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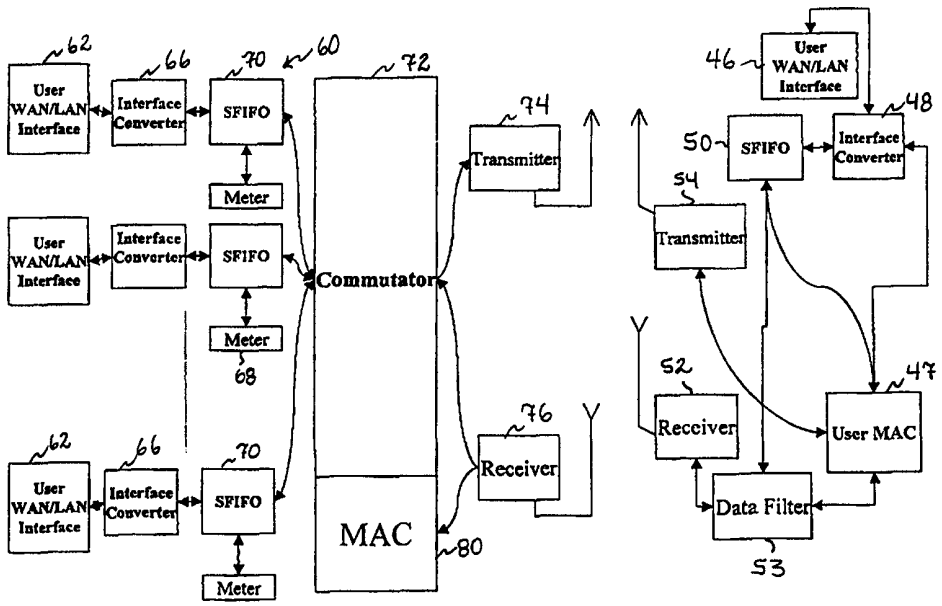
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(57) Abstract

A wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the system including a plurality of interface converters in the base station, each associated with one of the user stations, a dynamic commutator, for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, coupled between the base station and the user stations, a smart buffer (SFIFO) coupled between each interface converter and the commutator, a user interface converter in each user station, and a SFIFO coupled between each user interface converter and the commutator.

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DYNAMIC WIRELESS TELECOMMUNICATIONS SYSTEM

FIELD OF THE INVENTION

The present invention relates to wireless access systems, including wireless local loop systems in general and, in particular, to an add-on system for permitting data transmission and substantially increasing communication efficiency in wireless access systems.

BACKGROUND OF THE INVENTION

Wireless local loop communication systems are well known in the art. In these systems, data are transmitted by a wireless transmitter from a central switching office via one or more base stations and received by a receiver at the home of each of a plurality of users.

Recent innovations in wired communication technology have led to tremendous increases in the rate of transfer of information over competitive wired systems. However, these systems are all limited by the fact that the data must travel over wires, and by the fact that transmission and reception are symmetrical. In other words, even if there is no data to transmit, since each time slot or code is reserved for a particular uplink or downlink communication, empty bits (null bits) are transmitted in both directions.

There are also known in the literature statistical multiplexers for wired telephony systems, such as ATM statistical multiplexers, and E1 multiplexers. These multiplexers include a commutator for multiplexing signals from a plurality of stations, each station having its own time slot and code. In the event that one station has a large amount of data to transmit, while another has no data to transmit, the commutator can switch between the stations which have data to transmit. However, the switching can only take place at predetermined time intervals (time slots), with the result that some stations can build up a backlog of data to be transmitted, while another station is sending empty bits during part of its time slot.

Other wireless access systems are also known in the art. These systems are also limited in their performance capabilities.

There is provided in applicant's co-pending application, filed together with this application, a wireless access system, particularly useful as a wireless local loop system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the base station including a commutator including a base MAC (medium access controller), a HUB or other User WAN/LAN interface, and a plurality of remote bridges or other interface converter coupled between the User WAN/LAN interface and the commutator. This wireless access system permits the transmission of data, in addition to telephony transmission, and dramatically increases the data rate of transmission by reducing the number of empty bits, but it is still limited by the fact that the commutator acts as a conventional commutator, having time slots of fixed predefined length for data transmission. Furthermore, the resource allocation between uplink and downlink communications is fixed, regardless of the traffic load in each direction, as in conventional wireless access systems.

Accordingly, it would be desirable to have a wireless access system in which the resource allocation is carried out in real time. Such dynamic resource allocation would permit the allocation of transmission resources in accordance with the load to and/or from each user station, and between uplink and downlink transmissions, without being restricted to predefined time slots.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the system including a plurality of interface converters in the base station, each associated with at least one of the user

stations, a dynamic commutator coupled between the base station and the user stations, a smart buffer (SFIFO) coupled between each interface converter and the commutator, a user interface converter in each user station, and a SFIFO coupled between each user interface converter and the commutator.

According to a preferred embodiment, the base station includes a commutator including a base MAC (medium access controller), a User WAN/LAN interface, and a plurality of interface converters coupled between the User WAN/LAN interface and the commutator, a radio transmitter and a radio receiver, wherein a smart buffer (SFIFO) is coupled between each interface covnerter and the commutator.

According to a preferred embodiment of the invention, the wireless access system includes a wireless local loop system, and the interface converters include remote bridges.

Further according to a preferred embodiment, the commutator includes a MAC register, MAC logic coupled to the MAC register, a spooling state machine, a transmit state machine controllingly coupled to a RF module, and a transmit buffer coupled to the RF module.

According to a further preferred embodiment of the invention each user station includes a User WAN/LAN interface, a user MAC, an interface converter coupling the user MAC to the computer and to the base MAC, a radio transmitter, a smart buffer (SFIFO) coupled between the interface converter and the transmitter, a radio receiver, and a data filter coupled between the receiver and the interface converter.

There is also provided in accordance with the present invention a statistical multiplexer for use in wireless access systems including a commutator including a base MAC; a User WAN/LAN interface; a plurality of interface converters coupled between the User WAN/LAN interface and the commutator; and a smart buffer (SFIFO) coupled between each interface converter and the commutator. Preferably, the commutator includes a MAC register, MAC logic coupled to the MAC register, a spooling state machine, a transmit state

machine controllingly coupled to a RF module, and a transmit buffer coupled to the RF module.

There is further provided in accordance with the present invention a method for wireless downlink communication over a wireless access system including at least one base station and a plurality of user stations, the method including the steps of

at least partially filling a smart buffer with data packets to be transmitted from a source through interface converters in the base station to a user station;

providing a signal from a commutator in the base station to each of a plurality of smart buffers in the base station to determine if it is empty and, if not, what is the load to be transmitted;

registering the loads in each of the smart buffers which are not empty;

calculating the percentage of resources to be allocated to each smart buffer as a function of the load in each buffer;

causing each of the smart buffers to transmit data packets in accordance with the calculated allocation of resources to receivers in the user stations; and

repeating the steps of providing through transmitting after a predetermined period of time.

According to a preferred embodiment, the method further includes the steps of

receiving the data packet in each user station;

filtering address and destination information in the data packet in each user station to determine to which user station it is addressed;

transferring the data packet to a smart buffer in the appropriate user station, while rejecting the data in all the other user stations.

There is still further provided in accordance with the present invention a method for wireless uplink communication over a wireless access system including at least one base

station and a plurality of user stations, the method including the steps of

providing a signal from a smart buffer in each user station to a user MAC in that station indicating when it has a data packet to transmit to the base station and the data load;

providing a signal from the user MAC to a base MAC in the base station indicating that it has a defined data load to transmit;

registering the data loads in each user station;

calculating the percentage of resources to be allocated to each user station as a function of the load in each station;

causing each of the smart buffers in each user to transmit its data packets in accordance with the calculated allocation of resources to a receiver in the base station; and

repeating the steps of providing through transmitting after a predetermined period of time.

According to a preferred embodiment, the method further includes the steps of

receiving the data packet in the base station;

filtering address and destination information in the data packet in the base station to determine to which interface converter coupled to the base station it is addressed; and

transferring the data packet to the smart buffer associated with the appropriate interface converter.

There is also provided in accordance with the invention a method for dynamically allocating resources in real time between multiple sources of data packets in a wireless access system, the method including the steps of inputting to a commutator an indication of data load from each of a plurality of sources, calculating in the commutator the percentage resources allocation for each source based on the data load in that source divided by the total data load for all sources, and allocating transmission resources in

accordance with the calculated resources allocation. In this case, a "source" refers to any interface converter in the base station or a user station which has data packets to transmit.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further understood and appreciated from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is a schematic illustration of a wireless access system constructed and operative in accordance with one embodiment of the present invention;

Fig. 2 is a schematic electric circuit diagram of a commutator for the system of Fig. 1;

Fig. 3 is a schematic illustration of a wireless local loop system constructed and operative in accordance with one embodiment of the present invention;

Fig. 4 is a flow chart of the operation of the system of the present invention in a downlink communication;

Fig. 5 is a flow chart of the operation of a user station of the present invention in an uplink communication; and

Fig. 6 is a flow chart of the operation of a base station of the present invention in an uplink communication.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to wireless access systems having a significantly increased data rate. The system is based on inserting a novel statistical multiplexer into a wireless access system, thereby permitting dynamic resource allocation in real time resulting in traffic flow according to the available data load, without transmitting partially or completely empty bits. The statistical multiplexer includes a dynamic commutator, an array of interface converters coupled between the commutator and a User WAN/LAN interface of the wireless access base station, and a smart buffer (herein

referred to as a Smart FIFO or SFIFO) disposed between each interface converter and the dynamic commutator. The SFIFO is characterized in that it is capable of providing a signal to the base MAC of the quantity of data in the buffer at any given time, unlike conventional buffers, which can indicate only when they are full, half-full, or empty. This precise indication of load is utilized by the dynamic commutator to calculate the resource allocation between the various users based on the load to and/or from each station so as to transfer resources from those remote bridges having little or no load to those having large loads.

The device of the invention also permits dynamic resource allocation between uplink and downlink communications, which is not possible with conventional systems. It is a particular feature of the invention that the resource allocation is dynamic, and is carried out in real time so as to substantially continuously update the resource allocation as a function of the changing loads in the various smart buffers.

Referring now to Fig. 1, there is shown a schematic illustration of a wireless access system constructed and operative in accordance with one embodiment of the present invention. The system includes a wireless access base station 60 including a plurality of User WAN/LAN interfaces 62 for receiving communications from a communication system (not shown). An interface converter 66 is coupled to each User WAN/LAN interface 62 for interfacing between the communication system and a plurality of users. A smart buffer 70 is coupled to each interface converter 66, for receiving therefrom data to be transmitted via the base station to an associated user station, and for transmitting thereto data received from the user station. User WAN/LAN interfaces 62 can be any conventional User WAN/LAN interfaces, depending upon the particular external communication system. Interface converters 66 can be any conventional interface converters, which serve to convert the form of the data received from the

external communication system to a form which can be understood by the smart buffers.

Smart buffer 70 (hereinafter "SFIFO") is a buffer including a data input, data output, a memory, a load meter, and control logic, so as to enable it to provide an output signal corresponding to the traffic load at any load level from empty to full. It will be appreciated that the input data rate is not necessarily the same as the output data rate. Preferably, a cumulative traffic load meter 68 is also provided associated with each SFIFO 70 to record the traffic load of each interface converter (and, thus, of each user station) over time.

Each SFIFO 70 is coupled to a commutator 72. Commutator 72, in turn, is coupled to a radio transmitter 74, and to a radio receiver 76. Commutator 72 includes a Medium Access Controller (base MAC) 80 which coordinates the transmissions throughout the system and which allocates transmission resources. Commutator 72 is a device including a number of inputs/outputs at one side, and at least one output/input at the other side. In other words, the commutator is bi-directional, depending on the direction of data flow. For example, when data is sent from the base station to a user station, the commutator includes many inputs and at least one output. However, if data is flowing from a user station to the base station, the commutator functions with at least one input and a plurality of outputs.

The commutator 72 provides switching between the inputs and outputs according to a predefined switching pattern, which can be set by the base MAC, a user defined pattern, or any other conventional switching pattern. For example, the commutator can poll the inputs, one after another. Alternatively, it can perform statistical polling according to statistics input to the base MAC, or the commutator can operate according to any other pre-selected switching pattern.

The system further includes a plurality of user stations. Each user station includes a User WAN/LAN interface 46, belonging to individual users or applications. Each User WAN/LAN interface 46 includes a user MAC 47 and is coupled to interface converters 48, which can be a remote bridge, and which, in turn, is coupled to a smart buffer 50, similar to the SFIFO's in the base station. Each SFIFO 50 is coupled to a radio receiver 52 through a data filter 53, and to a radio transmitter 54.

With reference to Fig. 2, there is shown a schematic electric circuit diagram of a dynamic commutator 22' for the system of the present invention. Commutator 22' is coupled to each SFIFO 20' by a data bus 31 and a control line 32. Bus 31 is coupled to a transmitter buffer 34 for transfer of data, and to a MAC register 36 and MAC logic 38 for indicating the data load in each SFIFO. Transmitter buffer 34 is coupled, in turn, to an RF module 40, for transmitting outgoing data over transmitter 24.

Commutator 22' further includes a spooling state machine 42 coupled to control line 32 to check each SFIFO 20' to determine the data load in each, which it sends to MAC register 36. MAC logic 38 computes the resource allocation in accordance with an algorithm described in detail hereinbelow, and orders each SFIFO 20' to fill transmit buffer 34 in accordance with the calculated resources allocation. Commutator 22' also includes a transmit state machine 44 coupled to MAC logic 38, to the transmitter buffer 34, and to RF module 40.

One system for which the invention is particularly suited is a wireless local loop (WLL) system. It will be appreciated, however, that the invention is not limited to a WLL system, but rather can be effectively utilized in any wireless access system.

With reference to Fig. 3, there is shown a schematic illustration of a wireless local loop system constructed and operative in accordance with one embodiment of the present invention. The system includes a wireless local loop base

station 10 including a HUB 12, or any other device with an interface to Ethernet, such as a Router, LAN switch, Switched HUB, bridge, etc., for receiving communications from a communications system(not shown). A plurality of remote bridges 16 are coupled to HUB 12 for interfacing between the communications system and a plurality of users. HUB 12 can be any conventional HUB, such as the Unmanaged HUB Model DFE-812TX+, manufactured by D-Link Corporation, CA, USA. Remote bridges 16 can be any conventional remote bridges, such as Remote Bridge Model D1-1140, of D-Link Corporation.

A smart buffer 20 (hereinafter "SFIFO"), as described above, is coupled to each remote bridge 16, for receiving therefrom data to be transmitted via the base station to an associated user station, and for transmitting thereto data received from the user station. Preferably, a cumulative traffic load meter 18 is also provided associated with each SFIFO 20 to record the traffic load of each remote bridge (and, thus, of each user station) over time.

Each SFIFO 20 is coupled to a commutator 22, as described above. Commutator 22, in turn, is coupled to a radio transmitter 24, and to a radio receiver 26. Commutator 22 includes a Medium Access Controller (base MAC) 30 which coordinates the transmissions throughout the system and which allocates transmission resources.

Operation of the system of the present invention for downlink communication is as follows. Data is received from a communications system destined for several user stations 46. The data is received at several interface converters 66 and stored in the associated SFIFO's 20'. Spooling state machine 42 of commutator 22' checks each SFIFO to determine the data load in each and sends a signal corresponding thereto to the MAC register 36. When all the signals have entered MAC register 36, MAC logic 38 calculates the downlink user resources allocation (U_n) for each SFIFO (and, thus, for each ci) in accordance with the following algorithm:

$$U_n = \frac{\text{data in SFIFO}_n}{\Sigma \text{ all SFIFO downlink data}}$$

where n is the number of each particular user in turn.

In other words, the basic resource allocation (%) for each user is the data load in that user's SFIFO divided by the sum of downlink data loads in all the SFIFO's. In accordance with the percentage resource allocation for each user, spooling machine 42 orders each SFIFO, in order, to transfer its permitted data packets to transmitter buffer 34. When the transmitter is available, the transmitter buffer transmits the data packets in transmitter buffer 34.

When transmitter buffer 34 is empty, spooling state machine 42 again determines the load in each SFIFO, again calculates the resources allocation for each SFIFO (which is now different than it was during the previous calculation), and data packets are transferred to transmitter buffer 34 in accordance with the newly calculated resources allocation.

It will be appreciated that the algorithm for calculating the resources allocation can be altered so as to take into account minimum guaranteed data rate for certain users, as well as other special conditions.

Operation of the system for uplink communication is as follows. Data is received from several user stations 46 destined for the communications system. The data is received at the User WAN/LAN interface 46 in each user station, passed through interface converter 48, and stored in the associated SFIFO's 50. Each SFIFO sends a signal to the user MAC 47 of its user station indicating that it has data to transmit and the size of the load. User MAC 47 transmits this information to spooling state machine 42 of commutator 22' in the base MAC. All communications between the user MACs and the base MAC are conducted over a communication channel, via frequency, code, or time slot.

Spooling state machine 42 sends a signal corresponding to the data load in each user SFIFO to the MAC register 36. When all the signals have entered MAC register 36, MAC logic 38 calculates the uplink user resources allocation (U_n) for

the uplink communication for each SFIFO (and, thus, for each interface converter) in accordance with the following algorithm (essentially the same algorithm set forth above for downlink communications).

$$U_n = \frac{\text{data in SFIFO}_n}{\Sigma \text{ all SFIFO uplink data}}$$

where n is the number of each particular user in turn.

The basic uplink resource allocation (%) for each user is the data load in that user's SFIFO divided by the sum of uplink data loads in all the SFIFO's. When the base station receiver is available, MAC logic 38 orders transmit state machine 44 to order each SFIFO, in order, to transfer its permitted data packets to transmitter buffer 34, in accordance with the percentage resource allocation for each user.

When transmitter buffer 34 is empty, spooling state machine 42 again determines the load in each user SFIFO, again calculates the resources allocation for each SFIFO (which is now different than it was during the previous calculation), and data is transferred to transmitter buffer 34 in accordance with the newly calculated resources allocation.

It is a particular feature of the present invention that the resources allocation described herein can be utilized for downlink communications alone, for uplink communications alone, or for a combination of all communications, both uplink and downlink. In the latter case, unlike conventional resources allocation, wherein resources are allocated in a fixed manner between uplink and downlink communication channels or time slots, the present invention permits the utilization of resources as needed, in either direction. Thus, the resources allocation will be divided dynamically (on an ongoing basis) between uplink and downlink communications, as follows:

$$\text{uplink} = \frac{\Sigma \text{ all uplink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}}$$

$$\text{and} \quad \text{downlink} = \frac{\Sigma \text{ all downlink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}}$$

For example, if a user is a commercial application with much data to transmit, it can be allocated more resources than the base station, when needed.

Each user's resources allocation for uplink or downlink communication can then be calculated accordingly as a percentage of the total uplink or downlink resources allocation. For example, for a downlink communication, U_n is as follows:

$$U_n = \frac{\Sigma \text{ all downlink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}} \bullet \frac{\text{data in SFIFO}_n}{\Sigma \text{ all downlink traffic}}$$

A flow chart of the operation of the commutator in a downlink communication from the base station to a user station is set forth in Fig. 4. In Fig. 4, N is the total number of users (SFIFO's), and n is the specific SFIFO. Commutator 22' starts with the first smart buffer ($SFIFO_1$) and looks to see if it is empty. If yes, the commutator looks at the second smart buffer ($SFIFO_2$) to see if it is empty. If yes, it continues to look at each SFIFO, in turn, until it looks at the last $SFIFO_n$, at which point it starts again at $SFIFO_1$.

If a SFIFO is not empty, its data load is added to MAC register 36. When the data loads in all the SFIFO's have been entered in MAC register, MAC logic 38 calculates the percentage of resource allocation for each SFIFO, according to the appropriate algorithm. The commutator then sends a signal to each SFIFO, in accordance with the calculated resources allocation, to transfer its data packets to the transmitter buffer. The data packets in transmitter buffer are transmitted when downlink resources are available, in accordance with a transmit signal received from RF module 40.

It is a particular feature of the present invention that if an interface converter is empty, when commutator 22' allocates resources, the empty interface converter will not be allocated any resources. In other words, commutator 22' will skip over the empty interface converter until it is no longer empty. Furthermore, if a SFIFO has only a few data packets (i.e., is not half full or completely full), it is allocated resources according to the number of data packets it has. In this way, transmissions of empty data frames are practically eliminated.

The transmitted signals are received at the user stations by receivers 52 through data filters 53, which filter out those signals which are not addressed to the particular user, and transmits those signals which are addressed to computer 46' via SFIFO 50' to computer 46'. It will be appreciated that each user 46 sees a greatly increased data rate, since virtually no empty bits are transmitted between the base station and user stations.

Operation of the system for uplink communication is as follows, with reference to Figs. 5 and 6, showing flow charts of the operation of a user station and a base station, respectively. When a computer 46 wishes to send a data packet to the base station, it transfers the data packet to SFIFO 50 via interface converters 48, together with packet identification data. User MAC 47 indicates to base MAC 30' that its SFIFO is not empty, and asks base MAC 18 for allocation of resources. The data load in SFIFO 50 is entered into MAC register 36. When receiver 26 is available, MAC logic 38 calculates the resources allocation percentage for each user SFIFO which has data packets to transmit. Commutator 22' indicates to each SFIFO which has a data packet to transmit, in accordance with the calculated resources allocation, to transmit its data packet. The data packet is transferred from SFIFO 50 to receiver 26, and the data packet is stored in transmitter buffer 34 of commutator 22'. According to the destination address on each data

packet, the commutator transmits the data packet to the appropriate SFIFO.

It will be appreciated that the invention is not limited to what has been described hereinabove merely by way of example. Rather, the invention is limited solely by the claims which follow.

CLAIMS

1. For use in a wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, a base station comprising:

a commutator for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, and including a base MAC (medium access controller);

at least one User WAN/LAN interface;

an interface converter coupled between each said User WAN/LAN interface and said commutator; and

a smart buffer (SFIFO) coupled between each interface converter and said commutator.

2. The base station of claim 1, further comprising a radio transmitter and a radio receiver.

3. The base station of any of the preceding claims, wherein said commutator comprises:

a MAC register;

MAC logic coupled to said MAC register;

a spooling state machine;

a transmit state machine controllingly coupled to a RF module; and

a transmitter buffer coupled to said RF module.

4. A method for wireless downlink communication over a wireless access system including at least one base station and a plurality of user stations, the method comprising the steps of:

at least partially filling a smart buffer with data packets to be transmitted from a source through an interface converter in the base station to a user station;

providing a signal from a commutator in the base station to each of a plurality of smart buffers in the base station to determine if it is empty and, if not, what is the load to be transmitted;

registering the loads in each of the smart buffers which are not empty;

calculating the percentage of resources to be allocated to each smart buffer as a function of the load in each buffer;

causing each of the smart buffers to transmit data packets in accordance with the calculated allocation of resources to receivers in the user stations; and

repeating the steps of providing through transmitting after a predetermined period of time.

5. The method of claim 4, further including the steps of:

receiving the data packet in each user station;

filtering address and destination information in the data packet in each user station to determine to which user station it is addressed;

transferring the data packet to a smart buffer in the appropriate user station, while rejecting the data in all the other user stations.

6. A method for wireless uplink communication over a wireless access system including at least one base station and a plurality of user stations, the method comprising the steps of:

providing a signal from a smart buffer in each user station to a user MAC in that station indicating that it has a data packet to transmit to the base station and the data load;

providing a signal from the user MAC to a base MAC in the base station indicating that it has a defined data load to transmit;

registering the data loads in each user station;

calculating the percentage of resources to be allocated to each user station as a function of the load in each station;

causing each of the smart buffers in each user to transmit its data packets in accordance with the calculated allocation of resources to a receiver in the base station; and

repeating the steps of providing through transmitting after a predetermined period of time.

7. The method of claim 6, further comprising the steps of:

receiving the data packet in the base station;

filtering address and destination information in the data packet in the base station to determine to which remote bridge coupled to the base station it is addressed; and

transferring the data packet to the smart buffer associated with the appropriate interface converter.

8. For use in a wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, a user station comprising:

a User WAN/LAN interface;

a user MAC;

interface converters coupling the user MAC to the computer and to the base MAC;

a radio transmitter;

a smart buffer (SFIFO) coupled between the interface converter and the transmitter;

a radio receiver; and

a data filter coupled between the receiver and the interface converter.

9. A statistical multiplexer for use in wireless access systems comprising:

a commutator for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, and including a base MAC;

at least one User WAN/LAN interface;

an interface converter coupled between each User WAN/LAN interface and the commutator; and

a smart buffer (SFIFO) coupled between each interface converter and the commutator.

10. The statistical multiplexer of claim 9, wherein said commutator includes:

a MAC register,

MAC logic coupled to the MAC register,

a spooling state machine,

a transmit state machine controllingly coupled to a RF module, and

a transmitter buffer coupled to the RF module.

11. The statistical multiplexer of any of claims 9 to 10, wherein said SFIFO includes:

a data input;

a data output;

a memory;

a load meter; and

control logic to enable it to provide an output signal corresponding to the traffic load at any load level from empty to full.

12. A wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the system comprising:

a plurality of interface converters in said base station, each associated with one of the user stations;

a dynamic commutator, for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, coupled between said base station and said user stations;

a smart buffer (SFIFO) coupled between each interface converters and said commutator;

a user interface converters in each user station; and

a SFIFO coupled between each user interface converter and said commutator.

13. A wireless local loop system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the base station comprising:

a commutator for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, and including a base MAC (medium access controller);

an Ethernet interface; and

a plurality of remote bridges coupled between the Ethernet interface and the commutator;

a radio transmitter;

a radio receiver; and

a smart buffer (SFIFO) coupled between each remote bridge and the commutator.

14. The wireless local loop system of Claim 13, wherein said commutator includes:

a MAC register,

MAC logic coupled to the MAC register,

a spooling state machine,

a transmit state machine controllingly coupled to a RF module, and

a transmitter buffer coupled to the RF module.

15. The wireless local loop system of Claim 13 or 14, wherein each user station includes:

a User WAN/LAN interface;

a user MAC;

a remote bridge coupling the user MAC to the computer and to the base MAC;

a radio transmitter;

a smart buffer (SFIFO) coupled between the remote bridge and the transmitter;

a radio receiver; and

a data filter coupled between the receiver and the remote bridge.

16. A method for dynamically allocating resources in real time between multiple sources of data packets in a wireless access system including a plurality of user stations, and at least one base station coupled by RF transceiving apparatus to each of the user stations, the method comprising the steps of:

inputting to a commutator, for switching between a plurality of inputs/outputs at one side and at least one output/input at the other side, an indication of data load from each of a plurality of users;

calculating in said commutator the percentage resources allocation for each user based on the data load in that user divided by the total data load for all users;

allocating transmission resources in accordance with said calculated resources allocation.

17. The method of claim 16, wherein said steps of inputting through allocating are repeated periodically.

18. The method of claim 16, further including the step of transmitting said data packets to a transmitter having a transmitter buffer in accordance with said calculated resources allocation, and said steps of inputting through transmitting are repeated when said transmitter buffer is empty.

19. The method of any of claims 16-18 wherein said step of calculating includes calculating allocation of downlink resources for each user U_n according to the formula:

$$U_n = \frac{\text{data in SFIFO}_n}{\Sigma \text{ all SFIFO downlink data}}$$

20. The method of any of claims 16-19 wherein said step of calculating includes calculating allocation of uplink resources for each user U_n according to the formula:

$$U_n = \frac{\text{data in SFIFO}_n}{\Sigma \text{ all SFIFO uplink data}}$$

21. The method of any of claims 17-20 wherein said step of calculating includes calculating allocation of uplink resources for the wireless access system according to the formula:

$$\text{uplink} = \frac{\Sigma \text{ all uplink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}}$$

22. The method of any of claims 16-21 wherein said step of calculating includes calculating allocation of downlink resources for the wireless access system according to the formula:

$$\text{downlink} = \frac{\Sigma \text{ all downlink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}}$$

23. The method of claim 16 or 17 wherein said step of calculating includes calculating allocation of downlink resources for each user U_n according to the formula:

$$U_n = \frac{\Sigma \text{ all downlink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}} \bullet \frac{\text{data in SFIFO}_n}{\Sigma \text{ all downlink traffic}}$$

24. The method of claim 16 or claim 17 wherein said step of calculating includes calculating allocation of uplink resources for each user U_n according to the formula:

$$U_n = \frac{\Sigma \text{ all uplink traffic}}{\Sigma \text{ all uplink traffic} + \Sigma \text{ all downlink traffic}} \bullet \frac{\text{data in SFIFO}_n}{\Sigma \text{ all uplink traffic}}$$

25. The method of any of claims 16 to 24, further including the step of adjusting said formula to take into account minimum guaranteed rate for at least one user.

26. The method of claim 16, wherein:

said step of inputting includes:

inputting a data load to a SFIFO in each user;

registering the data load in the SFIFO;

signalling a user MAC that SFIFO is not empty; and

causing said user MAC to request allocation of resources from said commutator;

and said step of allocating includes:

signalling said user MAC when resources have been allocated; and

causing said SFIFO to transfer said data load therein to a herein to a transmitter.

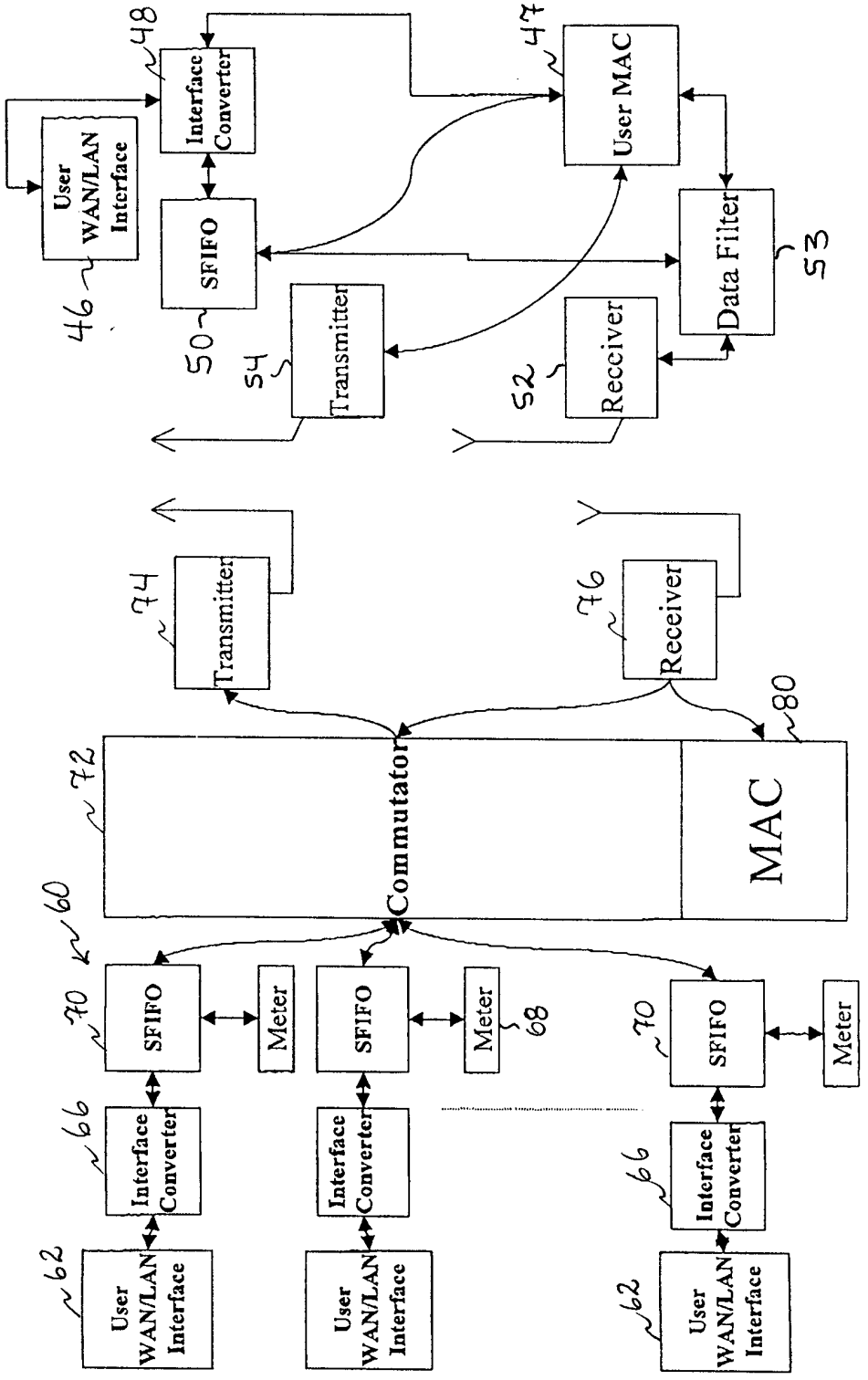

User WAN/LAN Interface
Interface Converter
SFIFO
User MAC
Data Filter
Transmitter
Recciver
Commutator
MAC
Receiver
Meter
46
47
48
50
52
53
54
60
62
66
68
70
72
74
76
80

Fig. 1

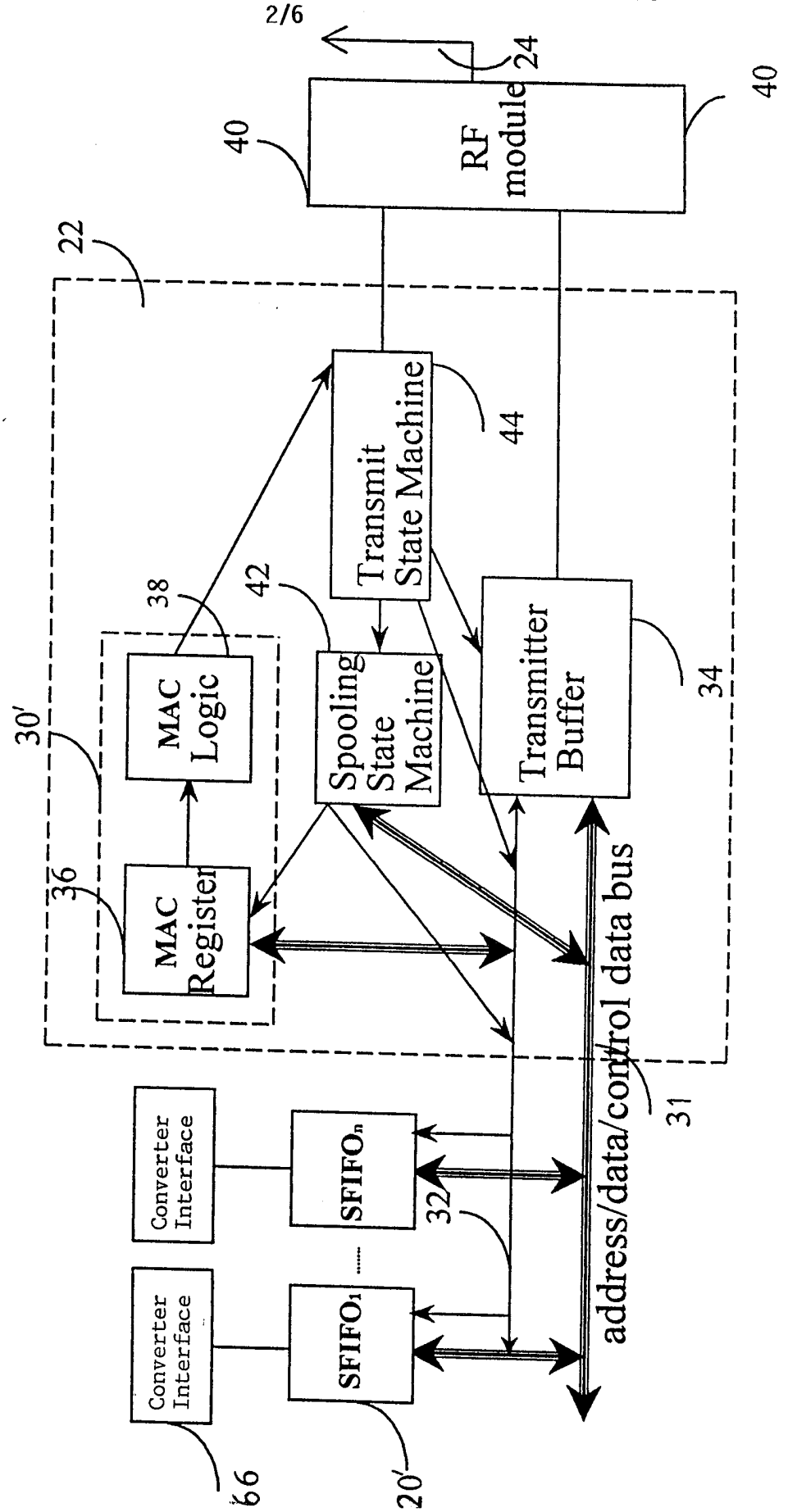

RF module
24
40
40
22
Transmit State Machine
44
42
38
MAC Logic
Spooling State Machine
Transmitter Buffer
34
30'
36
MAC Register
address/data/control data bus
31
Converter Interface
SFIFOn
32
Converter Interface
SFIFO1
66
20'

Fig. 2

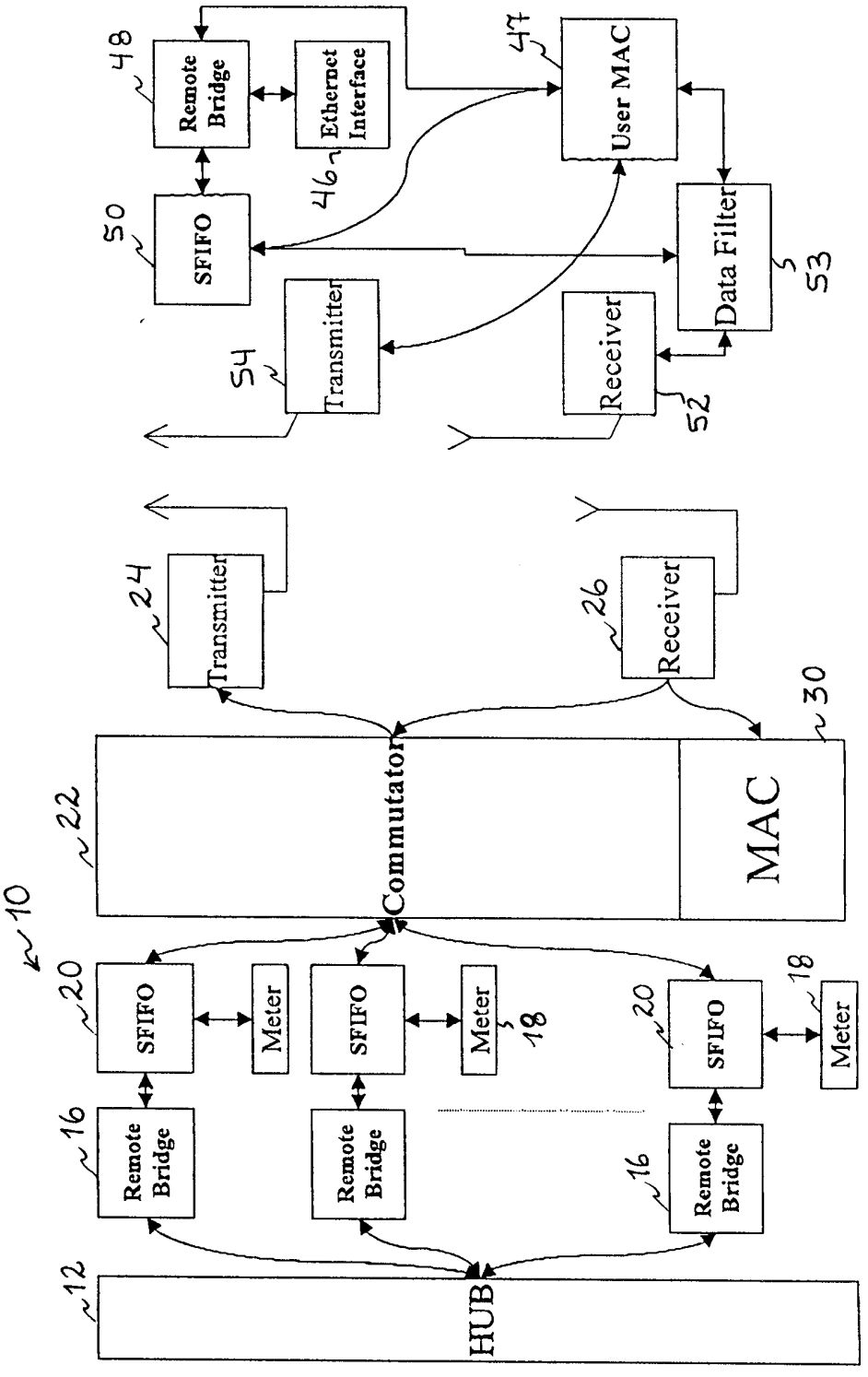

10
12
HUB
16
Remote Bridge
20
SFIFO
Meter
18
22
Commutator
24
Transmitter
26
Receiver
30
MAC
48
Remote Bridge
Ethernet Interface
46
47
User MAC
50
SFIFO
Data Filter
53
54
Transmitter
Receiver
52

Fig. 3

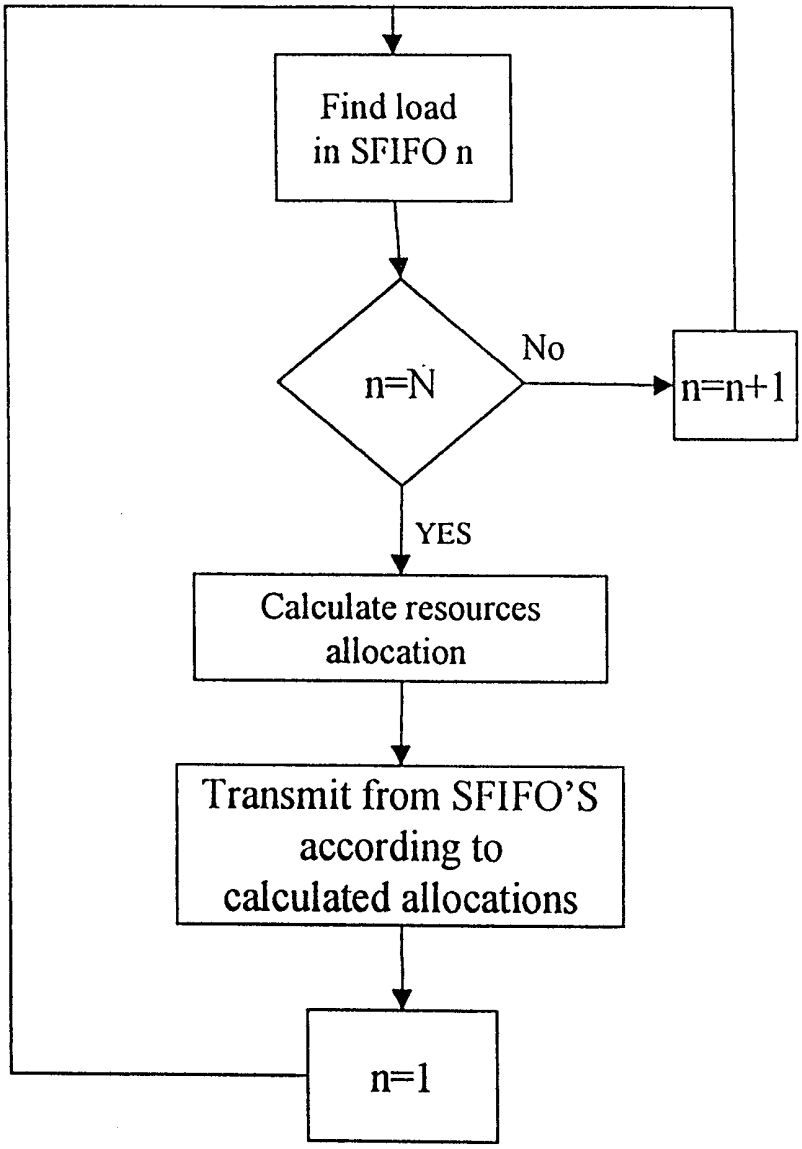

Find load in SFIFO n
n=N
No
n=n+1
YES
Calculate resources allocation
Transmit from SFIFO'S according to calculated allocations
n=1

Fig. 4

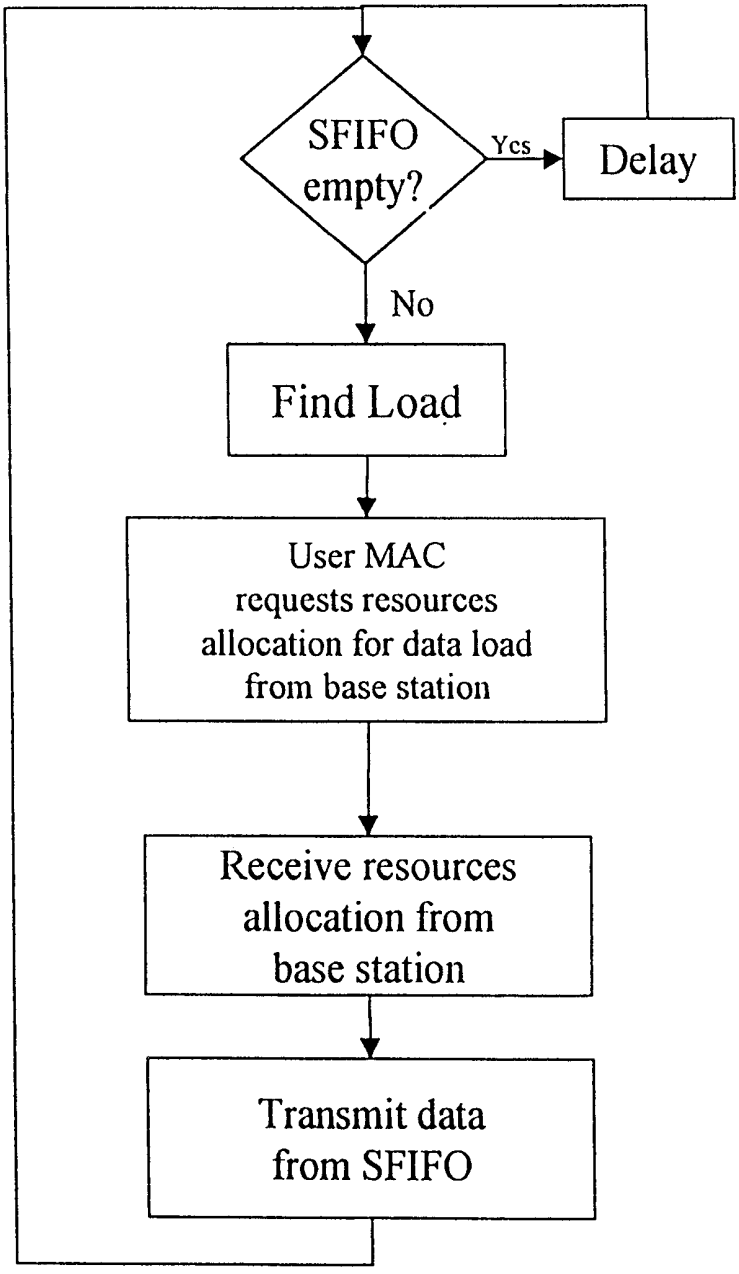

SFIFO empty?
Yes
Delay
No
Find Load
User MAC requests resources allocation for data load from base station
Receive resources allocation from base station
Transmit data from SFIFO

Fig. 5

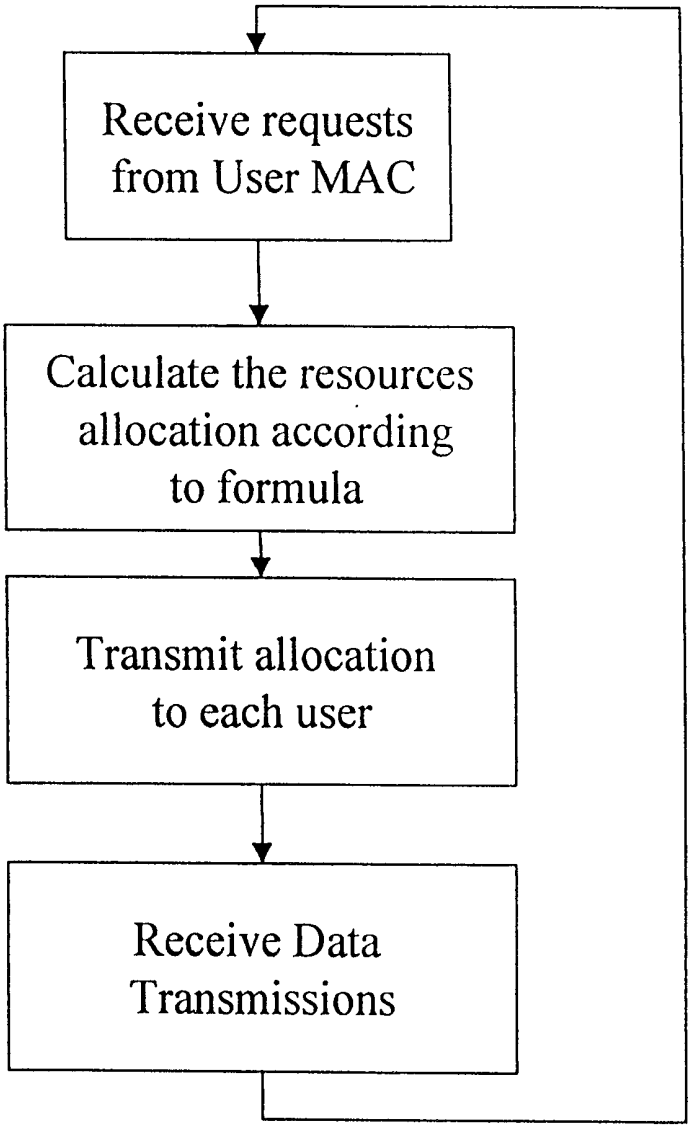

Receive requests from User MAC
Calculate the resources allocation according to formula
Transmit allocation to each user
Receive Data Transmissions

Fig. 6