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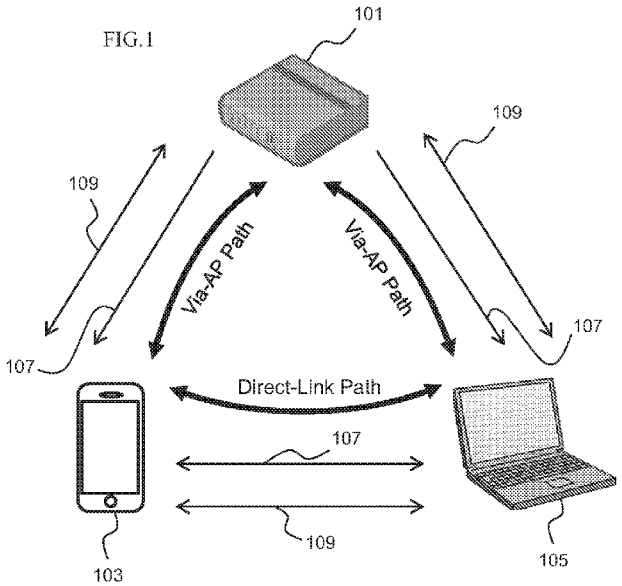
(54) Title: METHOD AND DEVICE FOR HOME WIFI STATION DEVICE TO SELECT LINK FOR DATA TRANSMITTING

FIG.1



(57) Abstract: A method for a WiFi station device to select a link for data transmitting, wherein a direct link between the WiFi station device and another WiFi station device is established after establishment of a communication via a WiFi AP, comprising: measuring at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link and via the WiFI AP; performing throughput testing by transmitting a test frame between the WiFi station device and another WiFi station device via the direct link and via the WiFi AP according to a predetermined policy; selecting the link via the WiFI AP if none of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP; selecting the direct link if at least one of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP.

METHOD AND DEVICE FOR HOME WIFI STATION DEVICE TO SELECT LINK FOR DATA TRANSMITTING

TECHNICAL FIELD

The present disclosure relates to a method and a device for a WiFi station device to select a link for data transmitting, and more particularly related to a method and a device for a WiFi station device to automatically select the best link for data transmitting by utilizing throughput testing.

BACKGROUND ART

In the home WiFi network environment, besides that traditional popular DLNA, more and more home network services come into field such as home cloud, Airplay, multiscreen-switching, etc. These services are all based on some connected WiFi devices in home.

In the meanwhile, a problem often exists in home WiFi scenario. These home WiFi station devices are mostly connected into the same WiFi AP (Access Point) (and SSID (Service Set Identifier)) in home, which is normally located at a fixed place such as on the desk in a reading room. However, the WiFi station devices in home could be separated at different places from AP where the WiFi performance is degraded much due to signal quality. In this situation, the user experience could be significantly impacted when two station devices communicate especially for HD (High Definition) media transmitting which needs high throughput. But, on the other side, the fact normally is that the WiFi station devices (e.g. smart phone and STB) (Set Top Box)) could be very close e.g. just in the same room. That means if they are capable to communicate directly at the moment when needed, the WiFi transmitting performance should be much better than via the AP. This requires a mechanism or method enables the WiFi station devices to be able

to automatically select the best performance link to communicate when needed, e.g. through AP, or directly. The existing relevant technologies are as follows:

There is indeed already such WiFi direct connecting technology e.g. TDLS (tunneled direct-link setup) and DLS (direct-link setup) which are defined in IEEE802.11. However, TDLS and DLS are just link layer methods which provide WiFi STA device to discovery each other and establish and disconnect the link between them. The technology doesn't further define with details when it should be utilized, which is open for device vendor and SW developer to devise. This is reasonable from the standard defining perspective as IEEE 802.11 is just a specification for WLAN Media Access Control and Physical Layer, not need to involve any specific description for use scenario and needs.

WiFi P2P is another technology support directly connecting defined by WiFi alliance. As well, the main content is focusing on how to discovery and establish group and relevant management for the WiFi device. And just some examples based on WiFi P2P technology are provided in annex such as, Apple's Bonjour, and UPnP.

Consequently, based on the WiFi directing technologies, some services are defined with dedicated specifications. Among them, WiFi Display is a famous one defined by WiFi alliance. It's a technology to support screen display transmitting between two WiFi directly connected devices, which can base on either TDLS or WiFi P2P technology.

Drawback of the existing WiFi direct link based solution is that they normally require the end user to explicitly select and force the device to work in direct link mode, but could not be triggered automatically based on factual needs. For the service defined based on it e.g. WiFi display (WFD), it defines the procedure of device and service discovery, which is

specifically applied to WFD devices to discovery each other and interoperate.

So far, there is no such method or solution enables the WiFi station devices to automatically switch the transmitting link from AP based link to direct link, or vice versa, based on factual needs and factors e.g. the factual situation of devices capability and the signal quality.

SUMMARY

According to an embodiment of the present disclosure, there is provided a method for a WiFi station device to automatically select the best link for data transmitting, wherein a direct link between the WiFi station device and other WiFi station device is established upon communicating via WiFi AP, comprising: measuring at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link and via the WiFI AP; performing throughput testing by transmitting a test frame between the WiFi station device and another WiFi station device via the direct link and via the WiFi AP according to a predetermined policy; selecting the link via the WiFI AP if none of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP; selecting the direct link if at least one of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP.

According to an embodiment of the present disclosure, there is provided a device for a WiFi station device to automatically select the best link for data transmitting, wherein a direct link between the WiFi station device and other WiFi station device is established upon communicating via WiFi AP, comprising a processor configured to implement: measuring

at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link and via the WiFI AP; performing throughput testing by transmitting a test frame between the WiFi station device and another WiFi station device via the direct link and via the WiFi AP according to a predetermined policy; selecting the link via the WiFI AP if none of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP; selecting the direct link if at least one of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a system diagram in a transmitting scenario according to an embodiment of the present disclosure;

FIG. 2 is a message/signal sequence diagram according to an embodiment of the present disclosure;

FIG. 3 is a hardware block diagram according to an embodiment of the present disclosure; and

FIG. 4 is a software block diagram according to an embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENT

A description is given below of embodiments of the present disclosure, with reference to the drawings.

The disclosure proposes a method and a device which enables the WiFi station devices to automatically select the best performance link to communicate with each other, e.g. via the AP or directly, to achieve the best communication performance. It would avoid the problem described above typically in home scenario. As well, it would be possible to free more resource of WLAN AP to process the real needed data

transmitting via it.

The method and device are based on TDLS (tunneled direct-link setup) or DLS (direct-link setup) as defined in IEEE802.11. When two WiFi station devices are connected within the same AP, and they are going to communicate as the request from the upper layer applications or services running within them, they will immediately start the transmit process via the link connected to the same AP. In the meanwhile as soon as possible, the WiFi devices also start to try setup of the direct link based on TDLS or DLS method. This is possible because the MAC address of the other device is already known to each other as their IP layer connection has been established. If the direct link can be successfully setup, then the two WiFi devices should be able to:

1. Measure the signal quality/strength of the frame received from the other device. This measurement can be supported by the radio measurement service of the WiFi devices.

2. Check the capability whether the HT (high throughput) is supported on the direct link. This checking can be supported by the devices supporting TDLS or DLS by checking the element of the received request or response/confirm frame of direct link setup.

3. Perform some throughput testing by transmitting the test frames between each other. This test frame should be explicitly marked to indicate that it is only for transmitting performance testing purpose and the frame should not be submitted to upper layer above link and physical layer.

This can be supported by extension of the IEEE802.11 Management frame, and its subtype the Action frame, and furthermore, the Radio Measurement action (in the section 8.5.7 of IEEE 802.11-2012). In the Radio Measurement action, there is action subtype "Link Measurement Request/Report". Some general link measurement request and report formats are defined in the

standard. The specific measurement action and semantic should be supported with the "Measurement Request/Report Elements". In the current IEEE802.11 standard, some measurement request/report elements were already defined (in the section 8.4.2.23 of IEEE 802.11-2012). However, there is still no element purposed for the link throughput or transmitting rate measurement. Thus, a new link measurement element could be defined for this purpose named as e.g. "Link Throughput Measurement" request/report element.

According to the check and measurement result in above steps, these further logic and behavior should be taken consequently:

1. For received signal strength detecting at the two WiFi STA devices which connected via the direct link, if none of the STA side has a better receiving signal quality/strength than the receiving signal quality/strength of its link connected to the AP, then the direct link shouldn't be applied to transmitting the upper layer data, but just keep the direct link which is active for later (periodical or random) measurement of the receiving signal strength/quality. In the meanwhile, it's no need to further do some transmitting performance test via the direct link to evaluate the throughput. However, the devices could still insist on trigger the throughput test in this situation, to ensure correctly selecting the link with better performance.

2. During step 1, if any of the two WiFi STA devices get a better receiving signal quality/strength than its current link in use e.g. the link to AP in this case, it shows that it's possible to achieve a better transmitting throughput via the other link. Then the devices can make a link selection based on a set of policies detailed in the "transmitting scenario" e.g. Fig.1. If HT (High Throughput) is supported over the direct link, it should be applied by the two WiFi STA devices to

perform the following actions for throughput test and transmitting for upper layer application/service data.

3. To evaluate the link performance, the two WiFi STA devices can perform some transmitting test over the direct link, to measure the throughput of the direct link. In the meanwhile, or in prior, the two WiFi STA devices should also perform the transmitting test via the link connected with the AP. If the throughput over the direct link is better than throughput over the link via AP, then the direct link should be applied for the upper layer data transmitting, and vice versa. During the data transmitting process for upper layer application/service, the throughput testing should be periodically or randomly perform over both the direct link and the link via AP, so that the two WiFi STA devices can dynamically select the most efficient link for data transmitting.

When the two devices has switched to the direct link (or the AP-link), the devices should still periodically or randomly trigger the link evaluating procedure similar to above.

In this disclosure, some points are considered:

1. WiFi STA device can select not to perform the throughput testing, but just after the measurement of receiving signal quality/strength has been completed and it shows the at least one of the WiFi STA device in the passive (means not in use for data frame transmitting) link has the better receiving signal quality/strength, then start to switching to the passive link for frame transmitting. As well, WiFi STA device can also select not to perform the receiving signal quality/strength measurement, but just go to perform the throughput testing over the direct link or passive link.

2. During the switching phase between the direct link and the link via AP, the WiFi STA device can select to transmit the same data frame via both links, and after ensuring the switching-to i.e. passive link is successfully used for upper

layer data transmitting e.g. received the confirm frame of the data frame via this link, the WiFi STA device can decide to terminate the transmitting over the original link. However, the original link should be kept active, for periodically or randomly throughput testing so that the most efficient link can be selected. Also, the WiFi STA device can select to immediately switch to the new link without need to transmit the same data frame via both links, after the signal measurement and throughput testing has shown the passive link has a better performance. In this case, the switching can happen when start to transmit the next data frame just after the new different link has been determined by the MLME. The link switching should be transparent to upper layer application/service, and only happens at the WiFi link layer and MAC layer.

3. Regarding to the WiFi channel selection and security of the direct link based on TDLS or DLS, it should comply with the specification defined in the IEEE 802.11.

When to trigger the process of this disclosure, and relevant behaviors:

1. The disclosure is applied for WiFi devices connected to the same AP in a BSS scenario. When two (or more) WiFi devices connected with the same AP which constructs a WLAN, each device will be assigned (or statically configured) with a IP address by a DHCP server in the connected network. Some services e.g. DLNA, home-cloud, or media-playback, etc. can be activated in this environment. At the first time when two WiFi STA devices are connected via AP, the direct link has never been established before as they don't know the destination MAC of each other. And only after their upper layer application/service has found each other via some application layer communication, i.e. knowing the destination MAC of the application/service's corresponding peer, would the two devices automatically start to setup the direct link and perform some

testing/measurement to determine the better link to use. During the link testing/selecting process, the data transmitting for application/service layer may already have been started via the link with the AP. The two WiFi STA devices may decide to switch the link for data transmitting at any moment.

2. After the two WiFi STA devices have known each other the MAC address of them, they could at any time try to setup the direct link between them, in spite of whether the link to AP is active or not, e.g. by trying to setup the direct link with the reserved MAC in list it has recorded and it's possible to setup multiple TDLS link with multiple peer STA at the same time. And furthermore, if the WiFi Device is not connected with the AP, e.g. AP is powered off, and if the WiFi STA device has setup direct link with peer STA, the linked STA devices can atomically setup the IP connection between them without a DHCP server. The device in the direct link can promote to use its own latest IP was ever received/assigned and connected within this AP WLAN, or its static IP. If the IP address of two device in direct link is collision, the device with small MAC address should try to promote another IP for itself, e.g. by increasing the IP address, or decreasing, or randomly select another one within the same IP address fragment, until ensure the new IP is not collision with any of the device in the direct link to this device. And this IP should firstly be promoted next time if in the same situation in direct link with other devices without a connected DHCP server.

As an example, user in home sitting in the sofa in living room, want to playback the video stored in his/her smartphone onto the STB or OTT box connected with the HD TV in living room. And assume there is a WiFi AP located in another room e.g. reading room.

In this disclosure, the typical procedure would be:

1. The user turns on the WiFi of the STB (or OTT box) and

his/her smartphone. And both of the devices connected to the WiFi AP.

2. The user clicks the DLNA or home cloud service and selects the STB (or OTT box) as the render to playback a video.

3. At this moment, since the smartphone and the STB (or OTT box) has known each other their MAC address, the two WiFi STA devices will try to setup the direct link.

4. The direct link will be successfully setup and the measurement and testing of the receiving signal and throughput shows the transmitting performance of the direct link is much better than it via the link to AP. It is because the two WiFi STA devices are very close in the same room, while their signal transmitting to the AP in another room is not very good.

5. Thus, the transmitting device, i.e. the smartphone, decides to switch to the direct link for data transmitting. This is fully transparent to the DLNA or home cloud application/service as the link switching is performed at the MLME (MAC sub layer management entity) of the device. Note, at the moment the transmitting link was switched, it could be that the application data has already started to transmit via the link to AP, just possibly with some jitter and delay of the video playback, the delay and jitter can be mitigated or avoided by simultaneously transmitting the frame via both link when performing the link switching.

6. The video playback performance is increased much after the link switching. After that, the measurement and testing of the receiving signal and throughput would be continuously (periodically or randomly) performed to ensure the better link is always applied for data transmitting. E.g. if the user take the smartphone to another room, the link may be switched to the AP link as the direct link performance is worse than that of AP link.

FIG. 1 is a system diagram according to an embodiment of

the present disclosure in a transmitting scenario. In the example scenario diagram, it consists of Home Gateway (Wireless AP) 101, Mobile 103, and PC 105. At the beginning the Mobile 103 and PC 105 start interacting via the path over the AP. Then, since they are in the same sub-network, they know the MAC address of each other. Steps in more details are shown below:

1) For example, Mobile 103 finds a service hosting at the PC 105, or is demanded to access a service link at the PC 105 by explicitly inputting the service URL containing the IP or alias name of the PC 105.

2) If the PC's IP belongs to the same subnet of the Mobile 103, then the Mobile 103 would trigger an ARP (Address Resolution Protocol) request trying to resolve the MAC address of the PC 105. If its alias name is IP address, firstly it needs to request the Home Gateway to return the corresponding IP according to the PC's alias name.

3) Upon receiving the ARP request, and if the requested IP is same to its own IP, the PC will return its MAC address to the Mobile 103.

After they know each other's MAC address, the Mobile 103 and PC 105 will start to evaluate and select a best link for data transmitting. Steps in details are shown below:

1) Firstly, both Mobile 103 and PC 105 evaluate the received wireless signal quality from the AP 101, as well evaluate the signal quality received from each other, just as the step 107 in the diagram.

2) With the result of step 107, the devices are able to make a selection of the link which has the better signal quality. The procedure could be:

A) At the Mobile 103, if the received signal quality from the PC 105 is better than the signal quality from the AP 101, then the Mobile 103 will prefer to use the direct link path. And the Mobile 103 will send its preference to

the other counterpart device i.e. the PC 105. In the meantime, at the PC 105, it will also evaluate the signal received from both the AP 101 and the Mobile 103. And if the signal quality from the Mobile 103 is better than it from the AP 101, the PC 105 will also prefer to use the direct link path. The PC 105 should also send its preference to the Mobile 103. It should be noted that before the direct link is established to use, the two devices' interaction is via the AP-path.

B) After receiving the counterpart's link preference, the device will make a decision according to a general policy, i.e.:

a) If their preferences are same, then the preferred link will be selected and the selection will be notified to each other. Besides, the devices can further trigger a throughput evaluating procedure to ensure the best performance link is correctly selected.

b) If their preferences are different, several policies can be applied to do further determining, e.g.:

- To simplify, the preference of the device whose MAC value is greater will be selected.
- Or, each device checks that, during a specified recent past time it exchanged data with the other device, whether the amount of the transmitted data is greater or the amount of the received data is greater. If the amount of the transmitted data is greater, it means this device plays more as a data provider during the just past phase. Otherwise it plays more as data consumer. Since the data consumer depends more on the received signal quality, so the data consumer

device's preference should be selected. And because this transmitting and receiving data statistic focuses on the link between only the two devices, the expected comparing result at the two devices should be identical. However, if the result is different, the other policy can be as backup e.g. back to the simple MAC comparing, or switch to the further link selecting method by throughput evaluating described below.

- Or, simply, the two devices can trigger a throughput evaluating procedure described below to correctly select the link with better performance.

3) The link selection method based on received signal quality evaluating has its limitation. For example, the TX signal power of the AP is strong enough so that the WiFi-Client A detected a preferable signal quality from that AP. But probably on the other side, the WiFi-Client's TX signal power is not strong for example on a mobile phone, that means the WiFi data from mobile phone to AP may result in much loss possibility, even though it detected the AP's signal is strong enough. In the meanwhile, probably even if the detected signal strength from another WiFi-client B is not strong as signal from that AP, yet the signal strength in between A and B is quite equal at a stable level, so that the direct link data transmitting throughput should be better than that via the AP. So, the throughput evaluating is more important than just signal strength detecting. The step 109 in Fig. 1 performs the throughput evaluating. The higher throughput link will then be selected by both of the two devices, e.g. Mobile 103 and PC 105 in Fig. 1. It should be noted that during the throughput evaluating, the other link (different to the link currently in use) should be established firstly. And, the wireless link layer should trigger and performing the data throughput test

over the two links one by one or simultaneously.

When the selected link was selected and confirmed by both devices, if the selected link is same as the link currently in use, nothing more needs to do. If the selected link is different to the current link in use, a link switching will be triggered at the link and physical layer of the wireless connection. The new link establishing procedure should comply to the already standards' definition. After the new link was established, it will replace the current link to undertake the data transmitting task for the upper application and service. The procedure is transparent to the upper application and service.

Since the signal environment may changes during the time, this link selecting procedure could be periodically triggered to ensure always the best link is selected.

FIG. 2 is a message/signal sequence diagram according to an embodiment of the present disclosure.

At step 201, STA A and B are assigned IP address via the DHCP interacting with AP (Home Gateway), or statically configured.

At step 202, the STAs A and B establish the link via the AP. And through some application/service layer protocol or demand by end user with URL inputting, the STA A requests to access the service hosting at the STA B. In that procedure, the STA A and B know each other's MAC since their IP address are within the same subnet.

At step 203, the STAs A and B may already start to transmit the application/service data e.g. DLNA content access and media playback, which is via the AP link.

At step 204, since the STAs A and B know each other's MAC, they interact and try to establish the direct link. In the meanwhile, the STAs A and B measure the received signal quality on the direct link.

At step 205, since the STAs A and B already have established link via the AP, they know the received signal quality from the AP. The STAs A and B compare the received signal quality from the AP and direct link, and follow the policy defined in Fig. 1 trying to select the link with better performance.

At step 206, the STAs A and B may decide to further trigger the link throughput testing to ensure a correct link selection. This throughput test occurs simultaneously or in turn alternatively at the direct link and AP link, with a predefined duration e.g. 30 seconds. It should be noted that this throughput testing and above signal quality measurement may be triggered periodically or randomly to ensure always better link is selected.

At step 207, after the evaluating of the received signal quality from both link, and probably with further throughput testing, the better performance link is selected, e.g. the direct link, or the link via the AP. And with the periodically or randomly link evaluating, the selected link may be changed next time.

FIG. 3 is a hardware block diagram according to an embodiment of the present disclosure. Home Gateway (Wireless AP) 301 includes CPU 305, Flash Memory 307, RAM 309, Wireless chipset 313, Ethernet Chipset 311, Ethernet 315, and Power 317. Wireless Station 303 includes CPU 305, Flash Memory 307, RAM 309, Wireless chipset 313, and Power or Battery 317. The Wireless Station 303 may include Other Accessories 319. The Home Gateway 301 and Wireless Station 303 may include other element or omit any element as needed.

FIG. 4 is a software block diagram according to an embodiment of the present disclosure.

The "Link Switch Decision" module 401 will regularly trigger the link measurement action. Further, based on the

reported result and statistic data, the "Link Switch Decision" module 401 makes a decision whether to switch the link (e.g. from AP link to direct link or vice versa) or keep the current link according to the "Link Selection Policy" 403.

The "Link Selection Policy" 403 is a module that stores the predefined link selection policies e.g. defined in Fig. 1. As well, the policy can be editable by end user or administration depends on the vendor's implementation and use scenario consideration.

The "Link Measurement" module 405, upon the input from "Link Switch Decision" 401, will do the link measuring includes received signal measuring and further link throughput evaluating if needed. And, it will report the measurement result to the "Link Switch Decision" module 401.

The "Link Switch" module 407, upon receiving the command from "Link Switch Decision" 401 will initiate and complete the link switching from the current link to the selected new link e.g. from AP link to direct link or vice versa.

The "Measurement Protocol and Framing" module 409 is responsible for link measurement protocol acting and frame encapsulating and de-capsulating.

The Physical layer management entity (PLME) 411 is responsible for wireless physical layer management as defined in the IEEE 802.11 standard.

The Station Management Entity (SME) 413 is responsible for Station Management as defined in the IEEE 802.11 standard.

The MAC sub-layer management entity (MLME) 415 is responsible for MAC sub-layer management as defined in the IEEE 802.11 standard.

Network layer 417 is the typical IP layer in the TCP/IP network.

App/Service layer 419 represents the actual application and service that utilize the wireless to do data transmitting,

e.g. DLNA.

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made. For example, elements of different implementations may be combined, supplemented, modified, or removed to produce other implementations. Additionally, one of ordinary skill will understand that other structures and processes may be substituted for those disclosed and the resulting implementations will perform at least substantially the same function(s), in at least substantially the same way(s), to achieve at least substantially the same result(s) as the implementations disclosed. Accordingly, these and other implementations are contemplated by this application and are within the scope of the disclosure as defined by the appended claims.

CLAIMS

1. A method for a WiFi station device to select a link for data transmitting, wherein a direct link between the WiFi station device and another WiFi station device is established after establishment of a communication via a WiFi AP, comprising:

measuring at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link and via the WiFI AP;

performing throughput testing by transmitting a test frame between the WiFi station device and another WiFi station device via the direct link and via the WiFi AP according to a predetermined policy;

selecting the link via the WiFI AP if none of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP;

selecting the direct link if at least one of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP.

2. The method as claimed in claim 1, wherein in the selecting, selecting the direct link if both of the WiFi station devices detected better received signal quality via the direct link than via the WiFi AP.

3. The method as claimed in claim 1 or 2, wherein the throughput testing is not performed if the at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link is stronger than via the WiFI AP.

4. The method as claimed in one of claims 1 - 3, wherein the measuring of the at least one of signal quality and signal strength of a frame and the throughput testing is performed periodically or randomly.

5. A device for a WiFi station device to select a link for data transmitting, wherein a direct link between the WiFi station device and another WiFi station device is established after establishment of a communication via a WiFi AP, comprising a processor configured to implement:

measuring at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link and via the WiFI AP;

performing throughput testing by transmitting a test frame between the WiFi station device and another WiFi station device via the direct link and via WiFi AP according to a predetermined policy;

selecting the link via the WiFI AP if none of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP;

selecting the direct link if at least one of the WiFi station device and another WiFi station device detects better result of the throughput test via the direct link than via the WiFi AP.

6. The device as claimed in claim 5, wherein in the selecting, selecting the direct link if both of the WiFi station devices detected better received signal quality via the direct link than via the WiFi AP.

7. The device as claimed in claim 5 or 6, wherein the

throughput testing is not performed if the at least one of signal quality and signal strength of a frame received by each of the WiFi station devices via the direct link is stronger than via the WiFI AP.

8. The device as claimed in one of claims 5 - 7, wherein the measuring of the at least one of signal quality and signal strength of a frame and the throughput testing is performed periodically or randomly.

FIG.1

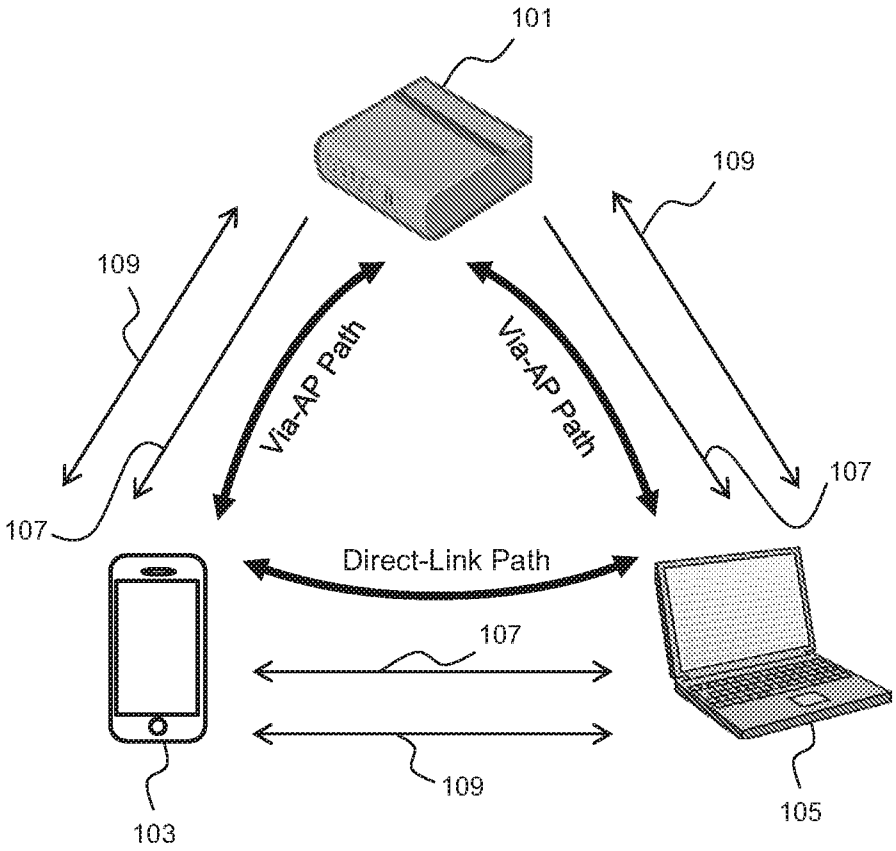

101
109
109
Via-AP Path
Via-AP Path
107
107
Direct-Link Path
107
109
103
105

FIG.2

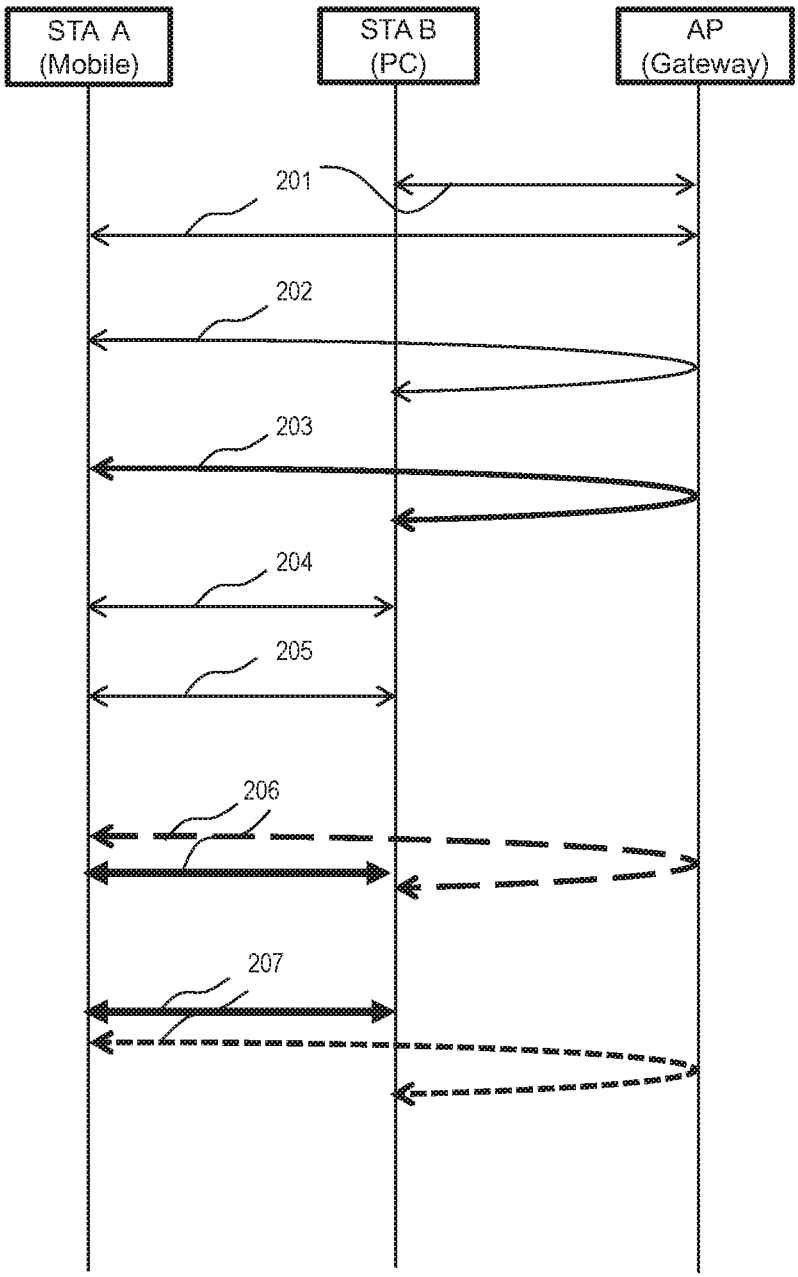


FIG.3

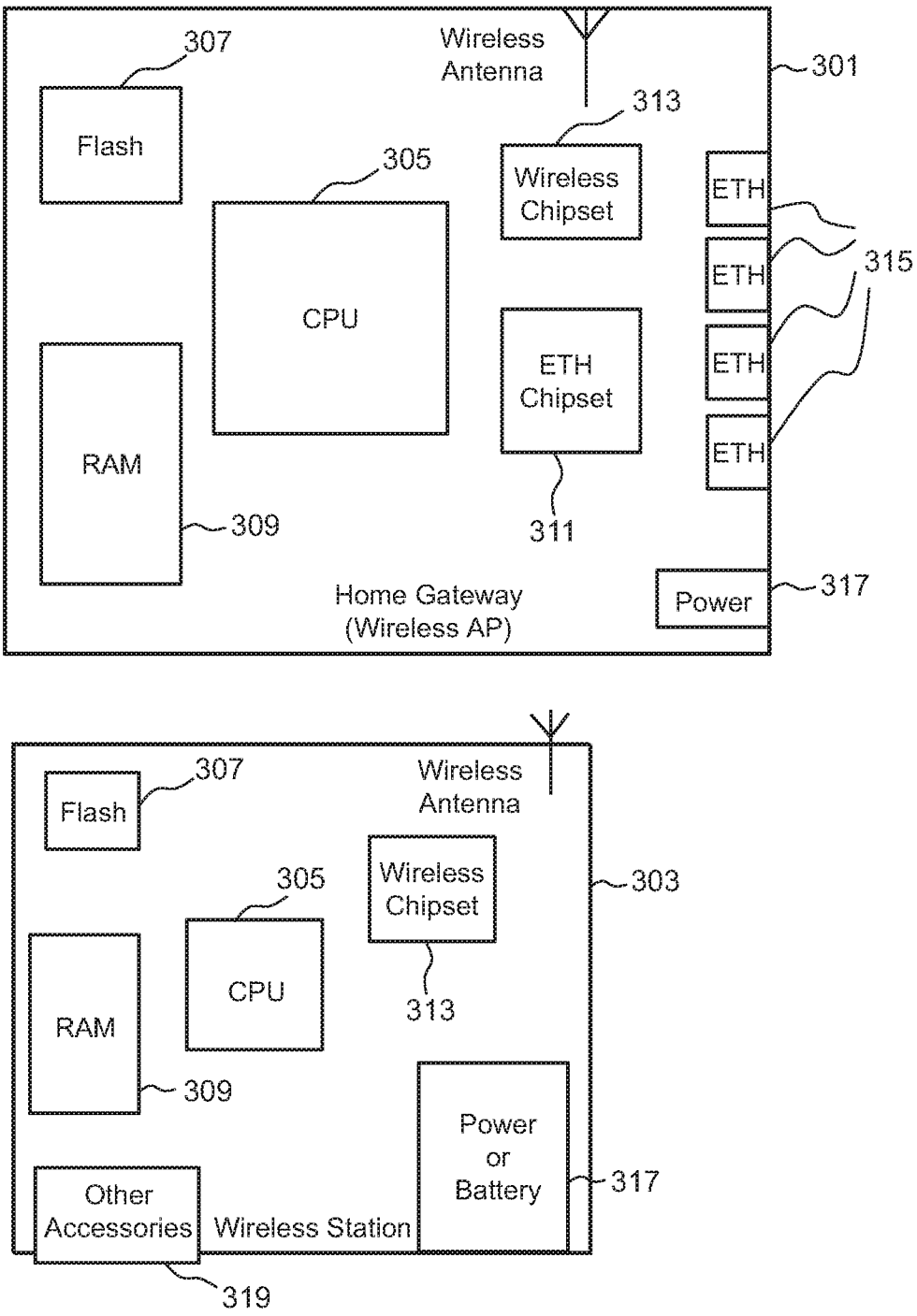
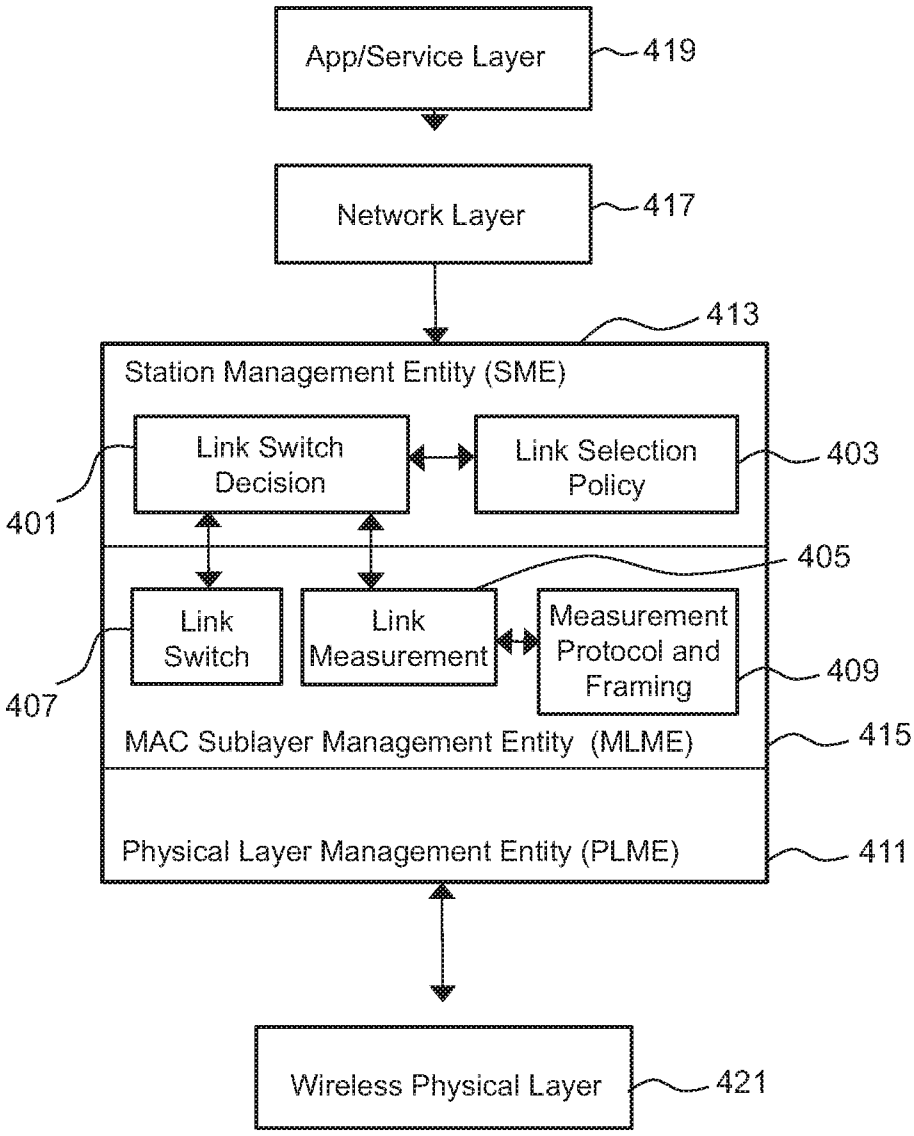

307
Flash
Wireless Antenna
301
313
Wireless Chipset
305
CPU
ETH
ETH
ETH
ETH
315
ETH Chipset
RAM
309
311
Home Gateway (Wireless AP)
Power
317
307
Flash
Wireless Antenna
303
305
Wireless Chipset
CPU
313
RAM
309
Power or Battery
317
Other Accessories
Wireless Station
319

FIG.4


App/Service Layer
419
Network Layer
417
413
Station Management Entity (SME)
Link Switch Decision
Link Selection Policy
403
401
405
Link Switch
Link Measurement
Measurement Protocol and Framing
409
407
MAC Sublayer Management Entity (MLME)
415
Physical Layer Management Entity (PLME)
411
Wireless Physical Layer
421

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/094040

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/02(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)

H04W, H04Q, H04B

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)

CNPAT、CNKI、WPI、EPODOC: WiFi、AP、select+、quality、strength、direct、throughput、link

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 102098796 A (INTEL CORPORATION) 15 June 2011 (2011-06-15) description, paragraph [0035] and claims 1-4	1-8
Y	CN 101218835 B (MICROSOFT CORPORATION) 25 April 2012 (2012-04-25) claims 1, 3	1-8
A	US 2009185492 A1 (NORTEL NETWORKS LIMITED) 23 July 2009 (2009-07-23) the whole document	1-8

☐ 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

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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
16 July 2015	**28 August 2015**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **WANG,Yixuan** Telephone No. **(86-10)62413244**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/094040

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				JP	2013514000	A	22 April 2013
				WO	2011081705	A2	07 July 2011
				US	2011145421	A1	16 June 2011
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				EP	1902590	A2	26 March 2008
				KR	20080032078	A	14 April 2008
				WO	2007008857	A2	18 January 2007
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				US	2007008922	A1	11 January 2007
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				JP	2009500969	A	08 January 2009
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				US	2013010601	A1	10 January 2013
				KR	20100103857	A	28 September 2010
				EP	2245885	A1	03 November 2010
				CN	102017714	A	13 April 2011
				US	2012155376	A1	21 June 2012
				EP	2571317	A1	20 March 2013
				WO	2009092155	A1	30 July 2009