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(71) **Applicant** *(for all designated States except US):* **ZTE USA INC.** [US/US]; 2425 N. Central Expressway, Suite 323, Richardson, TX 75080 (US).

(72) **Inventors; and**

(75) **Inventors/Applicants** *(for US only):* **SO, Trici** [CA/US]; 6096 Blue Dawn Trail, San Diego, CA 92130 (US). **CHU, Li** [CN/CN]; 24/f R&D Building, ZTE Plaza, Shenzhen,Nanshan District (CN). **SONG, Jianquan** [CN/CN]; 24/f R&D Building, Zte Plaza, Shenzhen, Nanshan District (CN). **LUO, Wen** [CN/CN]; No. 68 Zijinghua Road, Nanjing, Yuhuatai (CN). **TU, Yangwei** [CN/CN]; No. 68 Zijinghua Road, Nanjing, Yuhuatai (CN).

(74) **Agent: MORSE, David, M.;** Connolly Bove Lodge & Hutz LLP, 1007 North Orange Street, P.O. Box 2207, Wilmington, DE 19899-2207 (US).

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(54) Title: METHOD AND SYSTEM FOR WFAP AUTO-CONFIGURATION VIA NEIGHBOR BASE STATION AUTO-DISCOVERY

(57) Abstract: Certain embodiments of the present invention provide for methods of configuring a WFAP. In one embodiment, a WFAP receives neighbor base station identification information during its initial scanning. Subsequently, the WFAP reports this neighbor base station identification information as well as its own location information to a SON server. The WFAP then receives radio frequency (RF) parameters from the SON server. After receiving neighboring base station RF parameters, the WFAP scans neighboring base stations based on the received RF parameters.

S P E C I F I C A T I O N

METHOD AND SYSTEM FOR WFAP AUTO-CONFIGURATION VIA NEIGHBOR BASE STATION AUTO-DISCOVERY

PRIORITY

[0001] Priority is claimed to U.S. Provisional Patent Application No. 61/286,220, filed December 14, 2009, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The field of the present invention is wireless communication, particularly auto-configuration of a wireless femto access point.

BACKGROUND

[0003] Cellular communication systems are typically arranged so that a plurality of base stations are strategically positioned to provide wireless communication service over corresponding geographic areas. The area served by a base station is typically referred to as a cell. For various reasons it is desirable for the base station to have information regarding nearby, or neighboring base stations, one of these reasons being for facilitating handoffs as mobile stations travel between cells. A listing of such base stations is typically referred to as a neighbor relation table (NRT).

[0004] Generally, in cellular systems, system operators manually configure and manage neighbor lists based on the relative locations of base stations. This manual operation may be efficient for a network topology that hardly changes. However, in a femtocell network, WiMAX femtocell access points (WFAPs) can be frequently installed or uninstalled by a user, and not just by a system operator, making it difficult for system operators to effectively

manage neighbor lists. Therefore, automatic configuration schemes are desirable to lessen the system operator's burden of managing neighbor cells.

[0005] In existing auto-configuration design, the WFAP's neighbor list auto-configuration during WFAP initialization is done prior to location authorization by a self-organized network ("SON") server. It is to note that, when the WFAP performs free scanning before the location authorization, the WFAP has no way to determine if the target neighbor, regardless if it is a macro-base station or a WFAP, is a legitimate neighbor base station that the WFAP should consider. This is because the network access provider ("NAP") of the neighbor base station may not have any business relationship with the femto network service provider ("Femto-NSP") of which the WFAP is affiliated.

[0006] Therefore, a more accurate determination of the legitimate neighbor base station for the given WFAP should happen after the location authorization is complete with a SON server so that the SON server can provide scanning references by providing the radio frequency ("RF") and Media Access Control ("MAC")/Physical ("PHY") parameters to the WFAP based on the current location of the WFAP in order to assist the WFAP to proceed for the neighbor scanning operation.

SUMMARY OF THE INVENTION

[0007] The present invention is directed toward methods of WFAP auto-configuration.

[0008] In a first aspect of the present invention, a WFAP receives neighbor base station identification information during its initial scanning. The WFAP then sends this neighbor base station identification information as well as its own location information to a SON server. After authenticating the

WFAP's location, the SON server obtains MAC/PHY parameters associated with at least one neighbor base station. The WFAP then receives RF parameters from the SON server. Based on the neighboring base station RF parameters, the WFAP scans neighboring base stations, and reports the scanning results to the SON server.

[0009] In a second aspect of the present invention, a SON server receives a WFAP's location information. The SON server also receives identification information of each of the WFAP's neighbor base stations. The SON server then authenticates the WFAP location information. After authenticating the WFAP's location information, the SON server requests MAC/PHY configuration information associated with each of the neighbor base stations. The SON server then sends RF parameters to the WFAP. Based on scanning results received from the WFAP, the SON server determines the WFAP's configuration information. Finally, the SON server sends the configuration information to the WFAP.

[0010] Any of the above aspects may be implemented alone or in combination.

[0011] Additional aspects and advantages of the improvements will appear from the description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Embodiments of the present invention are illustrated by way of the accompanying drawings, in which:

[0013] Fig. 1 is a state diagram illustrating a process of bringing a WFAP from an initialization state to an operational state.

[0014] Fig. 2 illustrates signaling for WFAP self-configuration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Fig. 1 is a state diagram illustrating the process of bringing a WFAP from an initialization state to an operational state, and the role WFAP self-configuration plays in the process. The process 100 begins with the WFAP in an initialization state 105. If initialization fails, the WFAP proceeds to an exception processing state 120. Otherwise, upon discovery of the SON server, the WFAP enters a location authorization state 110. If the SON server does not authorize the WFAP's location, the WFAP enters the exception processing state 120. Alternatively, if the SON server authorizes the WFAP's location, the WFAP enters a self-configuration state 115. If the WFAP's self-configuration fails, the WFAP proceeds to the exception processing state 120. Otherwise, if WFAP self-configuration is successful, the WFAP enters an operational state 125.

[0016] Referring now to Fig. 2, WFAP self-configuration may be achieved using the following steps or signals. In Step 1, an initializing WFAP receives neighboring base station identification information from a downlink Multiple Access Protocol broadcast message. In Step 2, the initializing WFAP reports a list of neighboring base station identification information to a SON server. In Step 3, the WFAP reports its own location information to the SON server. The location information may be based on neighbor WFAP and macro base station information, WFAP public internet protocol (IP) address, Global Positioning System ("GPS") information, and/or other wireless cell information. In Step 4, the SON server authenticates the location of the WFAP. In Step 5, based on successful WFAP location authentication, the SON Server queries the femto management server for MAC/PHY configuration information of

neighboring WFAP(s) and macro base station(s). In Step 6, the femto management server returns the MAC/PHY configuration information of each neighboring base station based on the WFAP location. Examples of MAC/PHY configuration information include, but are not limited to:

- PHY independent uplink channel characteristics (Table 568, IEEE 802.16-2009)
- OFDMA uplink channel characteristics (Table 571, IEEE 802.16-2009)
- OFDMA uplink burst profiles (Table 574, IEEE 802.16-2009)
- OFDMA downlink channel characteristics (Table 575, IEEE 802.16-2009)
- OFDMA downlink burst profiles (Table 581, IEEE 802.16-2009)

[001 7] In Step 7, the SON server provides the neighboring base stations' radio frequency parameters to the WFAP to assist the initializing WFAP in scanning neighboring base stations. In Step 8, the initializing WFAP scans neighbor base stations to derive the associated MAC/PHY configuration information. In Step 9, the WFAP reports the results of the neighbor base station scanning to the SON server. These results may include a list of neighboring base station information and the MAC/PHY parameters associated with the neighboring base stations. The SON server will keep the results of the neighbor base station scanning for future self-optimization operations, including the automatic neighbor relations management for a given WFAP. In step 10, upon receiving the results of the neighbor base station scanning and the MAC/PHY configuration data obtained from the femto management server, the SON server will determine the appropriate RF

parameters and MAC/PHY configuration information for the serving WFAP. In addition to the configuration information listed above, the configuration information may include, but is not limited to:

- Tx power,
- Uplink center frequency
- Downlink center frequency
- Preamble sequence
- CP

[0018] In Step 11, to shorten the time required to download large amounts of MAC/PHY configuration information, the SON server may use a bulk data transfer protocol to send the MAC/PHY configuration data to the initializing WFAP.

[0019] While embodiments of this invention have been shown and described, it will be apparent to those skilled in the art that many more modifications are possible without departing from the inventive concepts herein. The invention, therefore, is not to be restricted except in the spirit of the following claims.

CLAIMS

What is claimed is:

1. A method of configuring a WFAP, the method comprising:

sending location information associated with the WFAP to at least one SON server, wherein, based on the location information, the at least one SON server obtains MAC/PHY configuration information associated with at least one neighbor base station;

receiving RF parameters from the at least one SON server;

based on the received RF parameters, scanning at least one neighbor base station;

reporting, to the at least one SON server, scanning results, wherein based on the scanning results, the at least one SON server determines RF parameters and MAC/PHY configuration information associated with the WFAP; and

receiving the MAC/PHY configuration information from the at least one SON server.

2. The method of claim 1, wherein the location information is based on neighbor base station identification information.

3. The method of claim 1, wherein the location information is based on a WFAP public IP address.

4. The method of claim 1, wherein the location information is based on GPS information.

5. The method of claim 1, prior to sending location information associated with the WFAP to at least one SON server, the method further comprising:

receiving, by the WFAP, neighbor base station identification information; and

sending, to the at least one SON server, neighbor base station identification information.

6. The method of claim 1, wherein the scanning results include MAC/PHY configuration information associated with the at least one neighbor base station.

7. The method of claim 1, wherein the scanning results include updated neighbor base station identification information.

8. A method of configuring a WFAP, the method comprising:

authenticating, at at least one SON server, location information associated with the WFAP;

in response to location information authentication, requesting, from at least one femto management server, MAC/PHY configuration information associated with at least one neighbor base station;

in response to receiving MAC/PHY configuration information associated with the at least one neighbor base station, sending RF parameters to the WFAP, wherein the WFAP scans at least one neighbor base station based on the RF parameters;

receiving neighbor base station scanning results;

based on neighbor base station scanning results, determining RF parameters and MAC/PHY configuration information associated with the WFAP; and

sending the MAC/PHY configuration information to the WFAP.

9. The method of claim 8, wherein the location information is based on neighbor base station identification information.

10. The method of claim 8, wherein the location information is based on a public IP address associated with the WFAP.

11. The method of claim 8, wherein the location information is based on GPS information.

12. The method of claim 8, wherein the RF parameters associated with the WFAP include transmit power information.

13. The method of claim 8, wherein the RF parameters associated with the WFAP include uplink center frequency information.

14. The method of claim 8, wherein the RF parameters associated with the WFAP include downlink center frequency information.

15. The method of claim 8, wherein the RF parameters associated with the WFAP include preamble sequence information.

16. The method of claim 8, wherein the RF parameters associated with the WFAP include cyclic prefix information.

17. A system for configuring a WFAP, the system comprising:

means for sending, to at least one SON server, location information associated with the WFAP, wherein, based on the location information, the at least one SON server obtains MAC/PHY configuration information associated with at least one neighbor base station;

means for receiving RF parameters from the at least one SON server;

based on the received RF parameters, means for scanning at least one neighbor base station;

means for reporting, to the at least one SON server, scanning results, wherein based on the scanning results, the at least one SON server determines RF parameters and MAC/PHY configuration information associated with the WFAP; and

means for receiving the MAC/PHY configuration information from the at least one SON server.

18. The system of claim 17, wherein the location information is based on neighbor base station identification information.

19. The system of claim 17, wherein the location information is based on a WFAP public IP address.

20. The system of claim 17, wherein the location information is based on GPS information.

21. The system of claim 17, wherein the scanning results include MAC/PHY configuration information associated with the at least one neighbor base station.

22. The system of claim 17, wherein the scanning results include updated neighbor base station identification information.

23. The system of claim 17 further comprising:

means for receiving, by the WFAP, neighbor base station identification information; and

means for sending, to the at least one SON server, the neighbor base station identification information.

24. A system for configuring a WFAP, the system comprising:

means for authenticating location information associated with the WFAP;

in response to location information authentication, means for requesting MAC/PHY configuration information associated with at least one neighbor base station;

in response to receiving MAC/PHY configuration information associated with the at least one neighbor base station, means for sending RF parameters to the WFAP, wherein the WFAP scans at least one neighbor base station based on the RF parameters;

means for receiving neighbor base station scanning results;

based on neighbor base station scanning results, means for determining RF parameters and MAC/PHY configuration information associated with the WFAP; and

means for sending the MAC/PHY configuration information to the WFAP.

25. The system of claim 24, wherein the location information is based on neighbor base station identification information.

26. The system of claim 24, wherein the location information is based on a public IP address associated with the WFAP.

27. The system of claim 24, wherein the location information is based on GPS information.

28. The system of claim 24, wherein the RF parameters associated with the WFAP include transmit power information.

29. The system of claim 24, wherein the RF parameters associated with the WFAP include uplink center frequency information.

30. The system of claim 24, wherein the RF parameters associated with the WFAP include downlink center frequency information.

31. The system of claim 24, wherein the RF parameters associated with the WFAP include preamble sequence information.

32. The system of claim 24, wherein the RF parameters associated with the WFAP include cyclic prefix information.

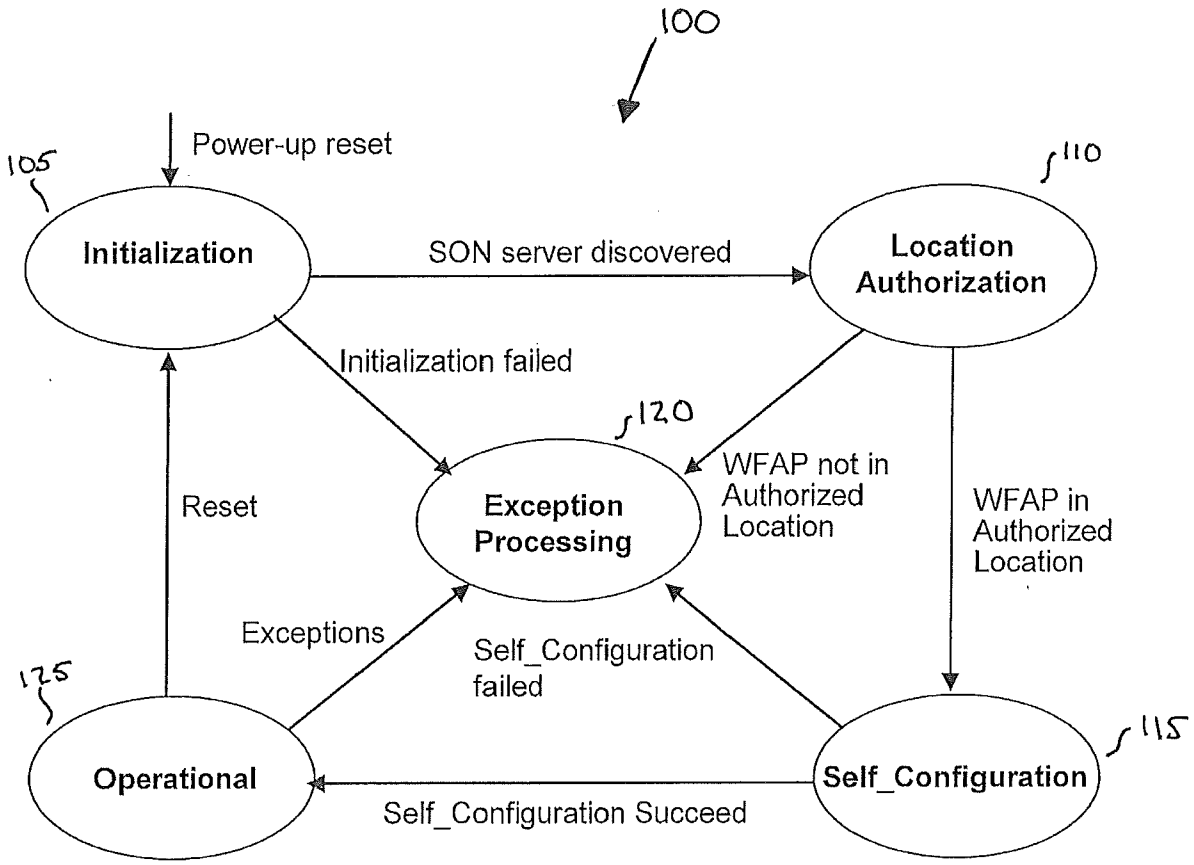
100
Power-up reset
105
Initialization
SON server discovered
110
Location Authorization
Initialization failed
120
Exception Processing
WFAP not in Authorized Location
WFAP in Authorized Location
Reset
Exceptions
Self_Configuration failed
125
Operational
Self_Configuration
115
Self_Configuration Succeed

Fig. 1

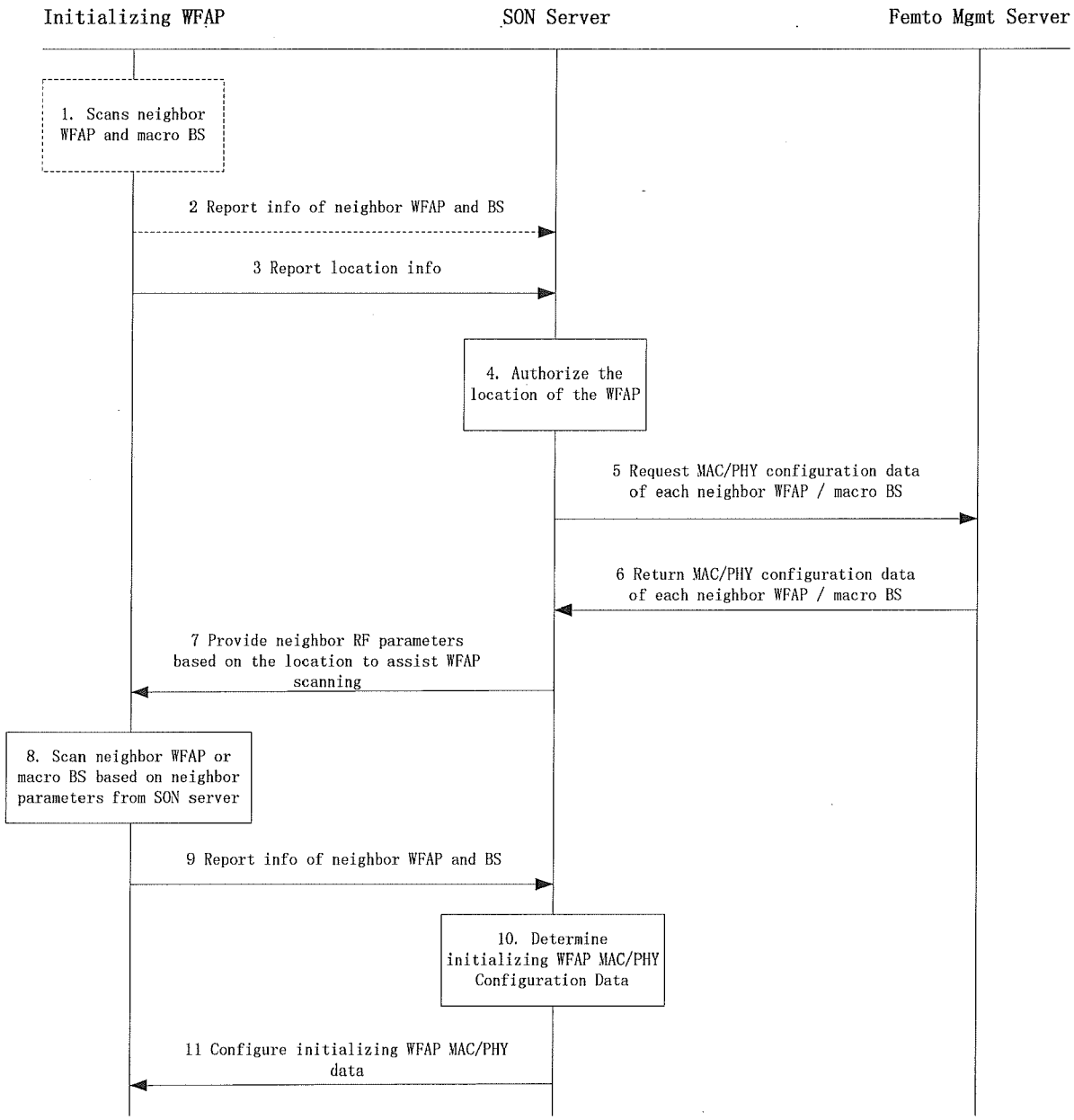
Initializing WFAP
SON Server
Femto Mgmt Server
1. Scans neighbor WFAP and macro BS
2 Report info of neighbor WFAP and BS
3 Report location info
4. Authorize the location of the WFAP
5 Request MAC/PHY configuration data of each neighbor WFAP / macro BS
6 Return MAC/PHY configuration data of each neighbor WFAP / macro BS
7 Provide neighbor RF parameters based on the location to assist WFAP scanning
8. Scan neighbor WFAP or macro BS based on neighbor parameters from SON server
9 Report info of neighbor WFAP and BS
10. Determine initializing WFAP MAC/PHY Configuration Data
11 Configure initializing WFAP MAC/PHY data

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/60217

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 15/177 (2011.01)
USPC - 709/220
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)
USPC: 709/220

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 370/328; 455/41.2 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (USPT, PGPB, EPAB, JPAB); GoogleScholar
Search Terms Used: configuring updating modifying adjusting BS iBS base station WFAP AP access point neighbor scanning checking monitoring checking authentication verification authorizing licensing parameter configuration characteristic frequency power level sending

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0148368 A1 (Scheinert et al.) 07 July 2005 (07.07.2005), entire document, especially; [0005], [0006], [0009], [0010], [0021], [0022], [0023], [0030], [0032], [0033], [0036], [0047], [0061], [0067], [0071], [0083], [0101], [0115], [0147], [0148], Abstract	1-32
Y	US 2007/0254620 A1 (Lindqvist et al.) 01 November 2007 (01.11.2007), entire document, especially; para [0005], [0016], [0017], [0021], [0061], [0067], [0071], Abstract	1-32

☐ Further documents are listed in the continuation of Box C. ☐

* 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 international 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	Date of mailing of the international search report
07 Feburary 2011 (07.02.2011)	11 FEB 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774