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(54) **Title**: A METHOD AND A SYSTEM FOR A WIRELESS LINK OPTIMIZATION AND A USE THEREOF FOR TRANSMISSION POWER AND INTERFERENCE REDUCTION

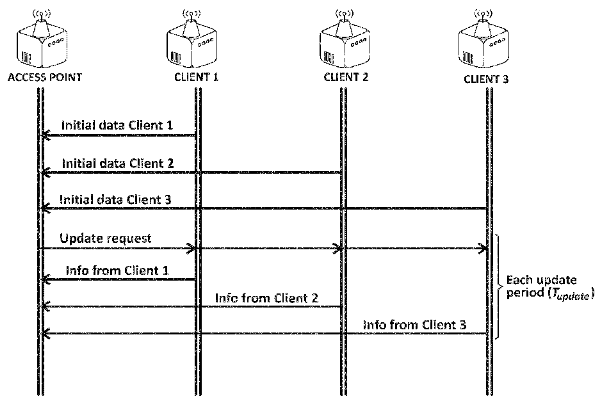

FIG. 1

(57) **Abstract**: The method comprising: an access point for establishing wireless communication with a plurality of wireless client devices, any of said wireless client devices connected to said access point through a dedicated wireless link, said method comprising the steps of: collecting information related to transmission features of any of said wireless client devices of operative communication status and adapting and prioritizing said dedicated wireless link, in order to perform said wireless link optimization, based on said transmission features collected from any of the wireless client devices. The system of the invention is adapted to implement the method of the invention. The use of the method of the invention for transmission power and interference reduction.

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A method and a system for a wireless link optimization and a use thereof for transmission power and interference reduction

Field of the art

The present invention generally relates, in a first aspect, to a method for a wireless link optimization, and more particularly to a method for distributing high rates of data effectively within said link.

A second aspect of the invention relates to a wireless link optimization deployment system for allowing the distribution of high rates of data and adapted for implementing the method of the first aspect.

A third aspect of the invention refers to a use of the method of the first aspect for transmission power and interference reduction.

Prior State of the Art

Nowadays, the increase of bandwidth demanded by suppliers of digital content on the Internet and the increase on customers who subscribe to them, has led to the change in interconnectivity access technologies within the user's premises, which has allowed increasing high access speeds. Distributing such high data rates effectively within the home is a challenge for future home networks that must be faced up, as well as allowing multiple users to wirelessly access to shared resources ensuring high quality of service and reliable communications throughout the home.

Customers with Fiber access or Digital subscriber Line (DSL) with additional services (HDTV, IPTV, High Data Rate services...) are demanding High Data Rate physical connectivity in the place where DSL router connection point is and also throughout the home. Wireless systems may play an important role in this challenge and specifically technologies based on the 802.11n standard WiFi could be candidates to cope with these needs. However there are a number of factors, associated with Radio Frequency (RF) technologies, which makes optimization processes necessary to define the links that are able to carry this type of communications and to guarantee that the wireless connectivity is done in an efficient manner, using all the bandwidth promised in the standards.

Wireless links can introduce a bottleneck in the process of distributing High Data Rate services within the home; new access services based on fiber to the home (FTTH) connectivity provide average throughputs above 50Mbps on user's CPE, a speed which is difficult to maintain using wireless connectivity throughout the home. The communication over a wireless channel is simply not able to achieve the same quality (throughput, error rate, etc.) as a wired channel, which reduces the quality of the multimedia services delivered. Some of the factors that make wireless communications particularly problematic for transmitting real time services like VoIP or video-streaming, as well as High Data Rate (HDR) services, are the continuous variable channel link conditions and the limited radio frequency spectrum which must be shared by in house clients. The continuous change on the wireless channel conditions causes signal fading, throughput variations and loss of packets, in addition to this, wireless communication causes the multiple users attempting to access on the same channel at the same time to generate interference in the medium and degrade the link performance.

Former WiFi home networks was composed by traditional computer equipment (PC and associated devices), but a growing range of consumer electronics such as smart phones, cameras, televisions, gaming consoles, own media players and devices of external digital content providers have being included. Most of these devices need high data rate communications features, on which are included real-time communications, Video-streaming or Voice over IP services. According to the different forecasts about the IP traffic through Internet, there is a high tendency to video communications, even more to HD video. This trend is happening in wired and wireless networks. If this trend is combined with the continuous traffic growth from wireless devices, it is clear that providing QoS for video traffic over wireless devices is mandatory.

For achieving High Data Rate links, high modulations rates are needed, for demodulating without errors high modulation rates a good SNR is mandatory, and for achieving a good SNR on reception, a low losses link without interference is required. According to this, the technical issues involved on the reducing of quality on wireless links, related to channel radio sharing and interference problems entail degradation on wireless link performances, making it difficult to transmit several streams with High Data Rate services at the same time, sharing the Access Point (AP) and assuring Quality of Service (QoS) and throughput on clients.

One of the most important issues that must be addressed regarding improvement on Wireless Link is how to avoid the harmful interference between network neighbor devices and also how adapt the radio emitter to environmental conditions at any time.

The current state of the art on 802.11 focuses on link optimization can be covered in different sections below.

IEEE Standard:

Different methods and algorithms have been developed on IEEE 802.11 Standards for allowing the RF channel sharing: CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), DCF (Distributed Control Function) and more lately the controlled access for guarantee QoS (IEEE 802.11e) over WiFi links.

IEEE 802.11 WLAN uses a media access control protocol called Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA). While the name is similar to Ethernet Carrier Sense Multiple Access with Collision Detection (CSMA/CD), the operating concept is totally different. WiFi systems are half duplex shared media configurations where all stations transmit and receive on the same radio channel. The main problem in a shared radio system is that a station cannot hear while it is sending, and hence it is impossible to detect a collision. Because of this, the developers of the 802.11 specifications developed a collision avoidance mechanism called the Distributed Control Function (DCF). According to DCF, a WiFi station will transmit only if it thinks the channel is clear. All transmissions are acknowledged, so if a station does not receive an acknowledgement, it assumes a collision occurred and retries after a random waiting interval. But DCF does not take into account the delay-sensitive nature of real-time based services (such as Video-streaming, VoIP) [7]

In order to enhance legacy IEEE 802.11 MAC channel sharing and the High Data Rate communication involving VoIP and video-streaming services over 802.11, the IEEE 802.11e [1] amendment of standard defines HCF (hybrid coordination function) which includes the two operating modes, either of which can be used to improve services, WiFi Multimedia Extensions (WME) and WiFi Scheduled Multimedia (WSM):

- WiFi Multimedia Extensions (WME) uses a protocol called Enhanced Multimedia Distributed Control Access (EDCA or EDFC), which is an enhanced version of the Distributed Control Function (DCF) defined in the original 802.11 MAC. EDCA is based on QoS prioritization specified on IEEE 802.1D; the enhanced part is that EDCA will define eight levels of access priority to the shared wireless channel. Like the original DCF, the EDCA access is a contention-based protocol that employs a set of waiting intervals and back-off timers designed to avoid collisions. However, with DCF, all stations use the same values and hence have the same priority for transmitting on the channel. With EDCA, each of the different access priorities is assigned a different range of waiting intervals and back-off counters. Transmissions with higher access priority are assigned shorter intervals. The standard also includes a packet-bursting mode that allows an AP or a mobile station to reserve the channel and send 3- to 5-packets in sequence. But the extension of DCF (EDCA) is not effective on supporting delay sensitive traffic (Video-streaming or VoIP) and it doesn’t work with traffic or services which are not identified on access protocol.

- WiFi Scheduled Multimedia (WSM) is an improvement for communicating real time transmission based services over IEEE 802.11. It uses a protocol called HCCA [4] (HCF coordinated channel access). WSM operates like the little used Point Control Function (PCF) defined with the original 802.11 MAC. In WSM, the AP periodically broadcasts a control message that forces all stations to treat the channel as busy and not attempt to transmit. During that period, the AP polls each station that is defined for time sensitive service. To use the HCCA option, devices must first send a traffic profile describing bandwidth, latency, and jitter requirements. If the AP does not have sufficient resources to meet the traffic profile, it will return a busy signal. As well as the PCF performances, this improved implementation has not been considered by any 802.11n device manufacturers.

More in detail, HCCA [5] is generally considered the most advanced and complex coordination function. With the HCCA, QoS can be configured with precision, QoS enabled stations can request specific transmission parameters (data rate, jitter…) which should allow advanced applications like VoIP or video-streaming to work more effectively on WLAN. But, as HCCA is not supported by any WLAN manufacturer, it is necessary that any other equivalent method should be implemented if users want to have reliable services with good QoS performances independent of the delivery service.

There are some groups within those who are defining the wireless standards focused on this QoS provisioning. But all of them are using IP traffic identification as the main factor to implement the QoS rules. This means that the traffic is prioritized depending on the type of data traffic that it is being transmitted, like voice, video, internet downloads, best-effort. So, if the video traffic is not marked as video traffic, and it is, for instance, when video is transmitted using UDP traffic, then all these QoS implementations are not valid. On the other way, in this example the methods based on QoS rules works even worse than without applying QoS because any other traffic identified according to the types of traffic on QoS rules is going to be prioritized to the target UDP traffic.

Methodologies that cover individual control algorithms based on protocols:

In this group the most important approaches are related to video streaming over 802.11 networks. There are some theoretical approach proposed such as [2] on which authors describe a solution for adapting the digital codification of video transmission signal over the IEEE 802.11 wireless channel taking into account the radio channel characteristics (basically SNR) in order to guarantee a good quality on the video transmission. It establishes communication architecture for video-streaming over 802.11 that it is capable of adapting the video Codification to dynamic changes in the wireless link quality.

Other solutions like [3] are based on algorithms for transmitting more than 2 video-streaming at the same time, the maximum allowed video-streaming defined on HCCA by 802.11e QoS. The method proposes an allocation on Traffic Stream Index for each video flow. The method can support up to 15 video streams, each is individually treated. In this case, the described simulations shows that method works properly for transmitting several video-streaming, but it does not consider any dynamic channel surveillance implementation or any method for improving or solving the possible communication problems between AP and its associated Stations.

A good approach is to use measurements of the link conditions, as it is proposed again in [2]. The SNR is directly related to the throughput and the bit error rate (BER) on the wireless link. Consequently, the SNR is linked to the packet delay and jitter, and throughput, and has the potential to provide rich feedback for automatic rate control. Knowing the current SNR and the throughputs would solve the modulation rate selection problem instantly.

Methodologies that include channel frequency control:

There are some methods related to channel optimization based on channel parameters monitoring and a later channel change. In general, they describe methods for determining when a channel frequency change should be made based on some parameters measured on AP or Stations, including a description of the algorithms for executing the channel change; in some cases being compliant with DFS mandatory specification.

Some of those methods for channel frequency management are mentioned bellow:

- On Patent US 2005/0060319 it is described a set of client parameters control on the Wireless AP in order to manage the roaming and communication change for associated Clients between different APs.

This patent is not focused on offering a reliable wireless channel link for the different Stations connected to the same AP. In this case the parameter managing is in order to achieve a reliable wireless roaming between different APs.

- In addition to this, patents US7512379, US7864744, US7606193 and US2007/0238417 are related to channel change and its performance selection mechanisms, which sometimes include automatic transmitted power adjustments.
- On patent US8036167 it is described a multiple local Area network for reliable video Streaming, using different WLAN cards in order to have multiple video streaming.

Device Manufacturers solutions:

It can be included here the most important approaches developed by manufacturers, which in general are based on 802.11n but they are devices manufacturer dependent solutions, and not interoperable with any other wireless devices.

- Smart Wi-Fi. Under this name are collected four different solutions associated with Ruckus manufacturer devices, like BeamFlex (control resistant and adaptable of RF) Qos proprietary solution (SmartCast), security mechanisms (SmartSec) and RF routing mechanisms ("Smart-Mesh" networks).
- Signal-Sustain Technology (SST) employs several techniques to enhance the rate-over-range of the WLAN signal, including Low Density Parity Check (LDPC), Maximum Likelihood Demodulation (MLD) for MIMO demodulation, beamforming transmit signals techniques and Maximal Ratio Combining to optimally combine the MIMO signal path. Also it can be included a special technique chip Qualcom-Atheros based (VOW). All these techniques are associated with Qualcomm-Atheros manufacturer devices.
- Channel state information (CSI): a channel monitoring and optimization proprietary based techniques associated with Quantenna devices.
- OptimizAIR: based on the concept of “Spatial Channel Awareness” closed-loop transmission. This method is a Celeno manufacturer patent pending technology.

Problems with existing solutions:

IEEE Standard:

IEEE 802.11e Medium Access Control (MAC) standard, on its advanced method (HCCA) for assuring QoS, performs a polling procedure with parameterized channel. However, a station may not always have pending data to transmit; so, polling all the stations may waste time and therefore deteriorate the transmission performance.

Wi-Fi Scheduled Multimedia (WSM), which developed HCCA functionality, has not been considered by any 802.11n device manufacturers.

The extension of DCF (EDCA) is not effective on supporting delay sensitive traffic (Video-streaming or VoIP) and it doesn’t work with traffic or services which are not identified on access protocol.

Besides, it must be taken in account that in a video streaming link, it is difficult to estimate the bandwidth needed to transfer because the rate per frame of compressed video data fluctuate widely depending on its content and encoding scheme. The latter makes that the set a priori estimates the reserved bandwidth and other parameters defined in the standard, which can increase the delay and the jitter, thus eventually degrade the quality of service. The fluctuation is also combined with the variability on the radio channel.

Methodologies that cover individual control algorithms based on protocols:

In relation to the proposal in [2], it has being mentioned that it is SNR measurement based. But, despite the advantages, SNR-based rate control has not been applied in practice yet because of the following problems:

a. The rate and SNR could be variable, this is because of the radio channel fluctuations and it is not easy to obtain or estimate a reliable value of the SNR on a wireless link.

b. On 802.11n, many radio interfaces only provide a signal strength indication (SSI) without any reference value and for an optimum calculation of the rate controller, which is on the sending side, in fact the SNR observed at the receiving side is needed. For instance, a high SSI does not mean high SNR.

c. Actually, 802.11n devices do not calculate the SNR on the client side from AP, and neither the transmitted data rate per wireless client, which makes it difficult to estimate the channel quality on real time communications.

The associated problems related to video transmission conditions and QoS make a continuous channel monitoring (i.e. SNR) applying policies necessary, in order to guarantee the carried services performance (services like HD video-streaming); that is because the channel conditions are dynamic, it is necessary to guarantee the channel conditions and bandwidth during all the life time on which a specific service is carried over the wireless link.

Methodologies that include channel control and channel jump:

All of the mentioned solutions on previous section are based on the IP traffic identification to implement the QoS over the wireless traffic, which do not always work. For instance, when the service protocol is not identified on the transmission (HD video-streaming over http) it is not possible to apply the QoS defined on IEEE 802.11e.

Those solutions that change the transmission features depending on the physical medium conditions are not based on associated Client requirements. They do not take into account the performance of the transmission features, static transmission features and dynamic transmission features that need to be updated continuously.

Although there are many patents related to how to improve wireless link status based on channel scanning and latter change, as well as power adjusting mechanisms, there are no current wireless solutions that take into account the dynamic channel quality changes without providing solutions for maintaining the link QoS.

When a wireless link is interfered or a low QoS is detected, tools for taking the appropriate actions must be implemented. The present invention copes with this issue taking into account the requirements of the associated Clients.

They do not consider client service parameters; they do not establish an especial management process or entity or even methods for achieving High data rate services or real-time services.

Device Manufacturers solutions:

All solutions presented before are based on properties associated with specific physical devices that do not allow its extension to other systems easily, which prevents their application in heterogeneous networks from different vendors. Moreover, the vast majority is trying to solve specific problems of transmission, as video communication, and may not be useful in other applications or services.

The main problems with the existing solutions are that all the prioritization work made on QoS mechanisms is based on the IP traffic identification. But traffic carried by wireless devices is not always identified. In addition to this, this classification is fixed and independent of the current client needs, so QoS mechanisms specified on standards are insufficient.

Summary of the Invention

It is necessary to offer an alternative to the state of the art which covers the gaps found therein, particularly those related to the lack of proposals which allow the delivery of real-time services like VoIP or Video-streaming or High Data Rate services, over different clients.

To that end, the present invention relates, in a first aspect, to a method for a wireless link optimization, comprising an access point for establishing wireless communication with a plurality of wireless client devices, any of said wireless client devices connected to said access point through a dedicated wireless link.

On contrary to the known proposals, the method of the first aspect comprises collecting information related to transmission features of any of said wireless client devices of operative communication status and adapting and prioritizing said dedicated wireless link, in order to perform said wireless link optimization, based on the performance of said transmission features collected from any of said wireless client devices.

The method performs said adapting and prioritizing dynamically in a real time continuous process by considering the continuous quality changes of said dedicated wireless link.

The method is preferably used for delivering real-time based services and/or high data rate services, such as a VoIP, a HD video, a video streaming or a combination thereof.

In a preferred embodiment, the transmission features are set at the start of the wireless link and are analyzed and compared with existing wireless link parameters.

The method is performed, automatically or manually, in order to ensure a high quality of service to any of the wireless client devices.

In a preferred embodiment the performance of the wireless link optimization is based on the wireless client devices requirements, on a transmission performance and/or a physical medium.

When the method is manually performed by a client, the performance is done through a configuration interface running in a device with computing capacity.

According to the method, the wireless link optimization can be performed in the access point and in the wireless client devices.

A second aspect of the present invention, relates to a wireless link optimization deployment system, comprising:

- a plurality of wireless client devices to communicate with an access point; and

- said access point adapted to provide said wireless communication through a dedicated wireless link with any of said wireless client devices,

On contrary to the known proposals, the system of the second aspect performs an adaptation of said dedicated wireless link in order to perform said wireless link optimization based on information related to transmission features of any of said wireless client devices.

The system of the second aspect is adapted to implement the method of the first aspect.

Other embodiments of the system of the second aspect of the invention are described according to appended claims 14 and 15, and in a subsequent section related to the detailed description of several embodiments.

A third aspect of the present invention, relates to a use of the method of the first aspect for transmission power and interference reduction.

Brief Description of the Drawings

The previous and other advantages and features will be more fully understood from the following detailed description of embodiments, with reference to the attached, which must be considered in an illustrative and non-limiting manner, in which:

Figure 1 shows an example of the coordination protocol mechanism used in the present invention.

Figure 2 shows an example of the high level system diagram of the present invention.

Figure 3 shows a control bridge functions GUI, according to an embodiment of the present invention.

Figure 4 shows an example of the link control updating process diagram.

Figure 5 shows an example of the ‘Steering Bridge’ control unit functionality.

Figure 6 shows a block specification diagram used in the present invention.

Figure 7 shows a video streaming delivery, according to an embodiment of the present invention.

Figure 8 shows an example of a dynamic link changing embodiment, according to an embodiment of the present invention.

Figure 9 shows an example of several end customer services attached to the same WIFI client, according to an embodiment of the present invention.

Figure 10 shows an example of an internal wireless distribution embodiment, according to an embodiment of the present invention.

Detailed Description of Several Embodiments

The present invention proposes a method being an adaptation of the transmission features and prioritization rules by means of a parameters list updated in real time, on a dynamic process over the IEEE 802.11 wireless link.

Wireless AP would identify their streams quality and requirements needed in order to apply the correct parameter for managing the wireless link. For this reason, it's important that the Wi-Fi infrastructure offer some alternative ways for identifying streams that carry especial services like HD Video streaming or VoIP.

The adaptation, related to a special service deliver, depends on the client needs or requirements, on the transmission performance and on physical medium conditions.

Basically the method consists on a request from the Clients to the AP in which are included the parameters needed for making the wireless link to work properly. The AP takes those and other measured parameters and adapts the transmission features in order to provide the required QoS on the specific associated Client.

In addition to the described process of identifying the type of protocol used, the network should know at any moment what kind of wireless link is being used and its prioritization parameters.

The main objective of applying this new method is to deliver reliable Data Transfer services over wireless links in a multi-room scenario. The main goal can be achieved by providing the QoS needed on each wireless link and by optimizing the use of the radio spectrum and managing the data frames, prioritizing them, searching for the best radio channel or minimizing transmission power and interference.

The new defined method is located in the AP module that manages the interconnections of STAs (from now on the wireless associated clients on a BSSID), or in the bridge module if is work; the module that includes the features added by the invention is called ‘Steering Bridge’.

The invention is based on the establishment of an owner link between an AP, that assume the role of Master in the wireless link communication, and the other associated wireless Client devices, from now on they are also called Stations (STAs), with a Slave role. When a Client device is associated to an AP device, a communications socket link between the Master (AP) and the new Client is opened.

The mechanism defined on the invention for optimizing the wireless link is based on the interchange of messages between the master (AP) and slave (Client) WiFi devices.

The AP is the coordinator, the device in charge of managing the interchange of information between the AP and the STAs. The AP has a managing function which collects the initial parameters and the individual parameters measured from Clients. After receiving the information from each one of its associated Clients, the AP adapts the different wireless links properties according to the received and the required parameters for each associated Client link. Those parameters are used in order to optimize the wireless link per Client. The overall optimization process is focused on the wireless link per Client, generally based on each Client communication services requirements and their associated parameters.

Without precluding any other action related to the wireless parameters and their communication procedures between the Client and the AP, the process on which the link parameters between the Master device (AP) and any associated Slave device (wireless Client Station STA) are communicated has got the following steps:

- The Client keeps the best parameters for initially working. If the parameters affected need to change because a new communication service is open, the STAs know how to change them.
- The STAs also sends Prioritizations data values to the AP which it is associated. They send these initial data into the initial link packets, taking advantage of any free wireless data transmission time.
- The Client periodically sends, under a Master request, a report of QoS status in the current channel. Including a measurement of the radio medium conditions, parameters such as SNR, RSSI, received power, transmitted power, modulation scheme, packets retries, percentage of maximum channel occupancy or any other parameter related to the wireless link quality.
- The Client performs a continuous scanning process in order to have an updated list of available RF channels conditions from the Client location point of view. The results of the scanning are saved on table files. In case of channel interference, the STAs will communicate the information about the wireless channels to the AP in order to make a smart channel switch.
- The server (AP) parses the report received including the information parameters from Clients and performs the expected change in each one of the wireless links configuration parameters. For instance, between the actions that can be taken it can be included a switch to a new radio channel if it is needed

because of the interference link status or an adjustment on the radio transmission power send to the Client.

The process performance include the analysis and comparison with existing wireless link parameters, the comparison with the threshold parameters values defined for guarantying a specific communication service over the wireless link, and per client packet analysis and radio channel features managing.

All the new functionalities related to the achievement of a reliable wireless link, based on client requirements are developed on a new module, which is called 'Steering Bridge.

The wireless link establishment between the AP and STAs and the information management process in the AP requires the installation of specific dedicated modules in the AP and STAs.

The AP control module has the core algorithm of the described invention. The Client module allows an effective and optimal parameters communication procedure in the wireless link.

In some embodiment the described modules can be on both, associated Clients and AP, in another embodiment the modules can be only on the AP, managing the related parameters by the provided GUI. The AP, according to the measurements of the wireless link state per STA, takes the decisions about the wireless link parameters configuration.

In other embodiments, the method described on the invention could work in networks without the Client module installed.

The process performances include functionalities like analysis of the information and requirements received from STAs. If the invention module is not on the STAs the AP collects and manages the wireless link information.

The wireless link parameters communicated between the AP and STAs and vice versa, are set at the start of the link. There is a process of prioritization and maximum bandwidth. Afterwards, some parameters can change dynamically according to the measurements of the wireless link QoS. These parameters are obtained on both, the AP and the STAs, if the STAs have being provided with the invention control module.

Wireless parameters values and information requires the interaction with the WiFi standards in order to obtain data and to manage the parameters o from the associated interface modules.

All the associated operations are performed on the called 'Steering Bridge' module. There are two cases described:

- Examining the process described in the invention by considering both the client and the AP have the modules for active communication control.
- Describing the process if the module is only present on the AP. As heterogeneous networks in which the AP has the control link optimization for clients with an active control process.

STAs parameters information and updating Process:

Initially there is a coordination process on which the initial parameters of each one of the STAs are communicated to the AP. The coordination protocol is schematically shown in Figure 1.

A scheduled time called 'Tupdate' is defined. Every prefix time (TUPDATE) the AP requests to the Client an updating process of its parameters measurements. The Client or Clients, in case that there were more than one associated Station, send the updated information and afterwards the AP updates and adapts the wireless link according to the parameters received from each Client.

The method described on the invention defines an automatic mechanism on which the AP can set the wireless links options and parameters by default. It can be set also on manual configuration. In case of doing it manually it is done through a configuration interface described on the invention that is described below on Figure 3. The manual performance mechanism is established in order to not reject STAs devices without the automatic described invention mechanism or STAs devices which have the described invention functionality disabled.

Initial Client configuration:

Each STA, with the method described on invention enabled, should send its own configuration with all the parameters, including the action that must be done on the wireless link optimization process.

Following lines include an example of this kind of configuration. The first line includes STA identification (client_id), that could be its ip-addres o mac-address, and the following lines include different parameter related to the wireless link performance.

Without precluding any other parameter not included bellow, the list of communicated parameters could be something like that::

client ***client_id***

- *Bandwidth min 10Kb max 100Kbs //Bandwidth need*
- *SNR min 10 max 20*

- *Associated*
  - *Signal Power jump 2 dB*
  - *Packet size 100 B*
- *RSSI min -80 max -50*
  - *Associated*
    - *Signal Power jump 5 dB*
- *Channel jump, Yes*
- *Frame burst 0*
- *Priority 1 // maximum priority level*
- *Latency 0 //minimum latency*
- *Link-symmetry Downlink/Uplink //direction AP->Cl1*
- *Favorite Channel 52*

Description of the communicated parameters:

Bandwidth: Include the maximum and minimum Bandwidth need to optimize the wireless link.

SNR: Signal to Noise thresholds maximum and minimum to modify the associated AP parameter. The parameters to change can be the transmitted Power, Packet Size, modulation codification and the frequency channel change when this threshold is exceeded.

RSSI: Received Signal Strength Indication. Maximum and minimum to modify the associated AP parameter, in this case Signal Power and the channel change jump when this threshold is exceeded.

Channel jump: Enables the possibility of making changes in frequency or channel when it exceeds the limits set.

Frame burst: Enable the possibility of send several frames in burst mode according to the standard.

Priority: Kernel process priority interface related. Maximum 1, Minimum 5

Latency: Related to previous parameter.

Link-symmetry: Indicates whether or not that link is going to be mainly in one direction AP->CL (downlink) or CL->AP (uplink). Valid value: Downlink, Uplink, Downlink/Uplink.

Favorite Channel: Indicates best channel in the client's environment.

This parameter set can be easily adapted to include as much parameters as can be related to the wireless link performances. There are parameters that must be differentiated, such as prioritization, for different devices linked through the LAN interface to the associated WIFI STAs. The parameters will be something like that:

Priority <MAC_lan associated_1> 1

Priority <MAC_lan associated_1> 1

From AP point of view, it is needed to establish the level of prioritization based on the final destination address of the packet.

The format parameters are shown as an approximation description. The communication mechanisms of these parameters must be adapted according to the chosen communication protocol and does not affect the method developed in the invention.

AP Module. ‘Steering Bridge’:

This module extends the concept of standard Media Access Control Bridge which allows the interconnection of Stations (Clients) as if they were attached to a single LAN, even if they are attached to separate LANs each of them having its own independent MAC.

Inside the defined ‘Steering Bridge’ block, every data-packet that passes through the AP to associated Client can be managed into the wireless link, configuring the different parameters associated to each one of Clients wireless links.

As it has being mentioned in the previous paragraph the procedure implementation requires the introduction of algorithm modules inside the stack architecture and packet managed unit in the AP core. This module can be a part of the stack implemented in the WiFi devices core system. Such implementation does not require any modification into the wireless chip-set devices currently available. The Figure 2 shows a high level system block diagram.

It can be distinguished three main functional blocks (sub-modules) within the new ‘Steering Bridge’ module:

- The Commands Control, It has the default parameters values defined for an associated AP-STAs link and the parameters values received from the associated Clients in case that the link would have been able to be established.. It also allows different actions for configuring the parameters values through a web user interface environment.
- The main block. It is the master block. It is responsible for filtering packets sent by the associated STAs and for associating the appropriate parameters depending on the settings defined for each AP-Client Association requirements.
- The Link Control Update. In this block are performed functions related to the exchange of information from each one of the STAs to the AP. It opens the communication channel and initially asks for knowing the configuration and

required link parameters of each associated client. It processes this initial values sent by the Clients and makes the request for new values of measures in each defined period in order to have a dynamic control of the wireless performance.

Command control Bridge functions and interfaces:

This Command control bridge sub-module is responsible for managing the configuration information of the actions on each one of the links related to the system and focused on each of the clients associated.

Figure 3 shows a possible configuration interface in a web-page example description. Describing a particular case of 3 Clients associated in order to show the different parameters and values managed in this block.

The initial group ('Create Sbridge') includes the definitions of standard configuration for a normal Bridge and it doesn't need more extended details.

The second group ('Assign Interface Group') includes particular references needed for the defined procedure. It defines the interface to which the described optimization procedure is going to be applied.

The 'Wifi Interface Control' group contains the main parameters values related to the procedure. In the first column, appears the MAC of the associated client (Slaves Identification link), in the second column the data received in the last report submitted by the STAs when the procedure is supported by the associated wireless client device. The third and fourth contains the proceedings or related functions which are changed in a particular associated customer's link, and finally, the last column presents the initial values of these parameters.

If the STA does not implement the procedures described on the invention (it does not have the control module Clients installed or enabled) some data in this group can be defined manually by the WLAN customer. Those data are associated with the parameters obtained in the AP directly from the wireless link, which usually are related to each one of the STA's wireless link. For example, parameters like data-rate and number of retries per STA link.

WIFI Link Control:

This Link Control sub-module executes the coordination protocol between AP and associated Clients. A scheduled time called 'Tupdate' is defined. Every prefix time (Tupdate) the AP requests to STAs an updating of their parameters measurements. The Client or Clients, in case that there were more than one associated Station, send the updated information and afterwards the AP updates and adapts the link parameters received from each Client. According to these new parameters values, actions on wireless link will be taken or not.

This block also collects information accessible from the AP on the different links to different clients, so when the Clients have no mechanism enabled, the control can be executed based on these defined QoS parameters.

There is a mechanism on which the AP can set the wireless links options and parameters by default or by manually configuration. In case of doing it manually it is done through a configuration interface that is described below. The manual mechanism is established in order to not reject STAs devices without the described invention automatic procedure or STA devices which have the described invention functionality disabled.

This module has several functions into the AP:

- It Open a communications link and control the flow with associated STAs, if the STA is ready for the communication process.
- Collect AP local measured QoS related with each one of the associated STA.
- Ask for a measurement report update on every scheduled time both, on local and STA
- Sent the result of parameter measurements from STAs to AP.
- Scanning and maintaining a database of adjacent channels status (only the top 3 are updated) in AP and STAs

The figure 4 shows a schematics diagram of its functionality in both sides, one for the procedure into the Client unit and other for the link control module for the AP.

Control Unit. Steering Bridge:

The main component of this method procedure is the Control Unit functionality.

The Control Unit sub-module scans packets coming for other interface link identifying those traveling to the same Clients, assigning priorities and parameters associated with all the different wireless links corresponding to the different associated Clients.

There are two parallel processes executed and working inside this sub-module:

- First process runs a MAC bridge according to the standard described in [6], packages received in the wired LAN interface (LAN Frame reception), are analyzed, separating those that go to each of the clients associated with the AP (WFI Link control) and easily each plot according to the destination indicated in the same, that is the MAC Bridge oriented sub block in figure 5.

- The second process, named Link Control sub-block, verifies the state of the transmission WiFi channel. Every time a package is sent, this process, in accordance with the priority, latency and bandwidth assigned to the client (client transmission parameter), selects the appropriate channel configuration according to the calculated parameters in the control process of the wireless link status. Described in Figure 4 is shown the flowchart where each one of the processes are clearly marked up. The flow started with the LAN frame reception, following with the WIFI packet identification and destination queuing frame manage, and finally the specific Client transmission parameters are added.

There are differences with the standard MAC bridge defined on 802.11D. One difference is the separation of communication packets according to the destination end STA instead of grouping them by type of service. Another difference is the application of the parameters values, managed in the invention in the wireless link optimization for sending each data packet set to each of the STAs.

Figure 5 shows the process carried out on the main control unit of the ‘Steering Bridge’. Figure 6 depicts a block specification, in order to clarify the process included in the invention.

The environment on which the method and procedure may offer an improvement in the optimization of the link radio, is one on which an AP is attached to a services provider access line carrying high-capacity data transmission and it is responsible of distributing this service into a group of STAs located in an indoor environment, as for example a home network.

In a typical and generic embodiment of the invention, an AP distributes different services and user contents to several STAs located within the home through a Wireless Link. There are different types of services provided, each of them with its features, peculiarities and requirements. But the different types of services do not necessarily have to share the same link quality requirements. For example different video bandwidth is needed whether the video is sent to an HDTV or it is sent to a Smartphone, although the type of protocol could be the same.

One of the more important things about the procedure described on this invention is that the optimization is client focused and it is not transport protocol dependent. Data streams can use a lower loaded protocol like UDP without being affected by the prioritization process defined on WiFi Specifications. UDP throughput would be 15-20 percent higher than TCP because there is less protocol overhead associated with UDP compared to the associated overhead on TCP.

Based on this client orientation four typical embodiment cases can be distinguished. On every one of the embodiments the use of the procedure would optimize the link.

- The first one is described as an indoor WiFi environment for delivering a Web-TV service or video on demand, on which the quality of the service should be optimized on each one of the associated Clients.
- The second one described a dynamically changing customer profile, working on the same environment on which there are the same protocols in use.
- The third one is when there are several end customer services attached to same WiFi STA in order to show end customer level of prioritization.
- The forth is focused on a delivering Wireless Internal services within the wireless stations, and at the same time this services are shared with the external services provider.

Video-streaming indoor WiFi embodiment: In this embodiment, there is an On Demand Video Server or a TV web server located on an indoor wireless network. The TV signal is distributed through a wireless link to different associated Clients. In addition to that, there are other lower priority services, such as web browsing or VoIP conference that are sharing the wireless link system with the TV distribution services.

Before the web-tv or video on demand Client connects to the server, it needs to send to the WiFi-AP its working requirements and configuration. The Client configuration will allow the WiFi AP to have the information for managing the wireless link with the associated Client. This will provide a good overview of the service.

As an example and without precluding any other variables or parameters, the associated Clients parameters and requirements list are shown: *Client client1*

- *Bandwidth min 4Mb max 10Mbs //Bandwidth need*
- *SNR min 10 max 20*

- *Associated*
    - *Signal Power jump 2 dB*
    - *Packet size 100 B*
- *RSSI min -80 max -50*
    - *Assocciated*
        - *Signal Power jump 5 dB*
- *Channel jump, Yes*
- *Frame burst 2*
- *Priority 1 // maximun priority level*
- *Latency 0 //minimin latency*
- *Link-symmetry Downlink   //direction AP->Cl1*
- *Favorite Channel 52*

The most interesting thing included in this method is that the TV web server does not need to use a high loaded protocol like RTP for transmitting Video signals (RTP is a protocol that is defined on WiFi and can be easily prioritized) and in addition to that, TV transmissions can be received in different network elements using a very easy configuration and without cumbersome settings.

The rest of WiFi associated equipment (Data Clients) must be configured through GUI interface or using its default settings. In any case, the procedure should maintain the prioritization and optimization from the 'Steering Bridge'.

The associated problems related to video transmission QoS and conditions are that it is needed a continuous channel monitoring (i.e. SNR) applying policies in order to guarantee the carried services performance (services like HD video-streaming); that is because the channel conditions are dynamic, it is necessary to guarantee the channel conditions and bandwidth during all the life time on which a specific service is carried over the wireless link. That could be solved with the present invention in such described embodiment.

Dynamically changing connection type embodiment: In this embodiment one VoIP Client node is connected to the AP running 802.11 protocols. Due to VoIP, both uplink and downlink flows are performed through the AP. In this scenario there are bidirectional flows constantly present in the system which consume a portion of the wireless link capacity.

It can be showed with this type of embodiment how it is possible to maintain wireless communication throughout the time when communication is performed with a protocol determined as VoIP using dynamics configurations set of parameters as presented in this invention.

In this scenario, when the VoIP STA is joined to the WLAN, it sends to the AP a configuration set of typical parameters taking into account the kind of link services (VoIP) and the normal requirements of its wireless link:

client client1

- *bandwidth min 10Kb max 100Kbs //Bandwidth need*
- *SNR min 10 max 20*
- *Associated*
  - *Signal Power jump 2 dB*
  - *Packet size 100 B*
- *RSSI min -80 max -50*
  - *Associated*
    - *Signal Power jump 5 dB*
- *Channel jump, Yes*
- *Frame burst 0*
- *Priority 1 // maximum priority level*
- *Latency 0 //minimum latency*
- *Link-symmetry Downlink/Uplink //direction AP->Cl1*
- *Favorite Channel 52*

In this type of situations the most important thing is the AP knows the initial requirements of bandwidth and prioritization in both directions, from AP to Client and the other way round, from Client to AP.

But the situation can be better defined if it is known exactly the type of communication that it is provided using the wireless link communication channel.

For instance, when the associated Client is a User attending a Conference, during the conference presentation, the traffic is concentrated from AP to STA wireless direction (AP->STA), but on the conference questions time, the traffic prioritization should be changed. On the other way round, when the client is a web conference attendant, during the time of delivery of the talk it is needed to prioritize traffic in the direction of STA-> AP and at the time of a question, it could be switched to a full prioritization wireless channel. A traffic prioritization process should be developed on both links in order to maintain the wireless traffic quality.

These dynamic change connection settings can be easily managed by sending to the AP the new configuration set of parameters or the change on the initial configuration parameters from the STA changing Link-symmetry parameter, which allows to optimize and to prioritize dynamically the wireless link.

With the present invention it is possible to maintain wireless communication throughout the time when communication is performed with a protocol determined as VoIP.

Several end customer services attached to same WIFI Client: In this embodiment one WIFI Client node is connected to the AP running 802.11 protocols and the WiFi Client has several end customer services linked by a LAN connection. This is a good example of application of the procedure on which a single transmission channel based on the 802.11 standard must differ according to an external connection, and must be prioritized and optimized on the communication of each of the end customers.

Figure 10 shows, of a schematic form, the embodiment described. There is an on-demand TV service generated from an external server that must go through the 802.11-based link to the end client and shared the same WiFi link with a PC or any data services end user.

In this scenario, the initial set of parameters sent by the WIFI client to AP has to change to differentiate between the needs of the end connected devices partners, each of them identified by their ip-address or MAC.

The initial list of parameter communicated will be:

client client_wifi

- *Bandwidth min 10Kb max 100Kbs // the sum of the two endpoints associated*
- *SNR min 10 max 20 // related with more critical link == TV-end*
- *Associated*
    - *Signal Power jump 2 dB*
    - *Packet size 100 B*
- *RSSI min -80 max -50 // related with more critical link == TV-end*
    - *Associated*
        - *Signal Power jump 5 dB*
- *Channel jump, Yes*
- *Frame burst 0*
- *Priority MAC1 1 // maximum priority level*
- *Priority MAC2 5// minimum priority level*
- *Latency MAC1 0 //minimum latency*
- *Link-symmetry MAC1 Downlink //AP-CL*
- *Link-symmetry MAC2 Downlink/Uplink //both*
- *Favorite Channel 52*

As it is depicted on Figure 10, MAC 1 and MAC 2 are the MAC address of the 2 devices (end – clients) connected to the STA. AP must differentiate the services to the end points knowing their MAC address. From AP point of view, need to establish the level of prioritization, latency and symmetry based on the final destination address of the packets (MAC1 or MAC2). This feature clearly differentiates the procedure current optimization process and allows for flexible adaptation to heterogeneous environments.

Delivering Wireless Internal services Embodiment: In another embodiment, there is an AP connected to the fixed line service provider, which has more than 1 wireless devices connected. In this case, there is a possible scenario where the AP is the common node of an internal data communication process that has been established internally between two or more of their wireless associated Clients.

Figure 11 shows the architecture of this embodiment. The AP is the common node, connected to the LAN and which has several wireless clients associated. There is a direct communication between two or more associated Clients. One of the associated Clients will act as, for instance, media HDTV server and the other ones will be the internal receivers of the HDTV media services. In this scenario there is an independent from external connections service, distributed within the wireless environment. So, there is a need of prioritize the connections between the wireless Client which takes the role of ‘media Server’ and the associated clients which have the role of ‘media Clients’.

As it happens on other embodiments, in addition to the internal Media services distribution, there can be other lower priority services coming from the common LAN AP connectivity, such as web browsing.

In addition to that, in another scenario, there can be higher priority services coming from the LAN connection as for example HDTV distribution or VoIP conference. In every case the LAN co-existing services are sharing the wireless link system with the internal wireless Media TV distribution services and the prioritization scenario and parameters should be taken into account.

The prioritization is made on the AP steering bridge, it depends on the LAN external connection service whether the internal TV distribution has lower or higher priority.

In case of HDTV distribution and VoIP service provider, the LAN services will have always higher priority than the internal wireless Media distribution services.

If there is no currently HDTV or VoIP coming from the external services provider running on the AP, the internal TV distribution services can be higher prioritized on the ‘Steering bridge’ by the user, the user can configure its AP in order to have a reliable internal Media-TV wireless distribution network.

For instance, in this scenario, when the HDTV associated Client starts a communication with its external web on demand service it sends to the AP a configuration set of parameters taking into account the kind of link services (HDTV) and the normal requirements of its wireless link. If, at that moment, an internal wireless Distribution service is switched on by the user, on which one internal client acts as server and another as internal Client, both, the uplink from the internal server to the AP traffic and downlink from the AP to the internal Client traffic should be prioritized.

Below are showed some parameters send by internal wireless Client acting as internal server, with prioritization lower than external server clients:

client client1

- *Bandwidth min 10Kb max 100Kbs //Bandwidth need*
- *SNR min 10 max 20*
- *Associated*
    - *Signal Power jump 2 dB*
    - *Packet size 100 B*
- *RSSI min -80 max -50*
    - *Associated*
        - *Signal Power jump 5 dB*
- *Channel jump, Yes*
- *Frame burst 0*
- *Priority 2 // No maximum priority level*
- *Latency 0 //minimum latency*
- *Link-symmetry Uplink //direction CL->AP*
- *Favorite Channel 52*

The Parameters on wireless client acting as internal services wireless distribution client: In this case the prioritization is the same, (always lower than the external services), but the link-symmetry changes to Downlink (AP->Client).

Advantages of the Invention:

The AP is allowed to know dynamically what are the best environment and parameters in order to optimize the wireless link; everything is done and based on the associated Client requirements knowledge, independently of the transmission protocol used.

The proposed method takes into account the specific wireless client device requirements or the physical medium conditions and the initial client configuration for special services. For instance, in a wireless communication, it is not the same a client for receiving HDTV images than a smart phone for accessing to the internet.

One of the proposed solutions in the present invention is a method for estimating dynamically the SNR from the STAs point of view; the invention includes a procedure for transmitting the SNR measured on associated Client to the AP in order to improve the channel characteristics. It also includes procedure for calculating directly in AP the transmission rate per client in order to know exactly the wireless link situation.

The maintenance of QoS parameters per client is achieved. Knowing the client characteristics and requirements for guaranteeing its QoS it is possible to adapt the wireless link in order to be more efficient and to achieve the most reliable possible wireless link, taking into account the dynamic channel quality changes. When a wireless link is interfered or a low QoS is detected, tools for taking the appropriate actions must be implemented. The invention copes with this issue taking into account the requirements of the associated clients.

The method copes with the WiFi transmitting problems for high data rate and real-time based services through the utilization of a managing entity on the wireless AP with different sets of channel access parameters in order to differentiate the services on the wireless clients connectAPed to the AP and sharing the wireless media. Services such as premium content, real-time services, stored media services or low priority content services should be transported over the dynamic wireless channel but offering a reliable wireless link based on the clients prioritization parameters.

A good service should offer tiered QoS for gradual degradation, because of the dynamic wireless channel adaptation. The invention solves the above issues and is made in order to guarantee QoS on 802.11 links when there are several clients connected on the same network (BSS).

Some extra advantages associated to the use of invention procedure are:

- Better use of the medium within the 802.11n standard's possibilities (managing the wireless link dynamically in a continuous process)
- The reception of channel status periodically is a proactive action to help improve the link quality quickly.
- Identification of traffic client's requirements
- Transmission parameters adjusted to the traffic by final client signalling
- The optimization is client focused and not protocol dependent.
- Data stream can use a lower loaded protocol like UDP without affected prioritization process. Generally, UDP throughput will be 15-20 percent higher than TCP because there is less protocol overhead associated with UDP.
- "Dynamically best channel" selection. Dynamic process on which the wireless link is always on the less interfered RF channel.
- Transmit power control mitigate co-existence interference and increase capacity and also reduce energy consumption.

- Manufactured independent: It could be install easily on any platform.

ACRONYMS

AP	Access Point
CPE	Customer Premise Equipment
CSI	Channel State Information
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
DCF	Distributed Control Function
DSL	Digital subscriber Line
EDCA	Enhanced Multimedia Distributed Control Access
EDFC	Enhanced Multimedia Distributed Function Control
FTTH	Fiber To The Home
HCCA	HCF Coordinated Channel Access
HCF	Hybrid Coordination Function
HDTV	High Definition Television
IP	Internet Protocol
IPTV	Internet Protocol based Television
LAN	Local Area Network
LDPC	Low Density Parity Check
MAC	Media Access Control
MLD	Maximum Likelihood Demodulation
MIMO	Multiple Input Multiple Output
PC	Personal Computer
PCF	Point Control Function
QoS	Quality Of Service
RF	Radio Frequency
RSSI	Received Signal Strength Indication
SNR	Signal-to-Noise Ratio
SSI	Signal Strength Indication
SST	Signal Sustain Technology
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VoIP	Voice over Internet Protocol
VoWLAN	Voice over Wireless LAN
WIFI	Wireless Fidelity (IEEE 802.11)
WME	Wi-Fi Multimedia Extension

WSM Wi-Fi Scheduled Multimedia

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Claims

1. A method for a wireless link optimization, comprising an access point for establishing wireless communication with a plurality of wireless client devices, any of said wireless client devices connected to said access point through a dedicated wireless link, said method being **characterized** in that it further comprises collecting information related to transmission features of any of said wireless client devices of operative communication status and adapting and prioritizing said dedicated wireless link, in order to perform said wireless link optimization, based on the performance of said transmission features collected from any of said wireless client devices.

2. A method according to claim 1, comprising performing said adapting and prioritizing dynamically in a real time continuous process by considering the continuous quality changes of said dedicated wireless link.

3. A method according to claim 2, wherein said transmission features are set at the start of the wireless link.

4. A method according to claim 3, comprising analyzing and comparing said transmission features with existing wireless link parameters.

5. A method according to any of previous claims, wherein said wireless link optimization is done in order to ensure a high quality of service to any of said wireless client devices.

6. A method according to claim 1, further comprising performing said wireless link optimization based on any of said wireless client devices requirements, on a transmission performance and/or a physical medium.

7. A method according to claim 6, comprising performing said wireless link optimization automatically.

8. A method according to claim 6, comprising performing said wireless link optimization manually by a client.

9. A method according to claim 8, wherein said manually optimization performance is done through a configuration interface running in a device with computing capacity.

10. A method according to claim 1, characterized in that it comprises performing said wireless link optimization in said access point.

11. A method according to claim 10, characterized in that it further comprises performing said wireless link optimization in said plurality of wireless client devices.

12.- A method according to claim 1, comprising delivering real-time based services and/or high data rate services, such as a VoIP, a HD video, a video streaming or a combination thereof.

13. A wireless link optimization deployment system, said system comprising:

- a plurality of wireless client devices to communicate with an access point; and
- said access point adapted to provide said wireless communication through a dedicated wireless link with any of said wireless client devices,

wherein said system is **characterized** in that it comprises perform an adaptation of said dedicated wireless link in order to perform said wireless link optimization based on information related to transmission features of any of said wireless client devices.

14. A system according to claim 13, wherein said wireless link optimization is performed in said access point.

15. A system according to claim 14, wherein said wireless link optimization is performed in any of said wireless client devices.

16. Use of a method as per any of claims 1 to 12 for transmission power and interference reduction.

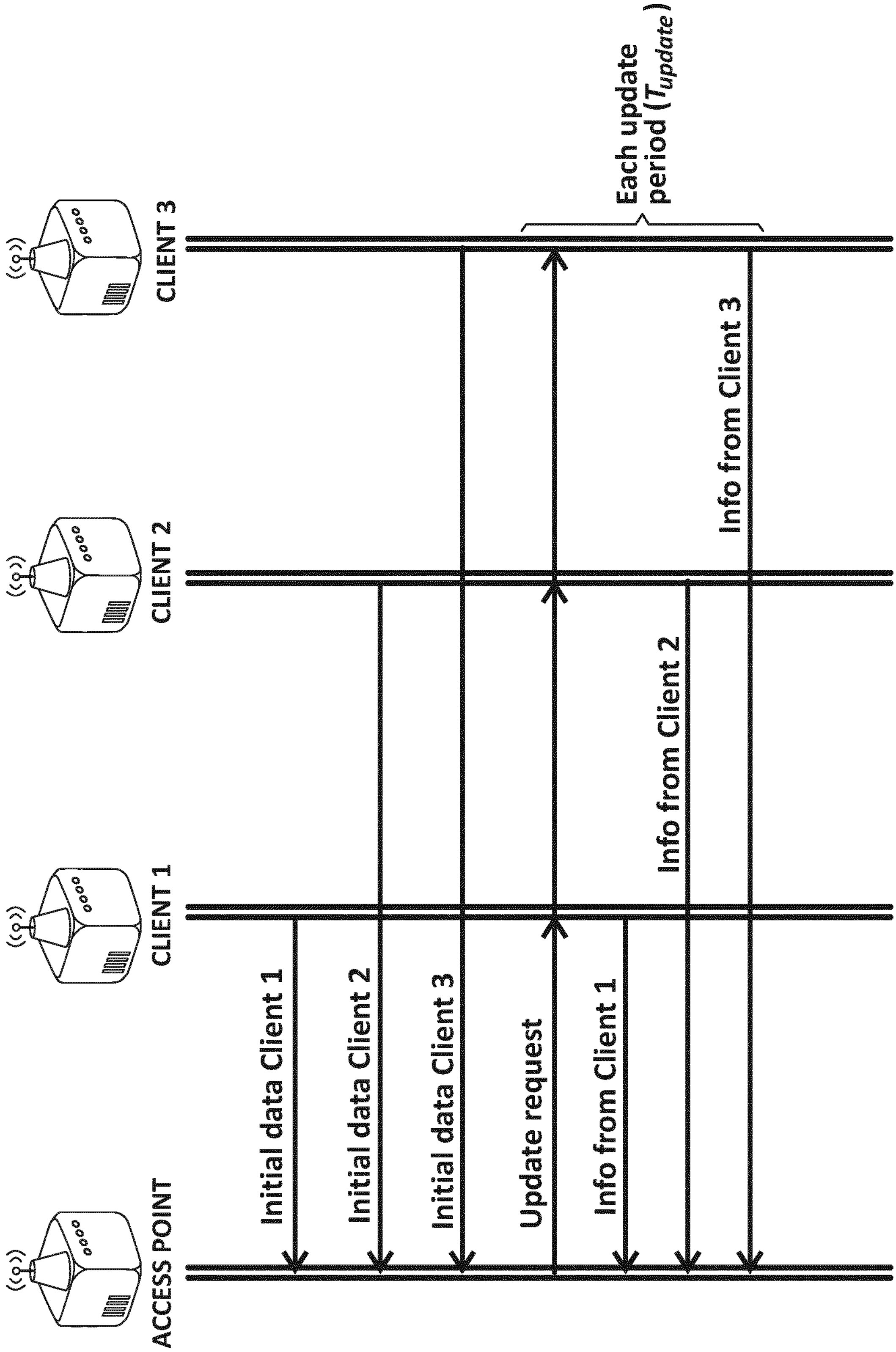

ACCESS POINT
CLIENT 1
CLIENT 2
CLIENT 3
Initial data Client 1
Initial data Client 2
Initial data Client 3
Update request
Info from Client 1
Info from Client 2
Info from Client 3
Each update period (T_{update})

FIG. 1

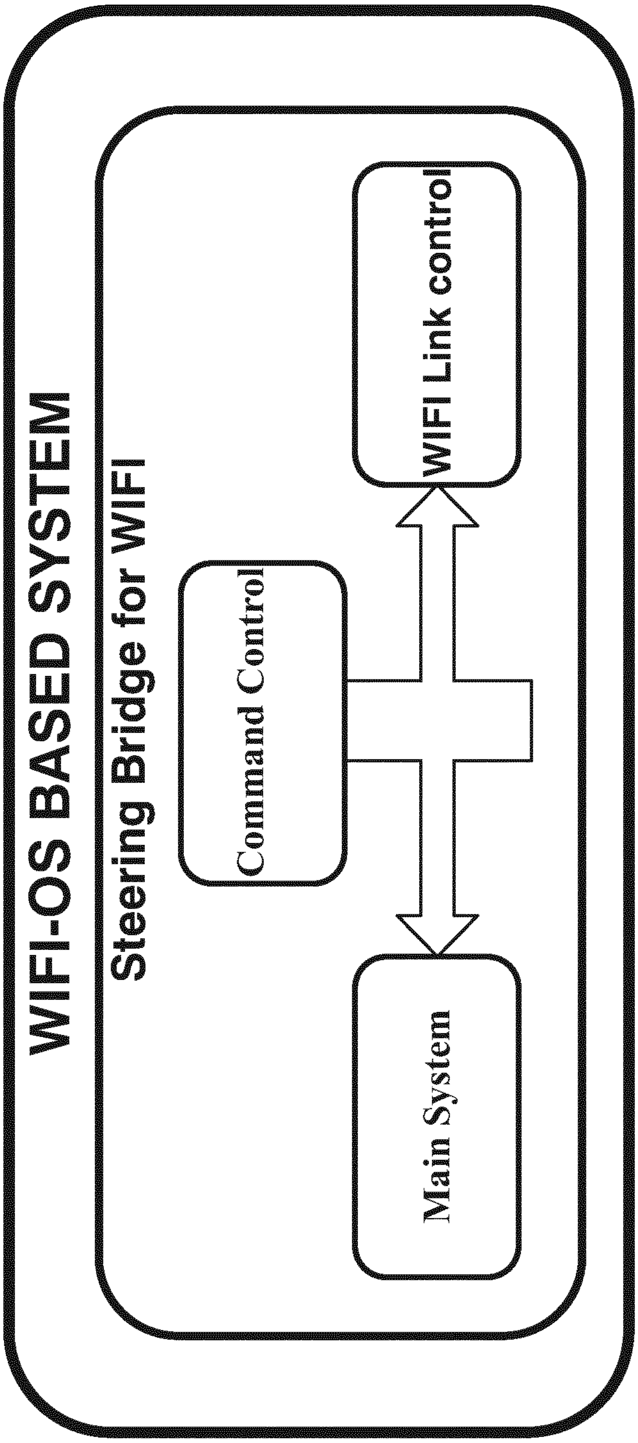

WIFI-OS BASED SYSTEM
Steering Bridge for WIFI
Command Control
WIFI Link control
Main System

FIG. 2

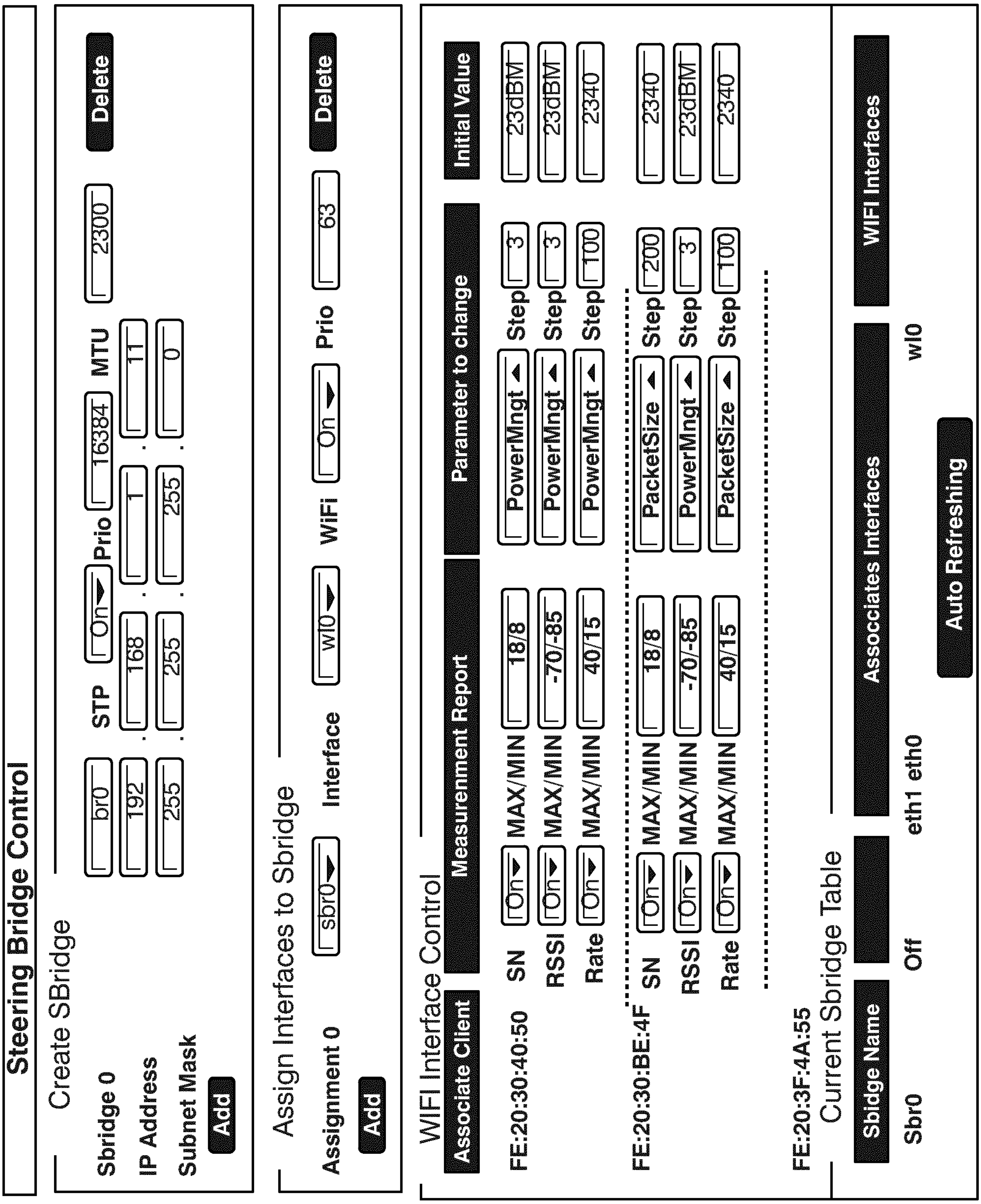

Steering Bridge Control
Create SBridge
Sbridge 0
br0
STP
On
Prio
16384
MTU
2300
Delete
IP Address
192 . 168 . 1 . 11
Subnet Mask
255 . 255 . 255 . 0
Add
Assign Interfaces to Sbridge
Assignment 0
sbr0
Interface
wl0
WiFi
On
Prio
63
Delete
Add
WIFI Interface Control
Associate Client
Measurement Report
Parameter to change
Initial Value
FE:20:30:40:50
SN On MAX/MIN 18/8 PowerMngt Step 3 23dBM
RSSI On MAX/MIN -70/-85 PowerMngt Step 3 23dBM
Rate On MAX/MIN 40/15 PowerMngt Step 100 2340
FE:20:30:BE:4F
SN On MAX/MIN 18/8 PacketSize Step 200 2340
RSSI On MAX/MIN -70/-85 PowerMngt Step 3 23dBM
Rate On MAX/MIN 40/15 PacketSize Step 100 2340
FE:20:3F:4A:55
Current Sbridge Table
Sbidge Name
Associates Interfaces
WIFI Interfaces
Sbr0
Off
eth1 eth0
wl0
Auto Refreshing

FIG. 3

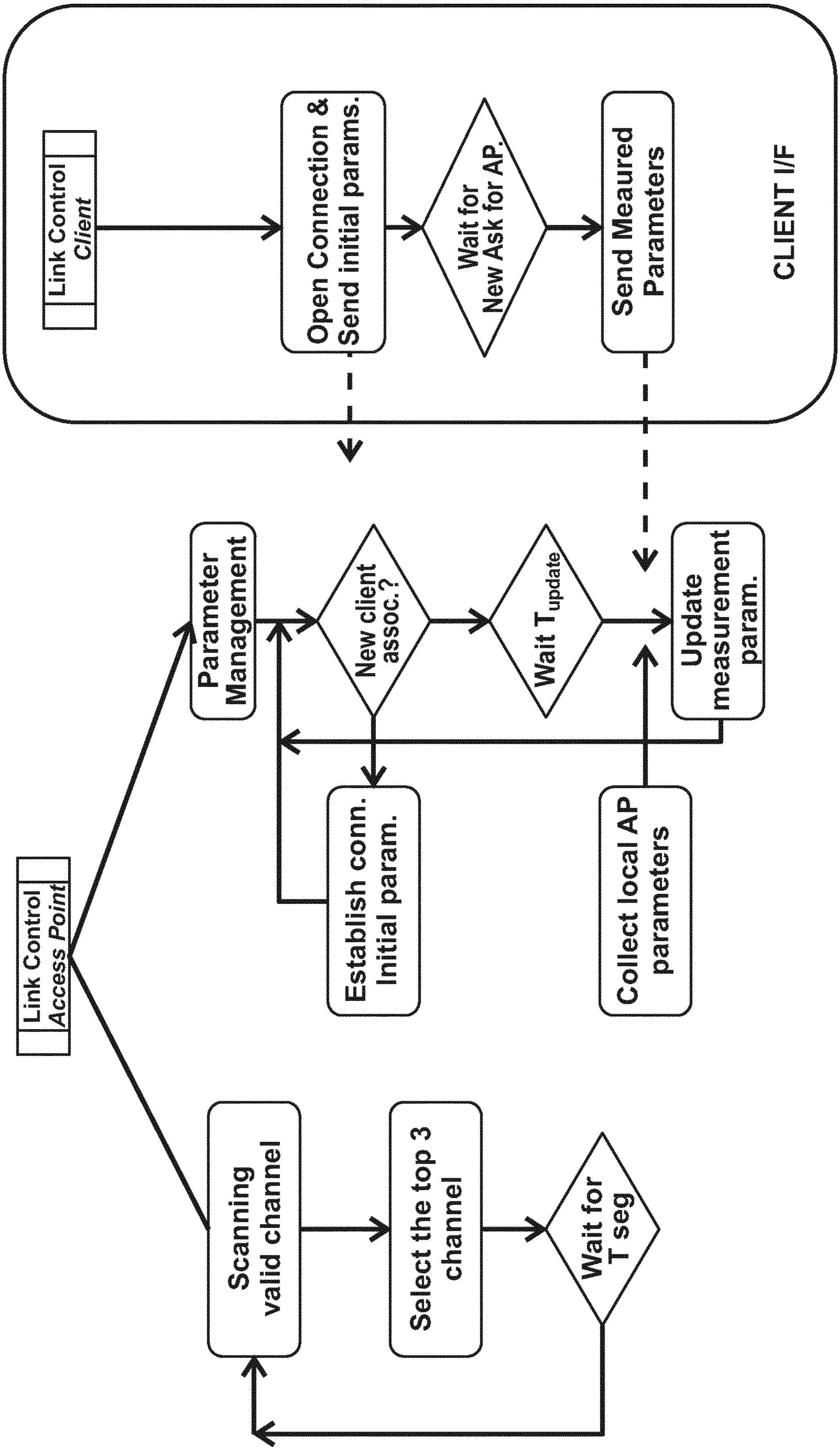

Link Control
Client
Open Connection &
Send initial params.
Wait for
New Ask for AP.
Send Meaured
Parameters
CLIENT I/F
Link Control
Access Point
Parameter
Management
New client
assoc.?
Wait T update
Update
measurement
param.
Establish conn.
Initial param.
Collect local AP
parameters
Scanning
valid channel
Select the top 3
channel
Wait for
T seg

FIG. 4

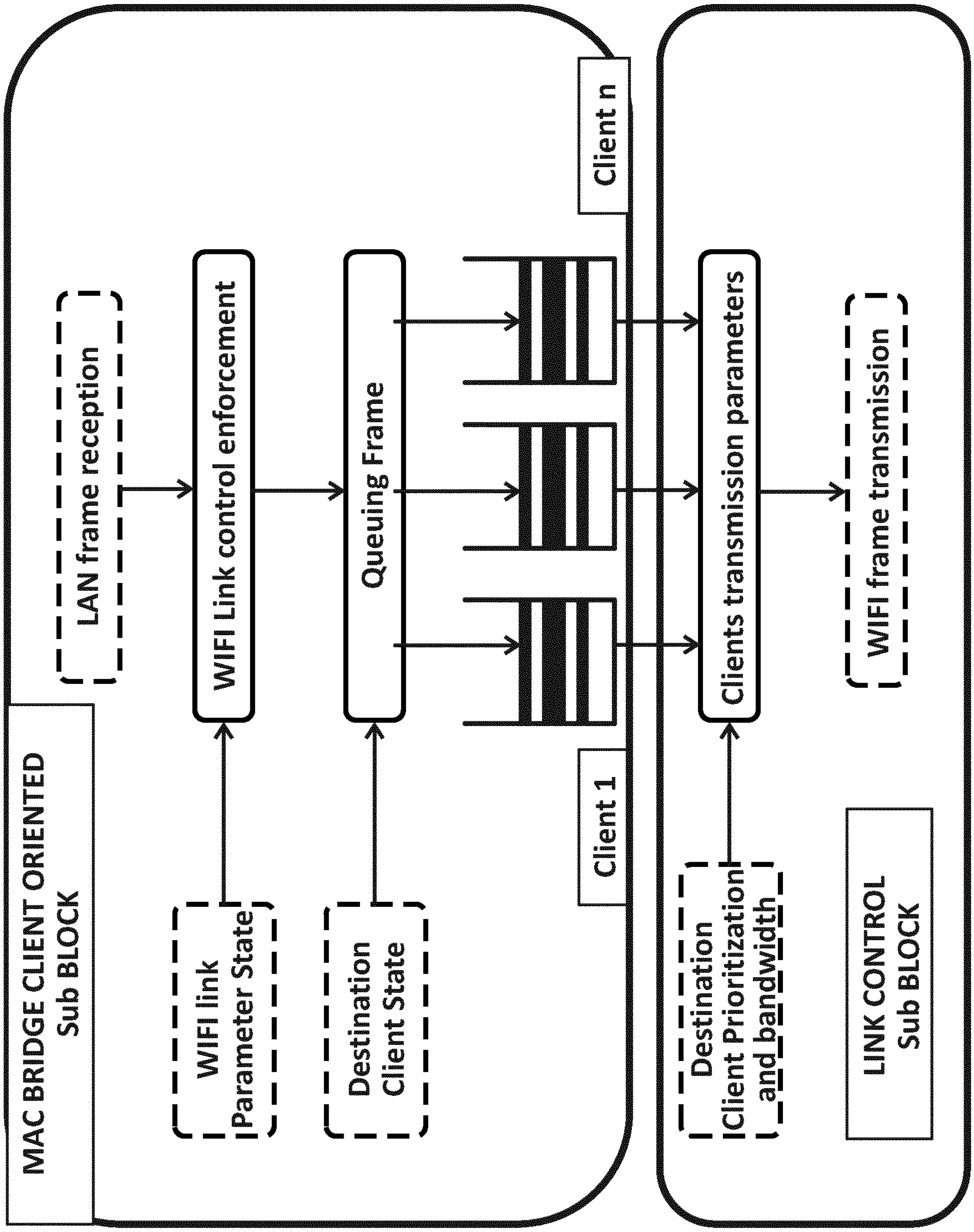

MAC BRIDGE CLIENT ORIENTED
Sub BLOCK
LAN frame reception
WIFI Link control enforcement
WIFI link
Parameter State
Queuing Frame
Destination
Client State
Client 1
Client n
Clients transmission parameters
Destination
Client Prioritization
and bandwidth
WIFI frame transmission
LINK CONTROL
Sub BLOCK

FIG. 5

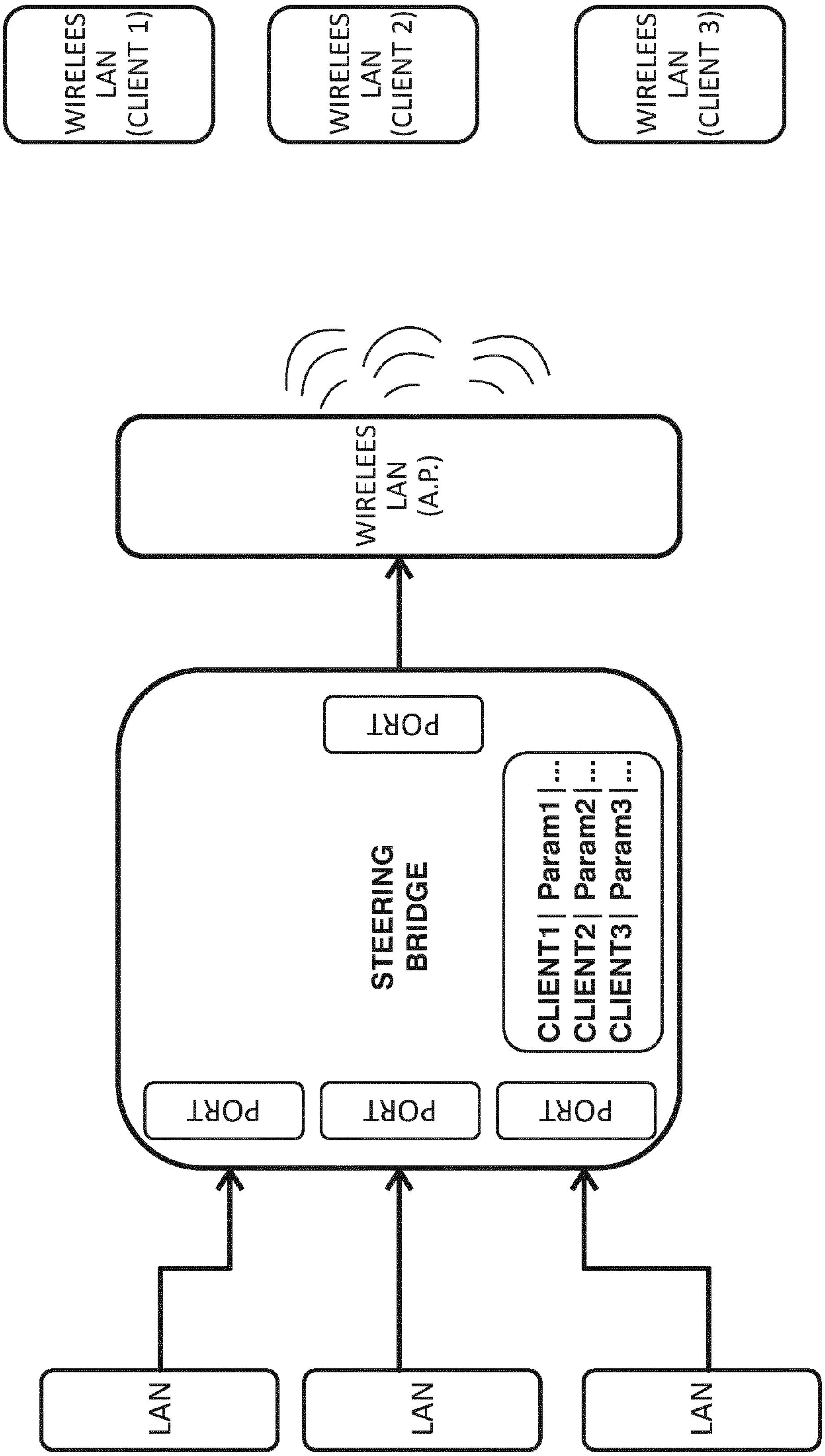

WIRELEES
LAN
(CLIENT 1)
WIRELEES
LAN
(CLIENT 2)
WIRELEES
LAN
(CLIENT 3)
WIRELEES
LAN
(A.P.)
PORT
STEERING
BRIDGE
CLIENT1 | Param1 | ...
CLIENT2 | Param2 | ...
CLIENT3 | Param3 | ...
PORT
PORT
PORT
LAN
LAN
LAN

FIG. 6

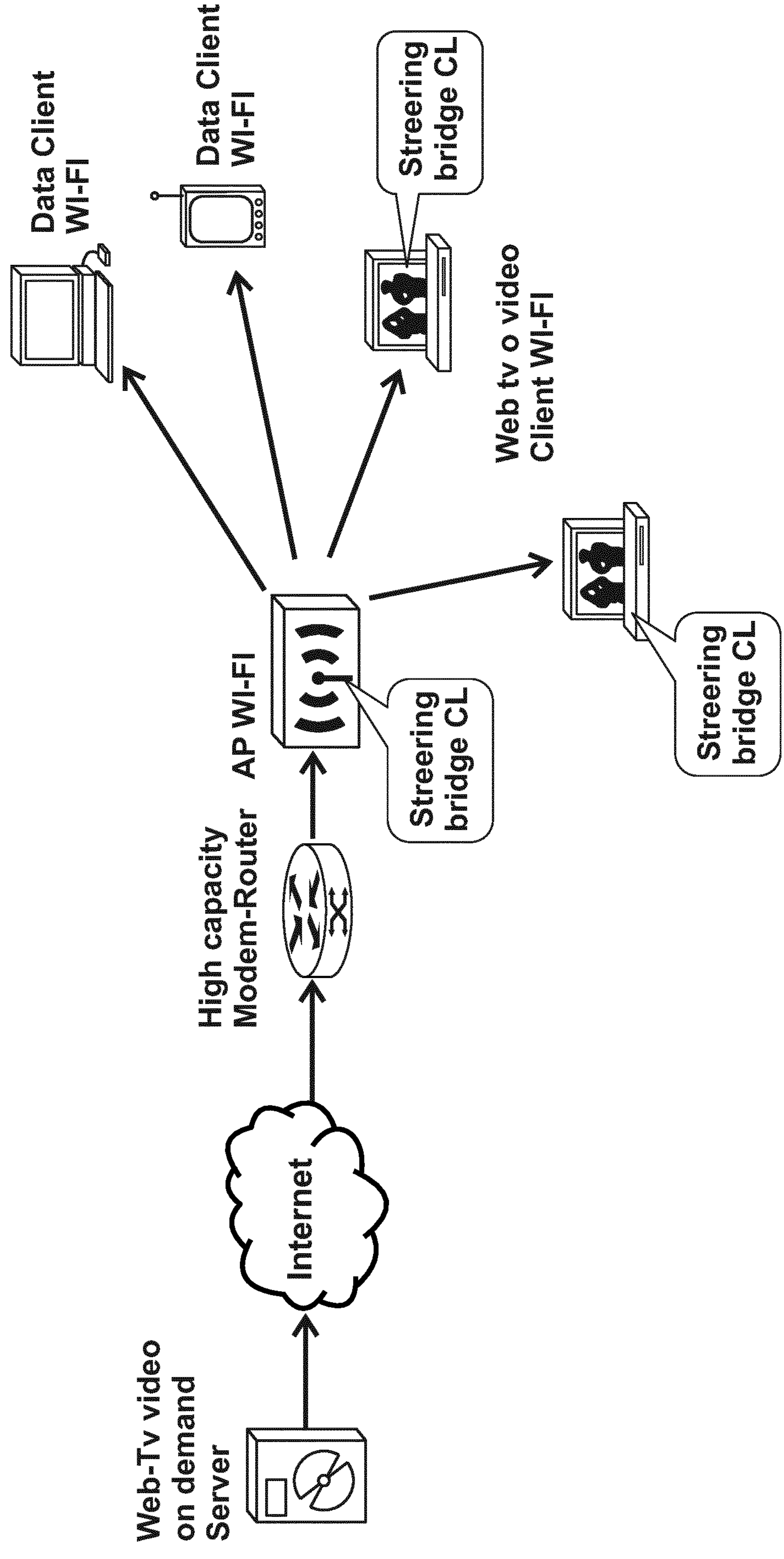

Web-Tv video
on demand
Server
Internet
High capacity
Modem-Router
AP WI-FI
Streering
bridge CL
Data Client
WI-FI
Data Client
WI-FI
Streering
bridge CL
Web tv o video
Client WI-FI
Streering
bridge CL

FIG. 7

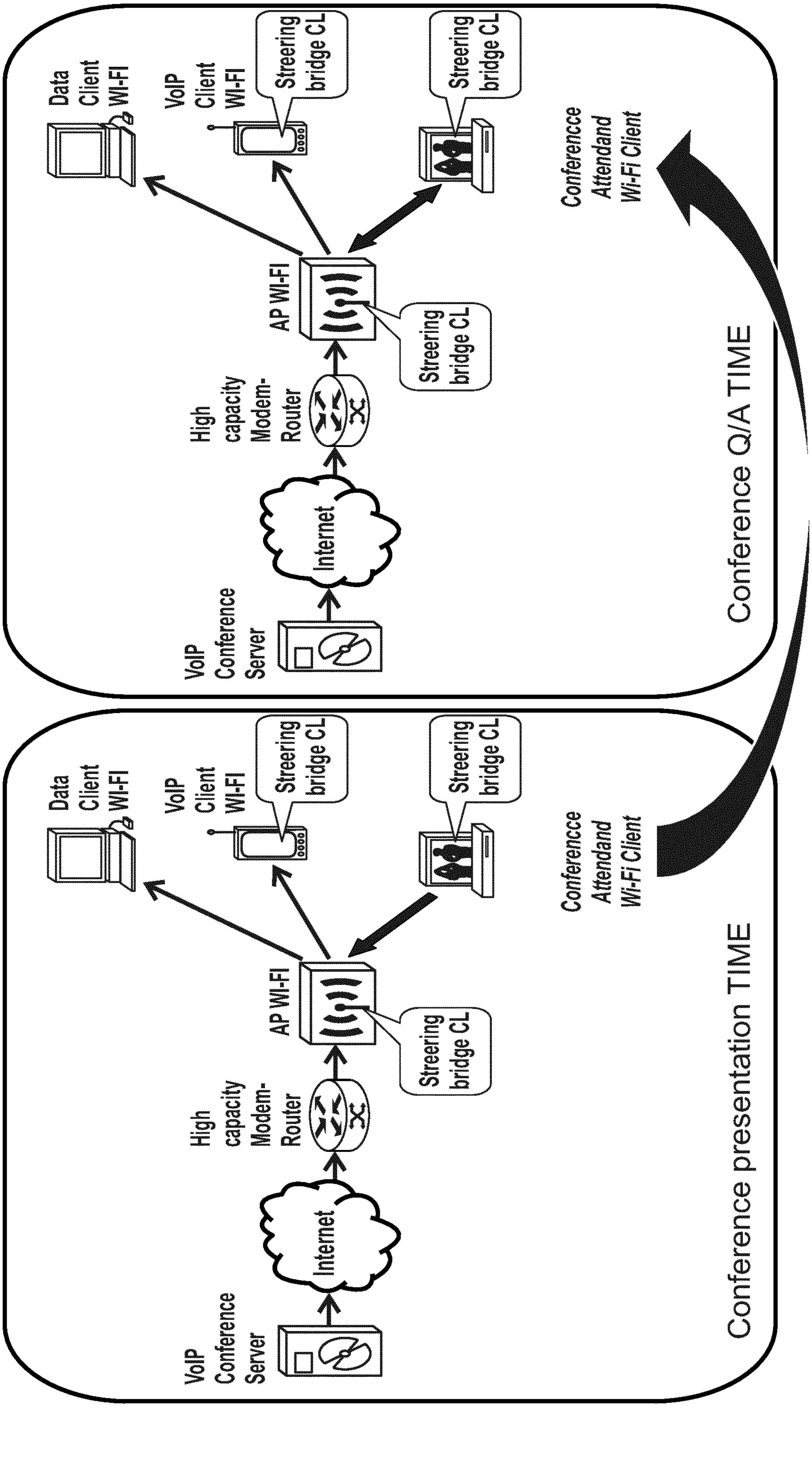

VoIP Conference Server
Internet
High capacity Modem-Router
AP WI-FI
Streering bridge CL
Data Client WI-FI
VoIP Client WI-FI
Streering bridge CL
Streering bridge CL
Conferencce Attendand Wi-Fi Client
Conference presentation TIME
VoIP Conference Server
Internet
High capacity Modem-Router
AP WI-FI
Streering bridge CL
Data Client WI-FI
VoIP Client WI-FI
Streering bridge CL
Streering bridge CL
Conferencce Attendand Wi-Fi Client
Conference Q/A TIME

FIG. 8

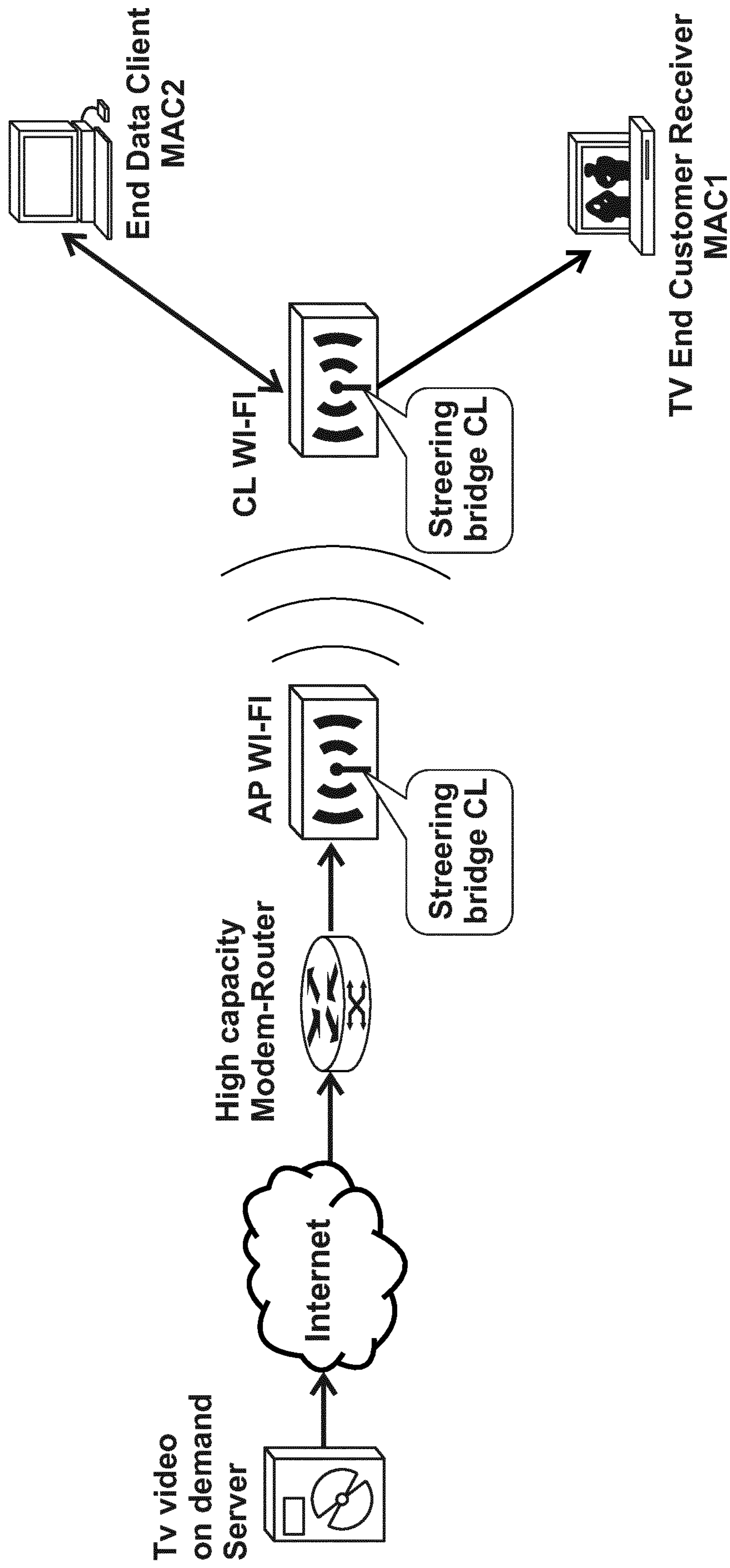
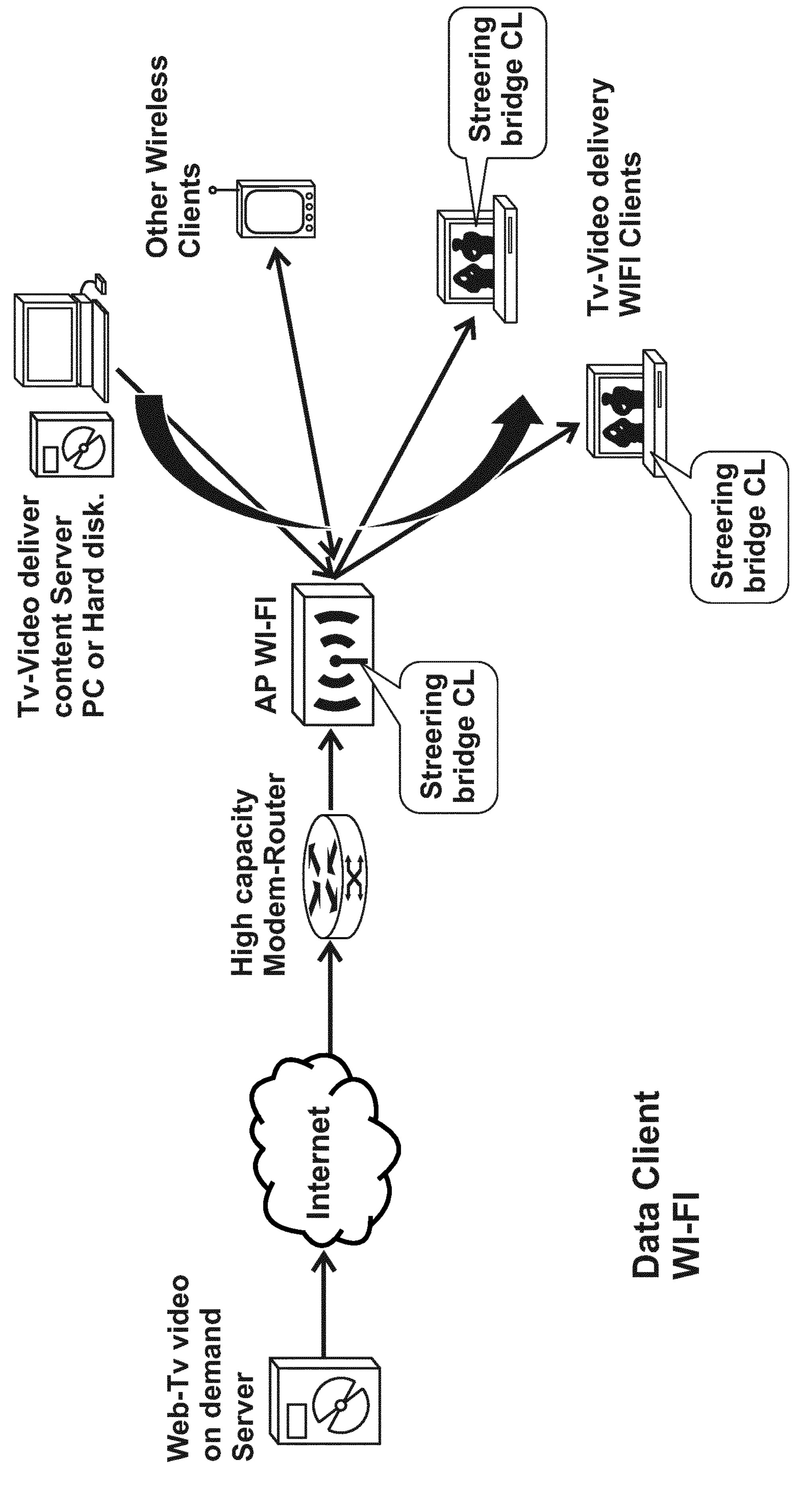

Tv video
on demand
Server
Internet
High capacity
Modem-Router
AP WI-FI
Streering
bridge CL
CL WI-FI
Streering
bridge CL
End Data Client
MAC2
TV End Customer Receiver
MAC1

FIG. 9



Web-Tv video on demand Server
Internet
High capacity Modem-Router
AP WI-FI
Streering bridge CL
Tv-Video deliver content Server PC or Hard disk.
Other Wireless Clients
Streering bridge CL
Tv-Video delivery WIFI Clients
Streering bridge CL
Data Client WI-FI

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/059837

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/12
ADD.

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

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/253332 A1 (FAWAZ AYMAN [US] ET AL) 1 November 2007 (2007-11-01)	1,13,16
Y	paragraphs [0022], [0024], [0028], [0029] paragraphs [0030] - [0034] paragraphs [0010] - [0012] -----	2-12,14, 15
Y	WO 2008/016885 A2 (QUALCOMM INC [US]; CATOVIC AMER [US]; RAUBER PETER H [US]) 7 February 2008 (2008-02-07)	2-12,14, 15
A	paragraphs [0007] - [0010], [0021] - [0024] -----	1,13,16
A	US 2009/161540 A1 (ZAKI MAGED [US] ET AL) 25 June 2009 (2009-06-25) paragraphs [0010] - [0013] -----	1-16

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

☒ See patent family annex.

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"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
19 September 2013	26/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mele, Marco

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2013/059837

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