal constellation is given.

In Figure 2, an exemplary CoMP-M modulation process is given. Source Information was equally spitted into sections at the controlling eNB based on the number of cooperative transmitting point decided in the system. In each section, information bit is divided into two parts, the second part, which is called signal part, is used to form a signal constellation such as BPSK,QPSK,8PSK, the first part, which is called base station modulation section, is used to map the second part into a particular cooperative transmitting point index. In figure 2, this is achieved in the base station modulation unit 220. The source information bits in the base station modulation section is mapped into the index of a group of candidate transmitting point in one CoMP set, at unit 230. Various mapping method can be used, such as gray code. At unit 240, information bits in the signal part is mapping to certain signal symbol.

For information bits in the signal parts, further multiple antenna technologies can be applied, for example, spatial time block coding, spatial multiplexing, etc.

At the time when the information is conveyed to the terminal, only one cooperative transmitting point is active at one time instant. The active transmitting point is chosen based on output of the base station modulation unit 220. Figures 3, 4, 5, and 6 depict the actual transmission situation during time instant 0, time instant 1, time instate 2, and time instant 3.

Claims

1. A cooperative multi-point transmitting and receiving system with base station modulation method in a wireless system, comprising:
receiving a signal with a plurality of bits and separating the received signal into a base station index bit section and a signal modulation bit section;
encoding the signal modulation bit section with certain signal modulation scheme; and
encoding the base station index bit block with an index of an base station which will be used to transmit the signal.

2. The CoMP-M modulation method of claim 1, wherein the separating of the received signal comprises separating log2 (total number of base stations in a cooperative multi-point processing set (CoMP) set) bits of the received signal as the base station bit section and separating log2 (total number of all possible cases represented by a signal modulation constellation) bits of the received signal as the signal modulation bit section.

3. The base station modulation method of claim 1, where in the encoding of the base station modulation section of the source signal, comprises generating a vector signal with as many symbols as a total number of cooperative transmitting point selected in a CoMP set; and encoding a symbol at a position corresponding to the index of the cooperative transmitting point to be activated in the vector signal to a signal modulation symbol value.

4. The base station modulation method of claim 4, wherein the encoding of the cooperative transmitting point index bit section comprises setting a symbol at a position corresponding to an inactive cooperative transmitting point in the vector signal to 0.

5. A Cooperative multi-point transmitting and receiving system (CoMP) with base station modulation, comprising: a separator for receiving a signal with a plurality of bits and separating the received signal into a cooperative transmitting point bit section and a signal modulation bit section; a signal modulation encoder for encoding the signal modulation bit block in a signal modulation scheme; and a cooperative transmitting point index encoder for encoding the cooperative transmitting point section with an index of a cooperative transmitting point to be activated.

6. The transmitter of claim 5, further comprising a plurality of cooperative transmitting point including an active cooperative transmitting point for sending the processed signal

during a unit time and inactive cooperative transmitting point for sending no signals during the unit time.

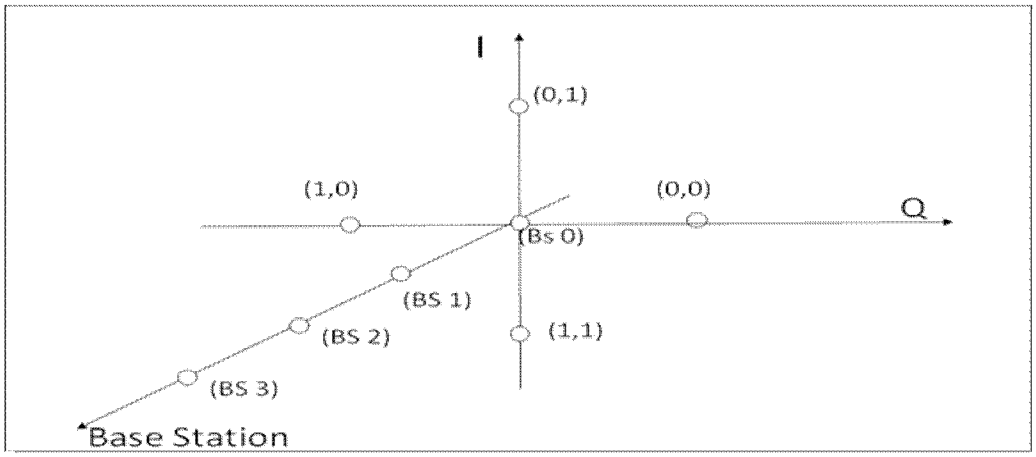

Figure 1 Exemplary constellation of a 4 base station CoMP-M

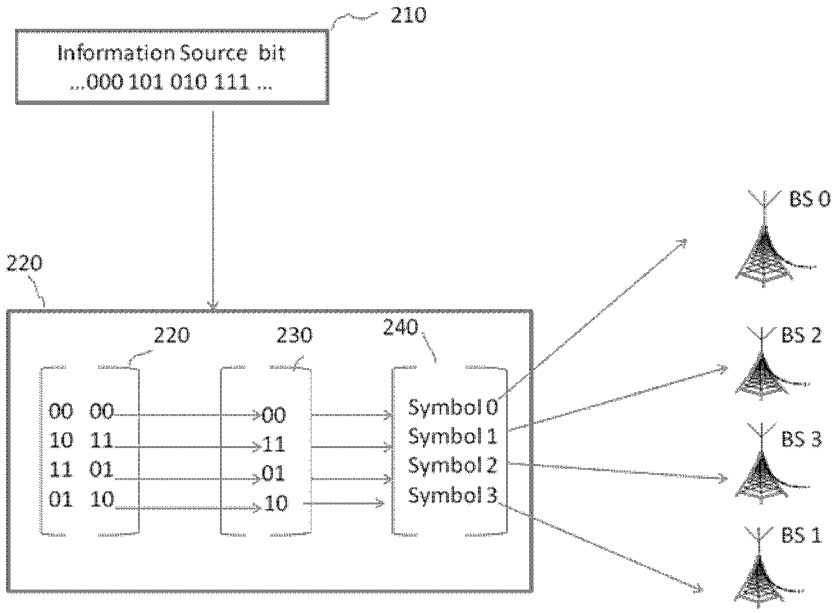

Figure 2 Modulation Process of an exemplary 4 base station CoMP-M system

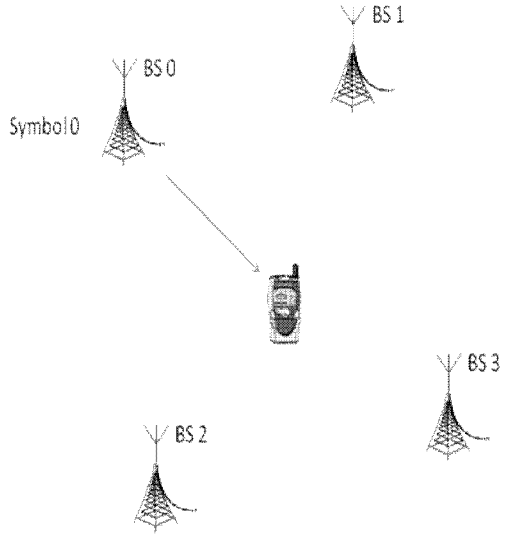

Figure 3 Cooperative multi-point transmission at time instant 0

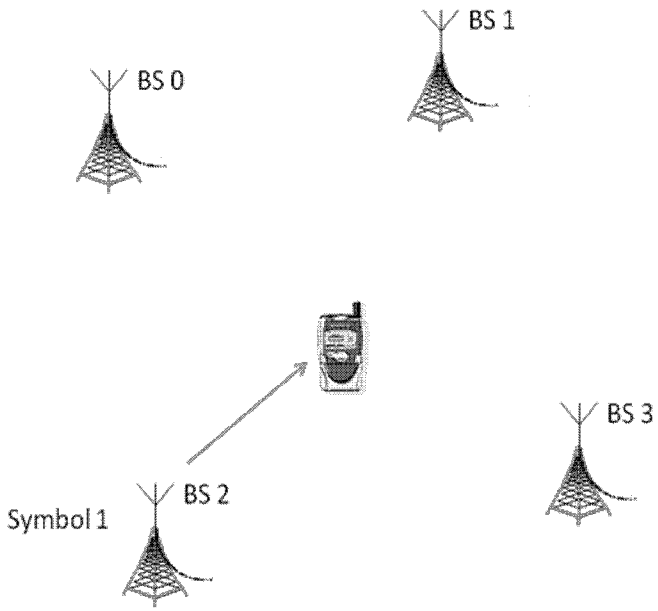

Figure 4 Cooperative multi-point transmission at time instant 1

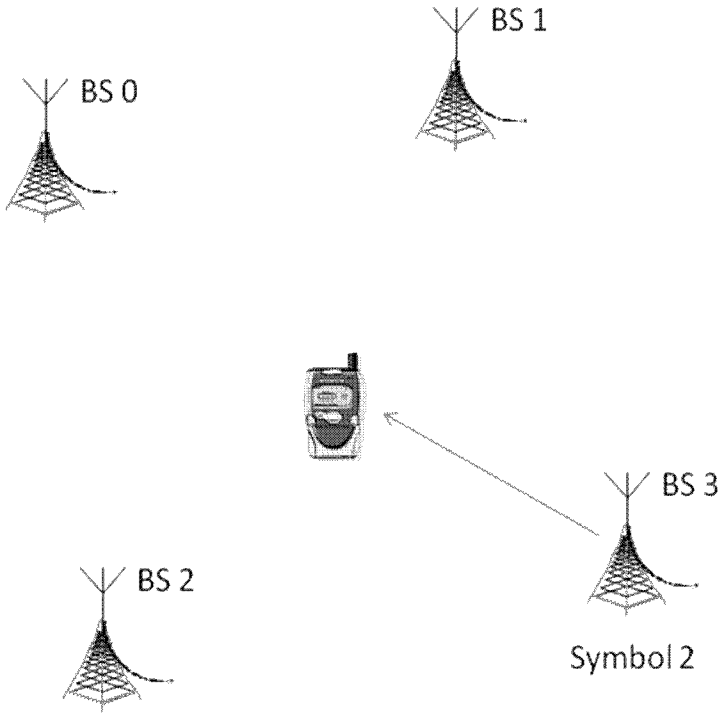

Figure 5 Cooperative multi-point transmission at time instant 2

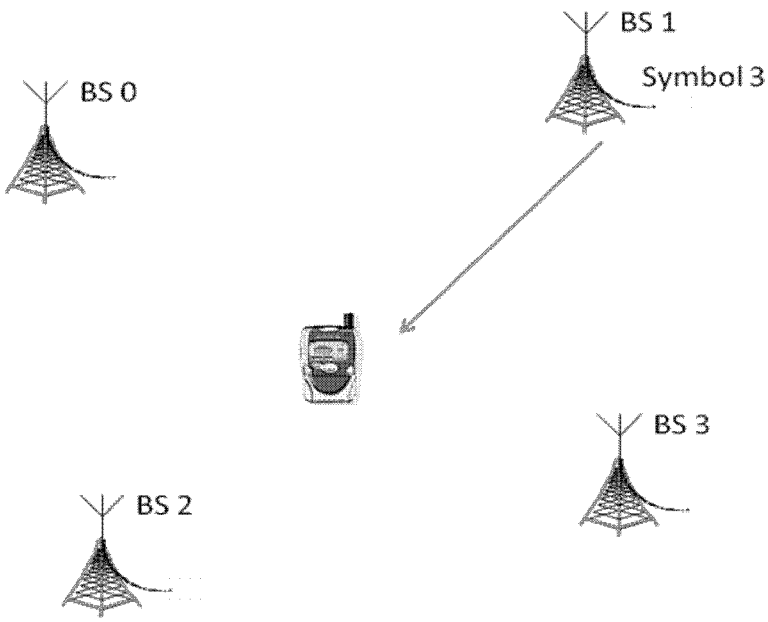

Figure 6 Cooperative multi-point transmission at time instant 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/085361

A. CLASSIFICATION OF SUBJECT MATTER

H04W28/00(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)

IPC：H04W, H04Q, H04L

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

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

CPRSABS, CNTXT, CNKI, VEN： cooperat+, coordinat+, multi?point, COMP, base station, node, modulat+, bit, receiv+, seperat+, signal, index, list, encod+, symbol.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN102142875A (UNIV TSINGHUA) 03 Aug. 2011(03.08.2011) the whole document	1-6
A	CN101789849A (ZTE CORP) 28 Jul. 2010(28.07.2010) the whole document	1-6
A	WO2011060589A1(ALCATEL LUCENT et al) 26 May 2011(26.05.2011) the whole document	1-6
A	CN101877887A (CHINA MOBILE COMMUNICATION CORP) 03 Nov. 2010(03.11.2010) the whole document	1-6

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

* Special categories of cited documents:

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"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)

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

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

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"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 Feb. 2013 (09.02.2013)	**07 Mar. 2013 (07.03.2013)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LI, Zhenhua Telephone No. (86-10)62411495

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN102142875A	03.08.2011	NONE	
CN101789849A	28.07.2010	KR2012115343A	17.10.2012
		WO2010149089A1	29.12.2010
		US20120320774A1	20.12.2012
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		WO2010124621A1	04.11.2010
		EP2426972A1	07.03.2012