



(51) International Patent Classification:

H04W 36/14 (2009.01) *H04W 80/00* (2009.01)
H04W 36/04 (2009.01)

(21) International Application Number:

PCT/MY2009/000138

(22) International Filing Date:

9 September 2009 (09.09.2009)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PI 20083482 9 September 2008 (09.09.2008) MY

(71) Applicant (for all designated States except US): **MIMOS BERHAD** [MY/MY]; Technology Park of Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **RASHID, Abdel-haleem, Saeed** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **HAFIZAL, Mohamad** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **BORHANUDDIN, Mohd, Ali** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY).

(74) Agent: **MOHAN, K.**; Adastra Intellectual Property SDN BHD, P.O. Box 43, Suite 2B, Level 7, Menara Dato' Onn,

Putra World Trade Centre, 45, Jalan Tun Ismail, 50480 Kuala Lumpur (MY).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: A DEVICE FOR VERTICAL RELAY AND HANDOVER OF NETWORK

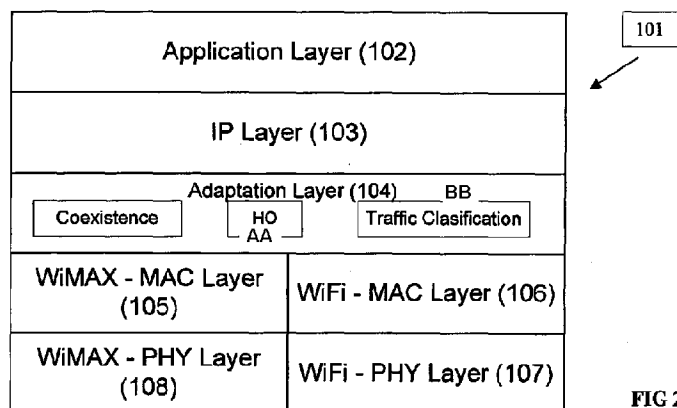


FIG 2

(57) Abstract: The present invention relates to a device (100) for providing vertical relay and handover between two networks, said device (100) comprising least one application layer (102), at least one Internet Protocol (IP) layer (103), at least one adaptation layer (104), a first physical (PHY) (108) layer, a first media access control (MAC) layer (105), a second physical (PHY) layer (107), and a second media access control layer MAC (106) layer. The handover process between two networks is accordingly performed within the adaptation layer (104). A request for handover is communicated to the adaptation layer (104) by anyone of the MAC layers.

A device for vertical relay and handover of network

Field of Invention

5

The present invention relates to a vertical relay and handover between two networks, more particularly, the invention discloses a device and converged module for two networks configured therein for providing accelerated vertical relay and handover
10 between the said two networks.

Background of Invention

15

At present, there are two prominent standards or mode of operation with respect to the advent of wireless network, said mode of operations are WiFi (wireless fidelity) which operates based on IEEE 802.11 and WiMAX (worldwide interoperability for microwave access) which deploys IEEE 802.16. WiMAX is supported by WMAN communication technique for mobility and fixed subscribe stations (SS) and therefore it
20 is known to have additional advantageous features as compared to the WiFi. The primary beneficial divergence of WiMAX as compared to WiFi is the capability to provide elevated flexibility in implementations whilst maintaining considerable level of data rate as well as transmission range. In contrast to WiMAX, WiFi (i.e. 802.11n) however

provides higher transmission rate as compared to WiMAX (802.16e/j) but in limited areas, as in many cases WiFi signal strength may be limited due to the use of unlicensed frequency band therefore restriction to the coverage area.

5

Following the above, it would be highly desirable to be able to use the advantageous features and thus eliminates the disadvantages of each network standard in order to provide a complete and ubiquitous wireless solution for delivering high speed Internet access in a wider scope of area, and more particularly for businesses, homes and
10 hot spots. Hence, the idea relative to a handover networks has been introduced.

Typically, while the mobile device is roaming, a vertical handover is performed with a gateway to shift the signal source from a base station (BS) to the local access point (AP) and vice versa, so as to maintain the connectivity for transmission and receiving
15 data or in other words to provide service continuity for users and applications within the network. Suitably, a general definition of a vertical handover is the shifting a connection between two different access networks. For instance, a handover involving WiFi and WiMAX necessitates WiFi and WiMAX cards in the laptop device (110), specifically PMCIA or PC cards which however are known to be prohibitively costly.

20

Characteristically, it is highly preferred by many users and operators that the handover is performed seamlessly, that is without or at least reduced delay and interruptions. Nevertheless, the said impediments have yet to be successfully prevailed

with the current techniques, as in many cases a method or approach which has significantly reduced handoff latency may not have the highest throughput.

Accordingly, the present invention has been accomplished to significantly provide
5 a system or capability to relay between two different technologies or networks, therefore eliminating the need for costly devices normally used to perform a vertical handover process. The present invention provides a wireless device or apparatus, in particular a mobile station (MS) comprising a converged module that allows expediency in the relay between two different technologies or networks, whereby the invention is configured on
10 WiMAX mobile device (100) or apparatus, therefore increasing the WiFi devices (110) range, depending on the mobility of the user of the said device (100).

It is therefore the primary object of the present invention to provide a combination of networks module for the WiMAX configured mobile or device, primarily to ensure
15 simplistic handover and thus providing ubiquitous network by way of relaying a signal from the available network to a device.

In yet another embodiment of the present invention there is provided a mobile relay station (MRS) which has the capability to support and provide connection to users
20 within any available network.

In yet another embodiment of the present invention there is provided a fixed and mobile convergence (FMC) modules between two different technologies devoid of a gateway device for a vertical handover.

5 It is a further embodiment of the present invention to eliminate the need for PMCIA or PC cards in the respective terminal.

Other embodiments and objects of the present invention will be apparent in the detailed description provided herein.

10

Summary of Invention

In one embodiment of the present invention, there is provided a device (100) configured to perform a vertical handover from a current network to a target network when there is more than one network available within an area, said device (100) comprising at least one application layer (102), at least one Internet Protocol (IP) layer (103), at least one adaptation layer (104), a first physical (PHY) (108) layer, a first media access control (MAC) layer (105), a second physical (PHY) layer (107), and a second media access control layer MAC (106) layer.

20

In another embodiment of the present invention, there is provided a device (100) configured to relay a network signal from a first device to a second device based on the availability of network within an area, said device (100) comprising at least one

application layer (102), at least one Internet Protocol (IP) layer (103), at least one adaptation layer (104), a first physical (PHY) (108) layer, a first media access control (MAC) layer (105), a second physical (PHY) layer (107), and a second media access control layer MAC (106) layer, wherein the adaptation layer (104) is in communication with the first and second physical layers (108,107) and the first and second media access control layers (105,106); wherein the adaptation layer (104) is configured to perform the vertical handover process, the determination of coexistence of networks and the classification of network traffic.

10

Brief Description of the Drawings

The present invention which will be disclosed herein both as to organizational and method of operation, together with features, objects and advantages thereof may be best understood by reference to the following detailed description when read with accompanying drawing in which:

FIG 1 illustrates a diagram the interaction between the two technologies (WiMAX and WiFi) with the proposed wireless module which demonstrates the module in accordance with an embodiment of the present invention matches the signals from each of the WiFi and WiMAX devices and vice versa;

20

FIG 2 illustrates the protocol stack for the proposed wireless module which demonstrate the handoff part within the adaptation layer (which is responsible for the protocol convergence between the WiMAX and WiFi in accordance with an embodiment of the present invention;

5

FIG 3a – FIG 3b illustrates the laptop within the coverage of both indoor WiFi and WiMAX which demonstrate the signal relay activity performed by an embodiment of the present invention;

10

FIG 4 illustrates the network selection process performed in accordance with an embodiment of the present invention;

FIG 5 illustrates the messages flow scheme involved in the handover process in accordance with an embodiment of the present invention;

15

FIG 6 illustrates the signaling process involved in the handover process in accordance with an embodiment of the present invention.

Detailed Description of the Invention

20

In line with the above summary, the following description of a number of specific and alternative embodiments is provided to understand the inventive features and the principles of the present invention. It shall be apparent to one skilled in the art, however

that this invention may be practiced without such specific details and in any suitably arranged. Some of the details may not be described at length so as not to obscure the invention.

5 In one embodiment of the present invention there is provided a wireless transceiver module which includes WiFi and WiMax protocol stacks, and wherein said module provides two primary capabilities: the first primary capability is to enable a WiMAX device configured with the said module to relay the WiMAX signal from the WiMAX base station (BS) to a WiFi device by using wireless transceiver module in the
10 said WiMAX mobile device when the WiFi device is out of WiFi coverage. Therefore, the WiMAX device is configured to work as a vertical relay station, having characteristics similar to that of a mobile relay station (MRS). Commonly, the MRS is a concept for the mobile WiMAX network, which functions as a relay station while in motion. A second primary capability of the module is to enable a handover from a
15 current network to a better network, said handover performed within the module preferably in the event that there is a plurality of networks, for instance two networks available within an area. The components involved and the operational effect for each capability will be described in detail herein.

20 It is noted that there are two operational approaches with respect to the present invention, whereby the first operation approach is an open approach and the second approach is the close approach. In the first approach, the access mobile relay station is open for any node to connect to the Internet through the base station (BS); while the close

or second approach allows only the user of the WiMAX device to relay the signal. In the close approach, a “user” refers to a single user for both of the WiMAX device and the WiFi device. The present invention approach is preferably the latter.

5

FIG 1 illustrates the block diagram relative to the wireless transceiver module of the present invention whereby it is shown that the said module matches the signal from each of the WiFi and WiMAX and vice versa.

10

Now referring to FIG 2, the overall converged wireless transceiver module (101) comprises of an application layer (102), Internet Protocol (IP) layer (103), an adaptation layer (104), and followed by the WiMAX media access control (MAC) layer (105) WiMAX physical (PHY) layer (108), WiFi media access control (MAC) (106) layer and WiFi physical (PHY) layer (107). As suitably shown in said FIG 2, the adaptation layer (104) which is an essential layer with respect to the present invention, is configured to perform the handover process upon initiated. The adaptation layer (104) in accordance with the preferred embodiment of the present invention is in communication with the Internet Protocol Layer (103) and the WiMAX and WiFi MAC and PHY layers. Requests for handover is initiated or communicated to the adaptation layer (104) by anyone of the MAC layers. It is noted that the tasks performed within the adaptation layer (104) includes performing the tasks of determining the characteristics of coexistence of network or services, and also classification of network traffic. These characteristics are crucial for ensuring exceptional quality of service (QoS) with respect to the connectivity.

15

20

The handover process in accordance with an embodiment of the present invention will be described in detail herein.

5 In the following description and to better elucidate one embodiment of the invention, it is assumed that there is at least one WiMAX base station (200), a WiFi access point (202), a WiFi device herein is the laptop (110) and a WiMAX mobile device (100) with the transceiver module (101) of the present invention. This example can be seen in FIG 3a to FIG 3b.

10 Suitably, in the occurrence when a WiFi device (110) is located beyond the access point (AP) (202) coverage, and the only network available is the WiMAX network, and in the event that the WiMAX device (100) configured with the convergence module (101) is within the same area, the WiMAX device (100) is able to relay the signal from or
15 to the WiMAX base station (BS) to the WiFi device (110). In this process, the wireless transceiver module (101) is configured to release WiMAX packet headers (whereby each layer has one header in the packet) and substituted with WiFi headers (for MAC and PHY). Accordingly, there is connectivity with wider coverage area even if the WiFi device (110) is not within the WiFi coverage as the WiMAX device (100) is able to relay
20 the WiFi signal with the assistance of the WiMAX device (100) configured with the module (101) of the present invention.

Firstly referring to FIG 3a, the laptop (110) is placed outside the coverage area of the WiFi access point (202), or the case maybe, the WiFi starts to disappear, and therefore the available network as seen is the WiMAX network. Nevertheless with the availability of a WiMAX device (100) configured with the convergence module (101),
5 the laptop (110) user is be able to use the said WiMAX device (100) to facilitate and thus attempt connection by way of relaying the signal from the WiMAX base station (200) to the laptop (110).

Another preferred embodiment of the present invention is further suitably
10 elucidated in FIG 3b which is based on the second occurrence, in particular the existence of a plurality of networks; whereby a mobile device (laptop, mobile phone and the likes) detects presence of two WLANs from the mobile relay station (MRS). For instance, in the event that the WiMAX device is within the WiFi coverage. In this occurrence, the signal strength from the wireless transceiver module (101) is better than that of the access point
15 (AP) signal even when the WiFi coverage is available. Nevertheless, it is known that the WiMAX/WiFi data rate is significantly lower than that of the WiFi. The superb signal and high data rate from the WiFi is therefore preferred for the wireless transceiver module (101). Due to this, it is not preferable to initiate the handover so much earlier even when the WiFi/WiMax service is available purely based on the initial fact the WiFi
20 network provides higher bandwidth and therefore good quality of service (QoS). This occurrence is further elucidated and therefore resolved in FIG 4 which illustrates the block diagram of the overview of the scheme for jointly vertical handover of WLAN to WiFi/WiMAX. With this approach and as seen in FIG 4, a network selection time is

provided so as to enable maximized or optimized delivery of data or bits prior to confirming the network for handover.

With reference to FIG 4, FIG 5 and FIG 6, it can be seen that the steps involved for the handover process include a channel search or selection (301), a handoff decision (302) and a signaling process (303).

The channel selection (301) may involve the process of suitable mobile station or base station scanning is performed; therefore producing the time required for the said process, referred as t_s . The information on the suitable base station is acquired and the hand off decision step (302) is initiated. Now referring to FIG 5, during the handoff decision (302), the number of available suitable networks is determined. In the event that there is more than a single network, the network providing the highest signal strength is preferred. Upon selected the suitable network, data connection is established.

15

The signaling scheme or process (303) is shown in FIG 6. As suitably shown, the laptop (110) or a suitable device scans for downlink channel of the wireless transceiver module (101). Upon established, downlink synchronization is initiated. Subsequently, uplink parameters are accordingly acquired by the said device (100), followed by ranging the total throughput calculation, based on throughput + RSSI. It is understood by a person skilled in the art that ranging is an impertinent step in this regard as it enables the device to acquire the power and frequency adjustment information. The throughput calculation algorithm is provided at the adaptation layer (104) of the module (101). The ranging and

20

throughput results are sent to the device (100). The network selection result is then sent to the module (101) followed by a message containing indication of acceptance or rejection query of handover request.

5 The total throughput (λ) for WiFi/WiMax network is calculated based on WiMAX throughput (λ_{WiMAX}) and the effect of vertical handover within the module (101). The said total throughput may be calculated with the following:

$$\lambda = \lambda_{WiMAX} - t_0 l$$

10

From the above it is noted that t_0 is the vertical handover between 802.16j and 802.11 within the module (101) and l is the mean frame size. It is assumed that there are no other mobile nodes sharing the channel with the WiFi device. It is noted that the λ_{WiMAX} throughput is dependant on the WiMAX channel bandwidth (BW) and the total
15 number of tones (typically 256 for fixed and 1024 for mobile) and the range from the base station (adaptive modulation and coding, with maximum quadrature amplitude modulation, specifically 64-QAM).

In another embodiment of the present invention, the module (101) provides both
20 access point (AP) (202) and base station (BS) reside in the same module (101) and therefore vertical handover is performed in the adaptation layer (104), specifically at the WiFi and WiMAX MAC layer. Comprehendingly, as the handover is performed within the module (101), the time taken for vertical handover is significantly reduced.

It is noted from the principles and inventive embodiments of the present invention that having a combination of WiMAX and WiFi module (101) in a WiMAX device which therefore serves as a relay station and capable to perform network handover
5 therein results to ubiquitous and dependant connection.

While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention.

10

15

20

CLAIMS

1. A device (100) configured to perform a vertical handover from a current
5 network to a target network when there is more than one network
available within an area, said device (100) comprising at least one
application layer (102), at least one Internet Protocol (IP) layer (103), at
least one adaptation layer (104), a first physical (PHY) (108) layer, a
first media access control (MAC) layer (105), a second physical (PHY)
10 layer (107), and a second media access control layer MAC (106) layer.

characterized in that the vertical handover process is performed
within the adaptation layer (104);

15 wherein the adaptation layer (104) is in communication
with the first and second physical layers (108,107) and the
first and second media access control layers (105,106);

20 wherein the adaptation layer (104) is further configured to
perform the determination of coexistence of networks and
the classification of network traffic.

- 5 2. The device (100) as claimed in Claim 1 wherein the request for initiation of handover is communicated to the adaptation layer (104) by anyone of the MAC layers (105,106)
- 10 3. The device (100) as claimed in Claim 1 wherein the handover process performed within the adaptation layer (104) further includes the steps of a channel search or selection (301), a handoff decision (302) and a signaling process (303).
- 15 4. The device (100) as claimed in Claim 1 to 3 wherein the channel search or selection (301) includes the task of base station or mobile device scanning.
- 20 5. The device (100) as claimed in Claim 1 to 4 wherein the handoff decision (302) includes the tasks of identifying the available networks, determining the network with the highest signal strength, determining the network with the highest throughput and establishing connection with the selected network.
6. The device (100) as claimed in Claim 1 to 5 wherein the handover process performed within the adaptation layer (104) further includes the

steps of running the throughput calculation algorithm for the signaling process (303).

5 7. The device (100) as claimed in Claim 1 wherein the first physical layer (108) is based on WiMAX standard.

 8. The device (100) as claimed in Claim 1 wherein the first media access control (MAC) (105) layer operates according to WiMAX standard.

10 9. The device (100) as claimed in Claim 1 wherein the second physical layer (PHY) (107) is based on WiFi standard.

 10. The device (100) as claimed in Claim 1 wherein the second media access control (MAC) (106) layer operates according to WiFi standard.

15

20

1/5

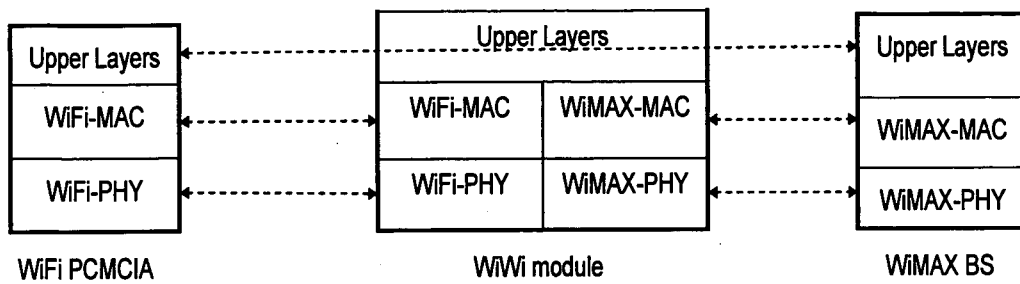


FIG 1

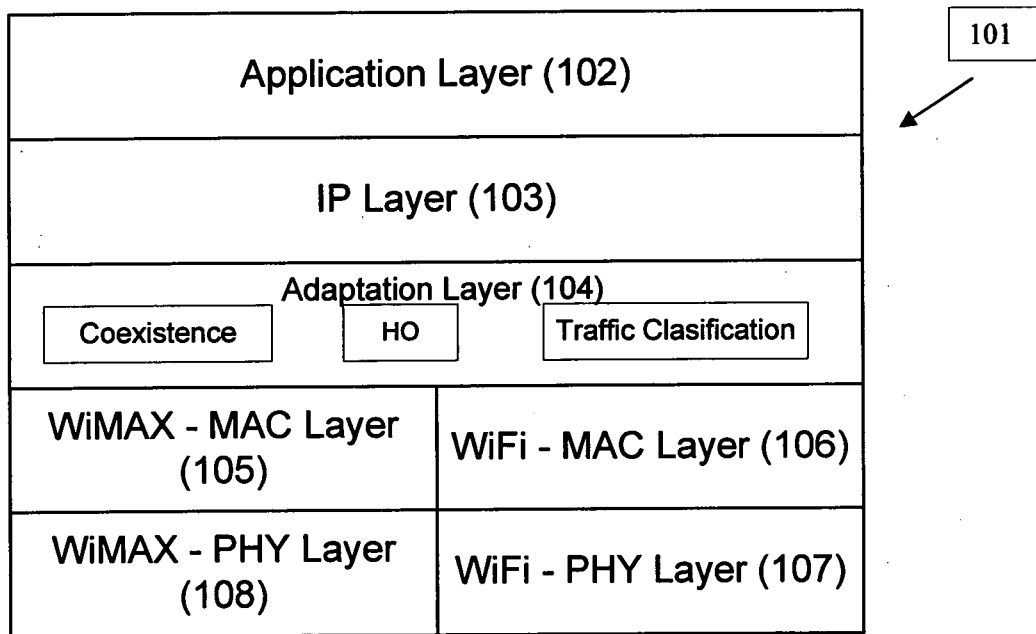
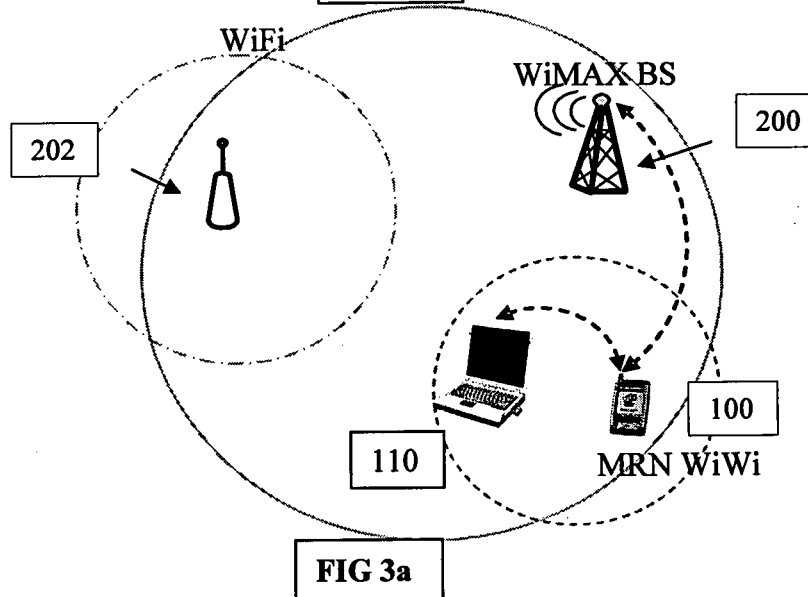
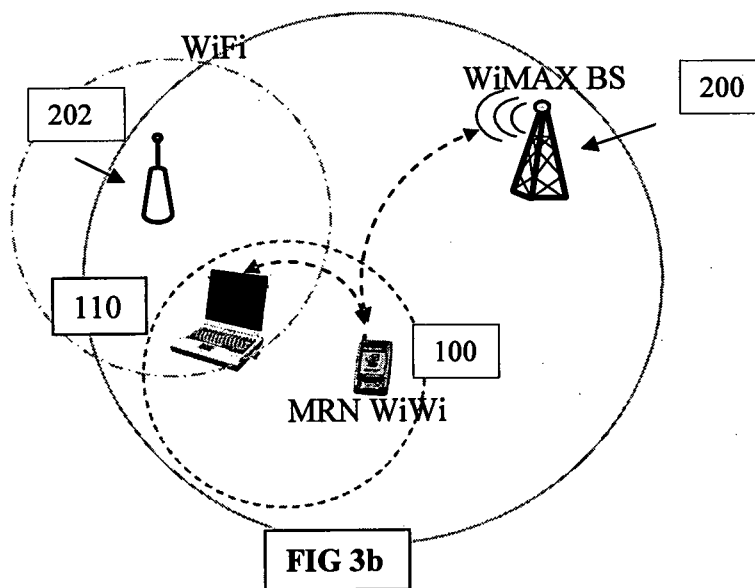


FIG 2

2/5



-  Laptop with only WiFi module
-  WiMAX mobile with WiWi module
-  WiFi Access point
-  WiMAX BS

3/5

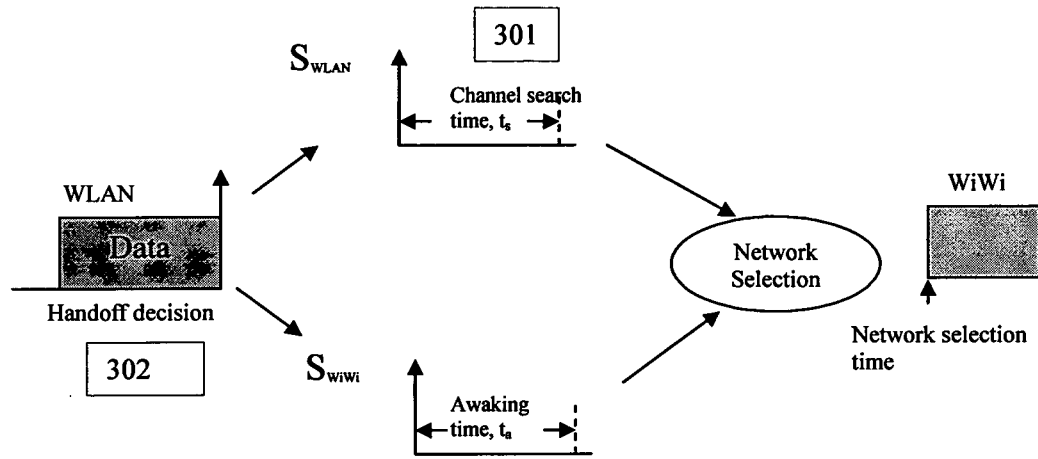


FIG 4

4/5

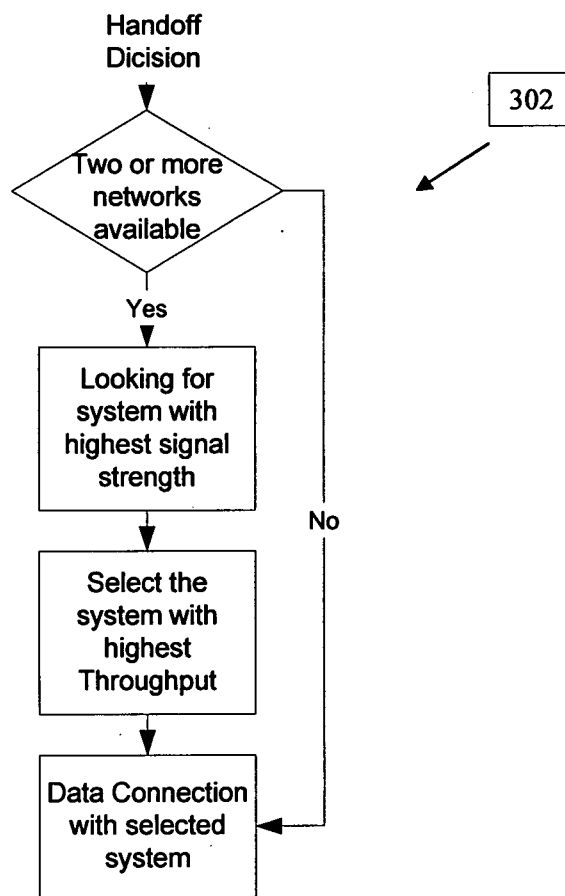


FIG 5

5/5

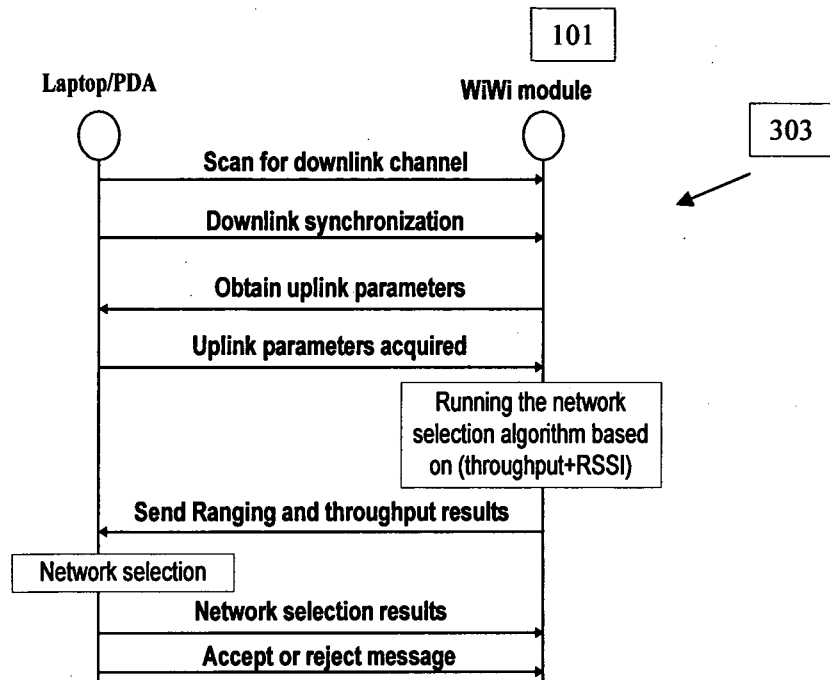


FIG 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2009/000138**A. CLASSIFICATION OF SUBJECT MATTER*****H04W 36/14(2009.01)i, H04W 36/04(2009.01)i, H04W 80/00(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 9: H04W, H04Q, H04L, H04B

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

Korean Utility models and applications for Utility Models

Japanese Utility models and applications for Utility Models

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

eKOMPASS(KIPO internal) & keywords: "vertical handover, adaptation layer, PHY layer, MAC layer"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008-0130581 A1 (EUI-SEOK HWANG et al.) 05 Jun. 2008 See abstract, figure 2, paragraphs [0013], [0023], [0027]-[0032], [0034], [0038]-[0039], [0053], and claims 1-9.	1-10
Y	US 2007-0253339 A1 (SHLOMO OVADIA et al.) 01 Nov. 2007 See abstract, figures 1,3,5, paragraphs [0019], [0021], [0029]-[0032], [0035], [0039]-[0040], and claims 1-5.	1-10
A	US 2005-0176473 A1 (DIEGO MELPIGNANO) 11 Aug. 2005 See abstract, figure 3, paragraphs [0018]-[0022], [0089]-[0091], and claims 1,3,5,9-14,16-19.	1-10
A	US 2008-0064401 A1 (MIKA FORSELL et al.) 13 Mar. 2008 See abstract, figures 5-6, paragraphs [0026], [0071]-[0073], and claims 1-4.	1-10
A	US 2007-0105589 A1 (WEI LU) 10 May 2007 See abstract, figures 1-2, paragraphs [0034], [0074]-[0076], [0093], [0117], [0120], [0124], [0128]-[0129], and claims 1,4.	1-10

☐ 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 international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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

02 FEBRUARY 2010 (02.02.2010)

Date of mailing of the international search report

02 FEBRUARY 2010 (02.02.2010)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-
gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

KIM, Kwang Sik

Telephone No. 82-42-481-8355



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2009/000138

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008-0130581 A1	05.06.2008	KR 10-2008-0035856 A	24.04.2008
US 2007-0253339 A1	01.11.2007	None	
US 2005-0176473 A1	11.08.2005	AU 2003-201139 A1	24.01.2003
		CN 1636356 A	06.07.2005
		EP 1472826 A1	03.11.2004
		JP 2005-516538 A	02.06.2005
		KR 10-2004-0075962 A	30.08.2004
		WO 2003-065654 A1	07.08.2003
US 2008-0064401 A1	13.03.2008	None	
US 2007-0105589 A1	10.05.2007	None	