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(54) **HIGH-CAPACITY SCALABLE INTEGRATED WIRELESS BACKHAUL FOR BROADBAND ACCESS NETWORKS**

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Publication Classification

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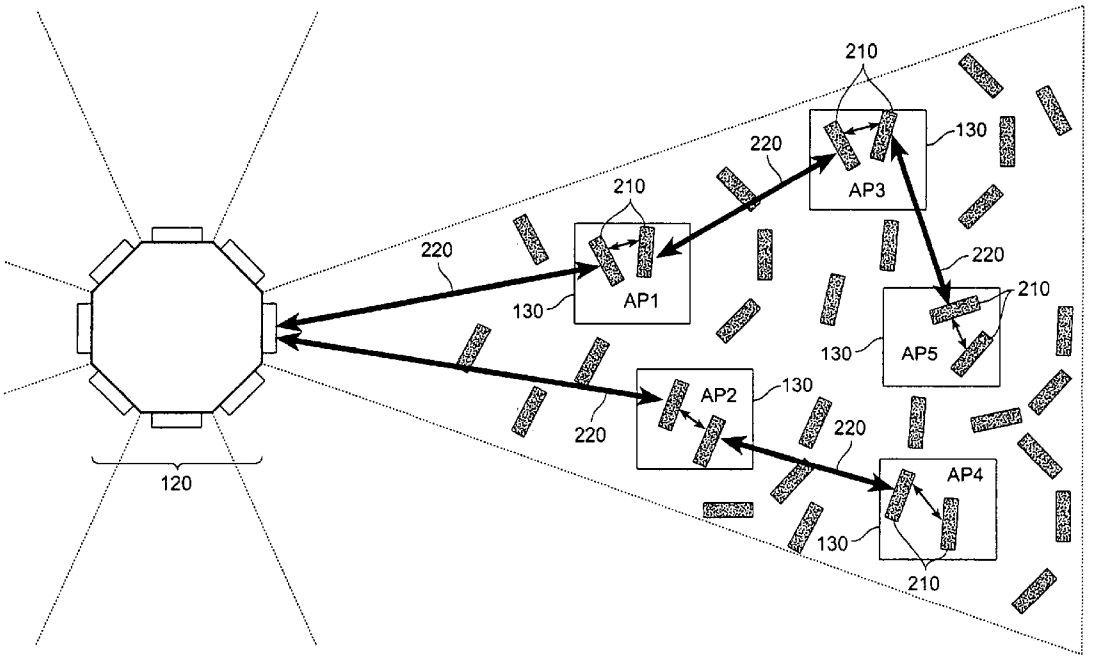
(52) **U.S. Cl.** **370/252**

(57) **ABSTRACT**

The invention provides a method and system for adaptive point-to-point communication between a wireless communication system and a non-wireless backhaul communication system. The wireless physical layer and the wireless media-access-control layer collectively include a set of parameters, which are adaptively modified by base station controllers in multiple cells of the wireless communication system for intercommunication among those multiple cells. The IP layer and QoS parameters for communication between a selected base station controller and the non-wireless backhaul communication system collectively include a second set of parameters, which are adaptively modified for intercommunication between that selected base station controller and the non-wireless backhaul communication system. The combination of wireless communication and non-wireless communication over the entire channel includes adaptive modification of parameters for the IP layer and QoS to optimize backhaul communication between customer premises equipment and the backhaul network.



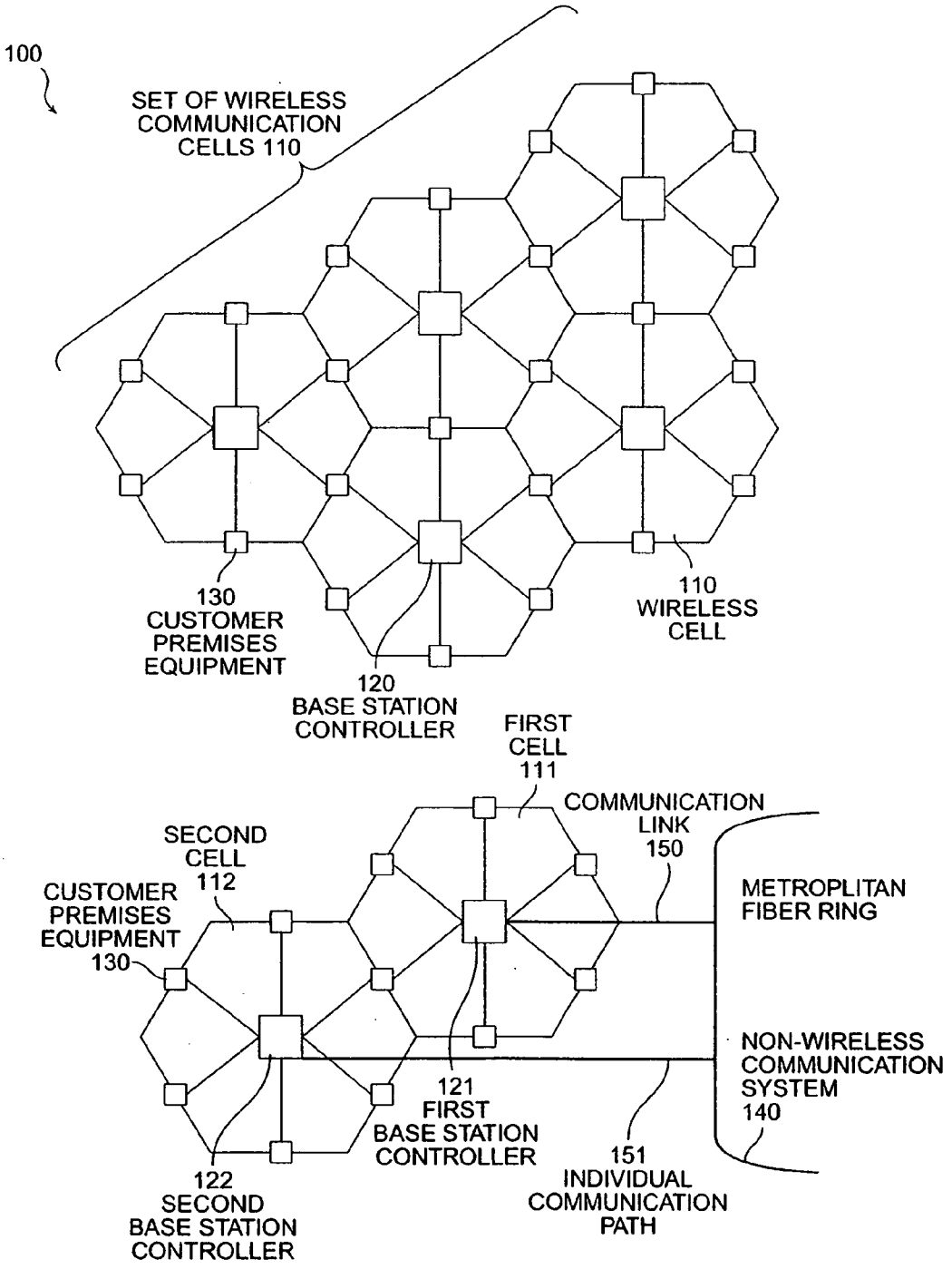

100
SET OF WIRELESS COMMUNICATION CELLS 110
130 CUSTOMER PREMISES EQUIPMENT
120 BASE STATION CONTROLLER
110 WIRELESS CELL
FIRST CELL 111
COMMUNICATION LINK 150
SECOND CELL 112
CUSTOMER PREMISES EQUIPMENT 130
METROPLITAN FIBER RING
NON-WIRELESS COMMUNICATION SYSTEM 140
121 FIRST BASE STATION CONTROLLER
151 INDIVIDUAL COMMUNICATION PATH
122 SECOND BASE STATION CONTROLLER

FIG. 1

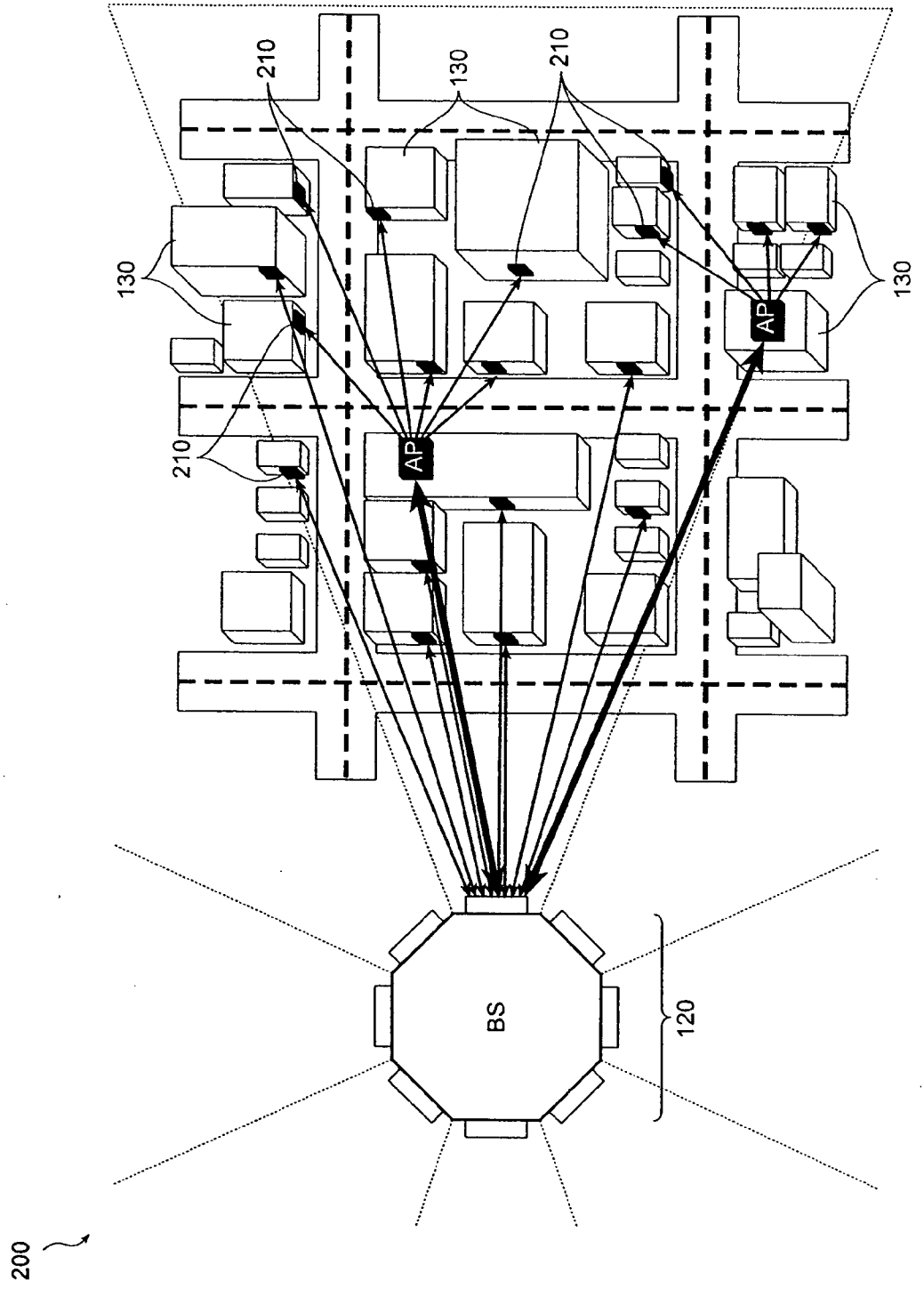


FIG. 2

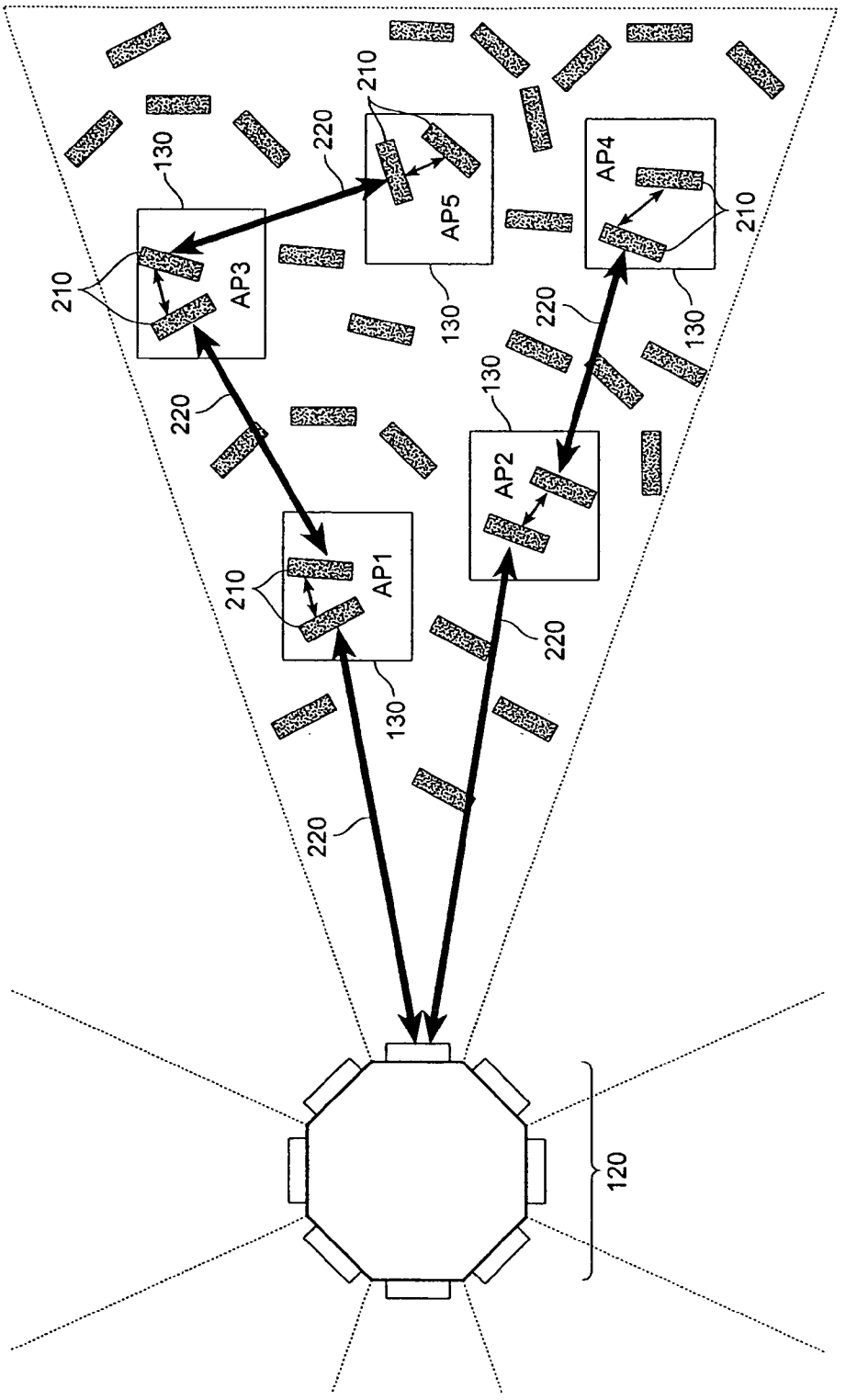


FIG. 3

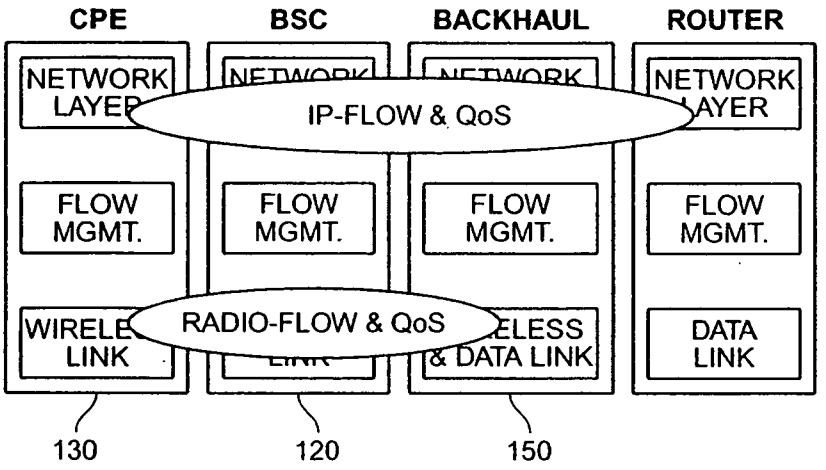

CPE
BSC
BACKHAUL
ROUTER
NETWORK LAYER
NETWORK LAYER
IP-FLOW & QoS
FLOW MGMT.
FLOW MGMT.
FLOW MGMT.
FLOW MGMT.
RADIO-FLOW & QoS
WIRELE LINK
& DATA LINK
DATA LINK
130
120
150

FIG. 4

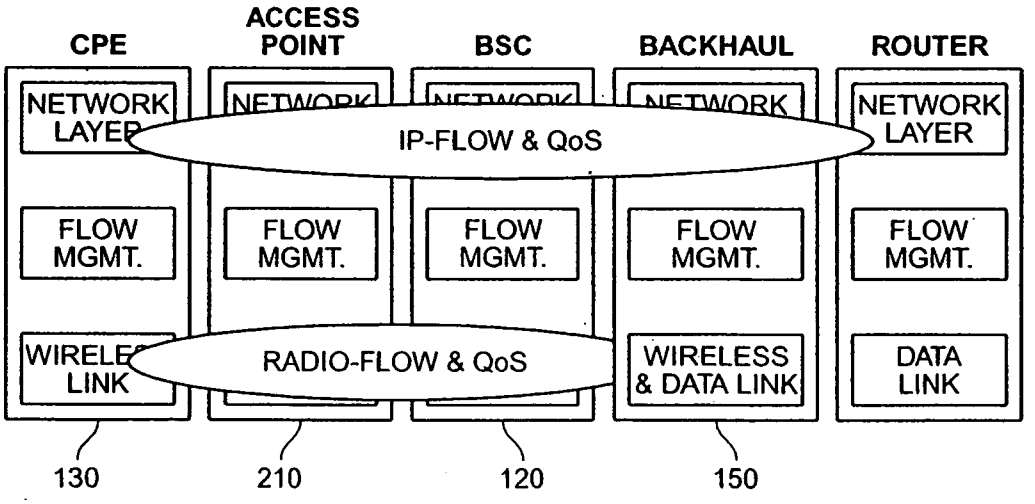

CPE
ACCESS POINT
BSC
BACKHAUL
ROUTER
NETWORK LAYER
NETWORK LAYER
IP-FLOW & QoS
FLOW MGMT.
FLOW MGMT.
FLOW MGMT.
FLOW MGMT.
FLOW MGMT.
RADIO-FLOW & QoS
WIRELE LINK
WIRELESS & DATA LINK
DATA LINK
130
210
120
150

FIG. 5

HIGH-CAPACITY SCALABLE INTEGRATED WIRELESS BACKHAUL FOR BROADBAND ACCESS NETWORKS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. application Ser. No. 09/604,784 filed Jun. 26, 2000 (Attorney Docket number 164.1010.01), hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to wireless communication systems, such as those including integrated backhaul.

[0004] 2. Related Art

[0005] Wireless communication systems include sending information between a sender and a receiver using a wireless communication link. In wireless communication, the sender modulates information onto a wireless communication channel (such as a frequency band reserved for wireless communication between the sender and the receiver), and the receiver demodulates that information from the wireless communication channel (so as to recover the original information). Known wireless communication systems often use a cell structure, in which within each cell a BSC (base station controller) communicate with CPE (customer premises equipment). This provides the features that (a) communication can independently be controlled within each cell, and (b) wireless communication resources, such as frequencies, can be used in multiple cells when those cells are sufficiently distant to prevent substantial interference.

[0006] One problem with known systems is the need to provide integrated backhaul connectivity between the wireless communication system and a non-wireless communication system. For example, such non-wireless communication systems might include a wire line or fiber communication system including routers and the Internet. Such backhaul connectivity might should advantageously include inter-cell communication, as well as communication between selected cells (more specifically, the base station controllers in selected cells) and the non-wireless communication system. However, attempts to integrate backhaul connectivity with known systems would suffer from similar drawbacks to those that are common to internal communication within wireless communication systems; these would include drawbacks described in the Incorporated Disclosures (see "Related Applications" below).

[0007] More specifically, the physical characteristics of the communication link between a first cell and a second cell can change substantially over relatively short periods of time, even though the physical location of the base station controllers for those cells is not substantially altered. This is particularly so for interference, such as co-channel interference (CCI), and for multipath effects, such as reflections resulting in intrasymbol interference, intersymbol interference, and fading. There are multiple such characteristics of the communication link, each of which can change over time independently of each other. As a result, selection of a single set of such physical characteristics, even when physical conditions of the lines of sight between the first cell and the second cell are known, can result in relatively ineffective or inefficient communication between cells.

[0008] Accordingly, it would be advantageous to provide a technique for wireless communication including an integrated backhaul capability that is not subject to drawbacks of the known art. For one example, it would be advantageous to provide an adaptive point to point, or point to point-to-point, connection between selected cells of a wireless commutation system and selected elements of a non-wireless communication system. For a second example, it would be advantageous to provide an adaptive point-to-point, or point to point-to-point, connection among multiple cells in a wireless communication system.

SUMMARY OF THE INVENTION

[0009] The invention provides a method and system for adaptive point-to-point, or point to point-to-point, communication between a wireless communication system and a non-wireless backhaul communication system. The invention also provides a method and system for adaptive point-to-point, or point to point-to-point, communication among multiple cells in a wireless communication system.

[0010] The wireless communication system includes a set of parameters for the physical layer and the MAC layer for communication with the non-wireless backhaul communication system, similar to those parameters for communication within individual cells of the wireless communication system. In a first aspect of the invention, selected base station controllers modify those parameters to provide connectivity with the non-wireless communication system.

[0011] In a second aspect of the invention, the selected base station controllers modify those parameters to provide connectivity for intercommunication among multiple cells in the wireless condition system. Those parameters are modified, for example, to optimize intercell or intracell communication without excessive interference with (other) intracell communication.

[0012] The wireless communication system also includes a set of second parameters, for the IP layer and QoS (quality of service) administration of communication between the selected base station controller and the non-wireless backhaul communication system. The selected base station controller adaptively modifies this set of second parameters to provide connectivity with at least one router in the non-wireless backhaul communication system. In a preferred embodiment, those second parameters are adaptively modified in response to the entire channel between multiple customer premises equipment and the router. This allows the selected base station controller to optimize backhaul communication between customer premises equipment and the non-wireless backhaul communication system.

[0013] The invention provides an enabling technology for a wide variety of applications for communication, so as to obtain substantial advantages and capabilities that are novel and non-obvious in view of the known art. Examples described below primarily relate to a wireless communication system, but the invention is broadly applicable to many different types of communication in which characteristics of the communication link are subject to change.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** shows a block diagram of a system including an integrated backhaul capability using adaptive communication in a wireless communication system.

[0015] **FIG. 2** shows a block diagram of a system including an integrated backhaul capability in a wireless communication system with access points.

[0016] **FIG. 3** shows a block diagram of a system including an integrated backhaul capability in a system with access points in a mesh network.

[0017] **FIG. 4** shows a block diagram of a system including an integrated backhaul capability including QoS and flow management.

[0018] **FIG. 5** shows a block diagram of a system including an integrated backhaul capability with QoS and flow management, using access points.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. Embodiments of the invention can be implemented using general-purpose processors or special purpose processors operating under program control, or other circuits, adapted to particular process steps and data structures described herein. Implementation of the process steps and data structures described herein would not require undue experimentation or further invention.

RELATED APPLICATIONS

[0020] Inventions described herein can be used in conjunction with inventions described in the following documents.

[0021] U.S. patent application Ser. No. 09/475,642, Express Mail Mailing No. EL 524 70 018 US, filed Dec. 30, 1999 in the name of Reza Ahy and Subir Varma, attorney docket number 164.1002.01, titled "Adaptive Link Layer for Point to Multipoint Communciations System"

[0022] U.S. patent application Ser. No. 09/475,716, Express Mail Mailing No. EL 524 780 021 US, filed Dec. 30, 1999 in the name of Reza Ahy and Subir Varma, attorney docket number 164.1003.01, titled "Integrating Self-Optimizing MultiParameter and Multivariable Point to Multipoint Communication System" and

[0023] U.S. patent application Ser. No. 09/540,674, Express Mail Mailing No. EL 524 781 512 US, filed Mar. 31, 2000, in the name of Reza Ahy, attorney docket number 164.1001.01, titled "Robust Topology Wireless Communication Using Broadband Access Points".

[0024] Each of these documents is hereby incorporated by reference as if fully set forth herein. These documents are collectively referred to as the "Incorporated Disclosures".

Lexicography

[0025] The following terms refer or relate to aspects of the invention as described below. The descriptions of general meanings of these terms are not intended to be limiting, only illustrative.

[0026] base station controller—in general, a device for performing coordination and control for a wireless communication cell. There is no particular requirement that the base station controller must be a single device; in alternative embodiments, the base station controller can include a portion of a single device, a combination of multiple devices, or some hybrid thereof.

[0027] communication link—in general, an element for sending information from a sender to a recipient. Although in a preferred embodiment the communication links referred to are generally wireless line of sight point to point communication links, there is no particular requirement that they are so restricted.

[0028] customer premises equipment—in general, a device for performing communication processes and tasks at a customer location, and operating in conjunction with the base station controller within a wireless communication cell. There is no particular requirement that the customer premises equipment must be a single device; in alternative embodiments, the customer premises equipment can include a portion of a single device, a combination of multiple devices, or some hybrid thereof

[0029] IP parameters—in general, a set of characteristics or parameters relating to an IP layer for a communication link.

[0030] MAC parameters—in general, with reference to a wireless communication link, a set of characteristics or parameters relating to media access control of a communication link. For example, MAC parameters can include (a) a number of payload data bytes assigned per message, (b) a frequency of acknowledgement messages and a number of message retransmission attempts, (c) a fraction of the communication link allocated to downstream versus upstream communication, and the like.

[0031] physical parameters—in general, with reference to a wireless communication link, a set of characteristics or parameters relating to physical transmission of information on a communication link. For example, physical characteristics can include (a) a symbol transmission rate, (b) a number of payload data bits assigned per symbol, (c) a number of error detection or correction bits assigned per symbol, and the like.

[0032] QoS parameters—in general, a set of characteristics or parameters relating to QoS (quality of service) for a communication link.

[0033] wireless communication system—in general, a communication system including at least one communication link that uses wireless communication techniques.

[0034] wireless transport layer—in general, a set of protocols and protocol parameters for sending and receiving information using wireless transport. In a preferred embodiment, the wireless transport layer is part of a multilayer systems architecture, in which the

wireless transport layer is built using a physical transport layer, and the wireless transport layer is used by a logical transport layer such as IP.

[0035] As noted above, these descriptions of general meanings of these terms are not intended to be limiting, only illustrative. Other and further applications of the invention, including extensions of these terms and concepts, would be clear to those of ordinary skill in the art after perusing this application. These other and further applications are part of the scope and spirit of the invention, and would be clear to those of ordinary skill in the art, without further invention or undue experimentation.

System Context

[0036] The context of the invention is similar to that of the Incorporated Disclosures.

[0037] A system using adaptive point-to-point wireless communication between cells in a wireless communication system operates as part of a cellular wireless communication system. The cellular wireless communication system includes a communication model in which devices coupled to a network (such as a computer network) intercommunicate using message signals. In a preferred embodiment, these message signals include sequences of packets or cells, which have header information and which conform to the OSI model. In the OSI model, an application protocol (layer 5, such as FTP), uses a transport protocol (layer 4, such as TCP), which uses a network protocol (layer 3, such as IP), which uses a media access control (MAC) protocol (layer 2), which uses a physical transport technique (layer 1).

[0038] The system using adaptive point-to-point wireless communication is described herein with regard to layer 1 and layer 2, particularly as it applies to interactions between layer 1 and layer 2 and between those layers and layer 3. However, concepts and techniques of the invention are also applicable to other layers of the OSI model. For example, there might be cases where the type of application in the application layer (layer 5) is detected and responded to, so as to improve communication. Adapting those concepts and techniques to such other layers would not require undue experimentation or further invention, and is within the scope and spirit of the invention.

System Elements

[0039] **FIG. 1** shows a block diagram of a system including an integrated backhaul capability using adaptive communication in a wireless communication system.

[0040] A system **100** includes a set of wireless communication cells **110**. Each wireless communication cell **110** occupies a region of space and includes a base station controller **120** and one or more customer premises equipment **130**.

[0041] Each wireless communication cell **110** includes a generally hexagon-shaped region of local surface area, such as might be found in a metropolitan region. Use of generally hexagon-shaped regions is known in the art of wireless communication because they are able to tile a local region with substantially no gaps. However, although in a preferred embodiment the wireless communication cell **110** includes a generally hexagon-shaped region, there is no particular requirement for using that particular shape; in alternative embodiments it may be useful to provide another shape or tiling of the local surface area.

[0042] The wireless communication cells **10** include at least a first cell **111** and a second cell **112**, in which the second cell **112** is disposed sufficiently near to the first cell **111** to allow wireless communication between the first cell **111** and the second cell **112**. Specifically, a first base station controller **121** (in the first cell **111**) and a second base station controller **122** (in the second cell **112**) communicate using the methods and system **100** described herein.

[0043] In a preferred embodiment, the first cell **111** is located relatively centrally with regard to a set of such second cells **112**. For example, as shown in the figure, the first cell **111** can be located in the center of a hexagon formed of such second cells **112**.

[0044] The base station controller **120** includes a processor, program and data memory, mass storage, and one or more antennas for sending or receiving information using wireless communication techniques.

[0045] Similar to the base station controller **120**, each customer premises equipment **130** includes a processor, program and data memory, mass storage, and one or more antennas for sending or receiving information using wireless communication techniques.

[0046] Communication among devices within the wireless communication cell **110** is conducted on one-to-one basis between each customer premises equipment **130** and the base station controller **120**. Thus, the base station controller **120** communicates with each customer premises equipment **130**, and each customer premises equipment **130** communicates with the base station controller **120**. Customer premises equipment **130** do not communicate directly with other customer premises equipment **130**.

[0047] Communication between the base station controller **120** and each customer premises equipment **130** is described in detail in the Incorporated Disclosures.

[0048] The system **100** also includes a non-wireless communication system **140**, and a communication link **150** coupling the first base station controller **121** and the non-wireless communication system **140**.

[0049] In a first preferred embodiment, the communication link **150** can include a wireless communication link, such as a wireless communication link between a base station controller **120** and customer premises equipment **130**. In a second preferred embodiment, the communication link **150** can include a non-wireless communication link, such as an OC-3 communication link, another fiber communication link, or another type of wire line communication link. In alternative embodiments, the communication link **150** can include a combination of non-wireless communication sub-links and wireless communication sub-links, which operate in conjunction or in parallel so as two coupled the first base station controller **121** and the non-wireless communication system **140**.

[0050] In alternative embodiments, the communication link **150** can include a plurality of separate individual communication paths **151**, such as one or moreover, or some combination of, the following:

[0051] a first individual communication path **151** from a first selected base station controller **120** to the non-wireless communication system **140**; and

[0052] a second individual communication path **151** from a second selected base station controller **120** to the non-wireless communication system **140**.

[0053] In a preferred embodiment, each of the first individual communication path **151** and the second individual communication path **151** include non-wireless (fiber-optic) communication links from a selected base station controller **120** to the non-wireless communication system **140**. However, in alternative embodiments, the first individual communication path **151** or the second individual communication path **151** may include wireless communication links from one or more base station controllers **120** to the non-wireless communication system **140**.

[0054] In a preferred embodiment, the non-wireless communication system **140** includes a fiber-optic network coupling the non-wireless communication system **140** to or from a router or switch. The router or switch is itself coupled to a computer communication network (such as an Internet, an intranet, an extranet, a virtual private network, or some other type of communication network).

Elements for Adaptive Point-to-Point Communication

[0055] The system performs adaptive control of point-to-point communication similarly to the technique described for adaptive control of point-to-multipoint communication in the Incorporated Disclosures.

[0056] The first base station controller **121** maintains a set of physical parameters and MAC parameters for each (nearby) second base station controller **122**. In a preferred embodiment, control of each parameter by the first base station controller **121** is independent and individual with regard to each second base station controller **122**. Thus for example, the first base station controller **121** determines power level and modulation type for each second base station controller **122** without regard to power level and modulation type for any other second base station controller **122**. Similarly, the first base station controller **121** determines power level for a particular second base station controller **122** without regard for modulation type for that same second base station controller **122**.

[0057] The various alternative embodiments for adaptive control of point-to-point communication are similar to the various alternative embodiments described in the Incorporated Disclosures for adaptive control of point-to-multipoint communication.

[0058] The system performs adaptive control of point-to-point communication between the first base station controller **121** and each (nearby) second base station controller **122**. This achieves at least the following purposes:

[0059] optimizing communication between the first base station controller **121** and each individual second base station controller **122**, such as by minimizing CCI, fading, and multipath effects; and

[0060] minimizing interference between intracell communication and intercell communication, such as by minimizing CCI and other forms of interference between intracell communication signals and intercell communication signals.

[0061] In a preferred embodiment, physical parameters and MAC parameters include the physical parameters described in the Incorporated Disclosures. These include: antenna selection, power level selection, channel selection, modulation type, symbol rate, error code type, and equalization parameters.

[0062] In a preferred embodiment, physical parameters and MAC parameters include the MAC parameters described in the Incorporated Disclosures. These include: message size, acknowledgment in the transmission, and TDD duty cycle.

[0063] Those skilled in the art would recognize, after perusal of this application, that physical parameters and MAC parameters selected by the first base station controller **120** for adaptive point-to-point communication with a particular nearby base station controller **120** in a nearby cell, need not be identical or even correlated with physical parameters and MAC parameters selected by the same first base station controller **120** for adaptive point-to-multipoint communication with customer premises equipment **130** in the same cell.

[0064] The first base station controller **120** maintains these physical parameters and MAC parameters, and adaptively modifies them with changing conditions on the communication link between the first base station controller **120** and nearby base station controllers **120**. In a preferred embodiment, the first base station controller **120** uses a technique for maintenance and adaptive modification similar to that described with respect to the base station controller **120** and its communication links with customer premises equipment **130** in the Incorporated Disclosures.

[0065] Those skilled in the art would recognize, after perusal of this application, that adaptive control of point-to-point communication by the first base station controller **120** with regard to nearby the station controllers **120** need not use the same values or the same hysteresis parameters as adaptive control of point-to-multipoint communication by the base station controller **120** with regard to customer premises equipment **130**. Thus for example, the hysteresis parameters shown in the Incorporated Disclosures might include a first set of values for adaptive control of point-to-point communication, and might include a second set of values for adaptive control of point to multipoint communication.

Access Points

[0066] **FIG. 2** shows a block diagram of a system including an integrated backhaul capability in a wireless communication system with access points.

[0067] In a preferred embodiment, an individual base station controller **120** is coupled to a plurality of customer premises equipment **130** using a set of access points **210**, as described in the Incorporated Disclosures. The access points **210**, provides enhanced communication and enhanced connectivity between the base station controller **120** and customer premises equipment **130**.

[0068] In addition to providing enhanced communication and enhanced connectivity, the access points **210** are integrated into the backhaul capability of the wireless communication system **100**. Thus, communication between customer premises equipment **130** and the non-wireless communication system **140** can include connectivity (between a base station controller **120** and one or more

customer premises equipment **130**) provided by one or more access points **210**. In addition to allowing a base station controller **120** to communicate with customer premises equipment **130**, access points **210** also allow customer premises equipment **130** to communicate with non-wireless communication system **140**, such as by means of one or more base station controllers **120**.

Access Points in a Mesh Network

[**0069**] **FIG. 3** shows a block diagram of a system including an integrated backhaul capability in a system with access points in a mesh network.

[**0070**] In a preferred embodiment, the access points **210** coupling an individual base station controller **120** a plurality of customer premises equipment **130** can include a mesh network **220**, as described in the Incorporated Disclosures. The mesh network **220** includes a plurality of access points **210**, each into communicating so as to deliver messages between the base station controller **120** and customer premises equipment **130**. The mesh network **220** thus provides enhanced communication and enhanced connectivity between the base station controller **120** and customer premises equipment **130**. The mesh network **220** thus also provides enhanced communication and enhanced connectivity between customer premises equipment **130** and non-wireless communication system **140**.

[**0071**] In addition to providing enhanced communication and enhanced connectivity, the mesh network **220** is integrated into the backhaul capability of the wireless communication system **100**. Thus, communication between customer premises equipment **130** and the non-wireless communication system **140** can include connectivity (between a base station controller **120** and one or more customer premises equipment **130**) provided by the mesh network **220**. Thus, in addition to allowing a base station controller **120** to communicate with customer premises equipment **130**, the mesh network **220** also allows customer premises equipment **130** to communicate with non-wireless communication system **140**, such as by means of one or more base station controllers **120**.

Elements for QoS and Flow Management

[**0072**] **FIG. 4** shows a block diagram of a system including an integrated backhaul capability including QoS and flow management.

[**0073**] In a preferred embodiment, the system **100** provides for an integrated backhaul capability with wireless communication, including an entire communication pathway. Thus, the integrated backhaul capability includes customer premises equipment **130**, base station controllers **120**, backhaul capability elements (such as the communication link **150** between a selected base station controller **120** and the non-wireless communication system **140**), and a router or switch coupled to the non-wireless communication system **140**.

[**0074**] As shown in **FIG. 4**, base station controllers **120** adaptively adjust wireless communication, including both physical parameters and MAC parameters, for a substantial fraction of the entire communication pathway. This includes backhaul capability elements, base station controllers **120**, and customer premises equipment **130**. (In systems where access points **210** or a mesh network **220** of access points **210** are employed, this includes the access points **210** or the mesh network **220**.) Adaptive adjustment of wireless communication causes the coupling of wireless link layers throughout the system **100**, including backhaul capability elements, base station controllers **120**, and customer premises equipment **130**. As noted in the Incorporated Disclosures, adaptive adjustment of wireless communication includes adjustment of physical parameters and MAC parameters for wireless communication including base station controllers **120** and customer premises equipment **130**.

[**0075**] Base station controllers **120** also adaptively adjust IP parameters, QoS (quality of service) parameters, and flow management parameters, also for substantial fraction of the entire communication pathway. This includes backhaul capability elements, base station controllers **120** and customer premises equipment **130**.

[**0076**] Where applicable, base station controllers **120** also adaptively adjust IP parameters, QoS parameters, and flow management parameters, for communication including one or more routers or switches in the non-wireless communication system **140**. Thus, base station controllers **120** can adjust communication between routers or switches in the non-wireless communication system **140** and all elements of the wireless communication system **100**. This allows base station controllers **120** to optimize the integrated backhaul capability of the wireless communication system **100** with regard to parameters used at the IP layer of communication. Thus, adaptive adjustment of IP layer parameters causes the coupling of network layer elements throughout the system **100**, including routers or switches, backhaul capability elements, base station controllers **120**, and customer premises equipment **130**.

Elements for QoS and Flow Management with Access Points

[**0077**] **FIG. 5** shows a block diagram of a system including an integrated backhaul capability with QoS and flow management, using access points.

[**0078**] As shown in **FIG. 5**, base station controllers **120** also adaptively adjust wireless communication, including both physical parameters and MAC parameters, for substantial fraction of the entire communication pathway, when that communication pathway includes access points **210** or mesh networks **220**. This includes those elements described with reference to **FIG. 4**, plus any access points **210** and mesh networks **220** of access points **210**. Adaptive adjustment of wireless communication causes the coupling of wireless link layers throughout the system **100**, including any access points **210** and mesh networks **220** of access points **210**. As noted in the Incorporated Disclosures, adaptive adjustment of wireless communication includes adjustment physical parameters and MAC parameters for wireless communication including base station controllers **120**, access points **210**, and customer premises equipment **130**.

[**0079**] Base station controllers **120** also adaptively adjust IP parameters, QoS parameters, and flow management parameters, as described with regard to **FIG. 4**, for any access points **210** and any mesh networks **220** of access points **210**. This also includes communication between routers or switches in the non-wireless communication system, as well as any access points **210** and any mesh network **220** of access points **210**, so as to form a completely

integrated wireless communication system **100** having integrated backhaul capability with a non-wireless communication system **140**.

Generality of the Invention

[**0080**] The invention has general applicability to various fields of use, not necessarily related to the services described above. For example, these fields of use can include one or more of, or some combination of, the following:

[**0081**] The invention is applicable to other forms of wireless communication, such as frequency division multiple access (FDMA) or code division multiple access (CDMA, also known as spread spectrum communication);

[**0082**] The invention is applicable to any non-wireless communication, in which relative effectiveness or efficiency of communication can be achieved from dynamically adjusting communication parameters, such as physical parameters or MAC parameters. For example, the invention can be generalized to non-wireless communication communication using modems in which equalization parameters are to be dynamically adjusted.

[**0083**] The invention is applicable to other wireless communication systems, such as satellite communication systems and (microwave tower or other) point to point transmission systems.

[**0084**] The invention is applicable to both fixed wireless communication systems, in which customer premises equipment do not move relative to the base station controller **120**, and to mobile wireless communication systems, and which customer premises equipment move substantially relative to the base station controller **120**.

[**0085**] Other and further applications of the invention in its most general form, will be clear to those skilled in the art after perusal of this application, and are within the scope and spirit of the invention.

[**0086**] Although preferred embodiments are disclosed herein, many variations are possible which remain within the concept, scope, and spirit of the invention, and these variations would become clear to those skilled in the art after perusal of this application.

1-15. (canceled)

16. A method, including steps of

performing wireless communication from a base station using a first set of values for parameters of an OSI model communication system;

performing non-wireless communication from the base station using a second set of values for parameters of an OSI model communication system, with the second set of values including values for one or more non-wireless communication elements including at least one router or switch in the OSI model communication system;

adaptively adjusting the first set of values and the second set of values, with the adaptive adjusting performed by the base station.

17. A method as in claim 16, wherein the wireless communication includes communication to access points within a cell that in turn communicate wirelessly with customer premises equipment in the call.

18. A method as in claim 16, wherein the non-wireless communication includes a backhaul capability.

19. A method as in claim 16, wherein the non-wireless communication includes communication over a computer communication network.

20. A method as in claim 16, wherein the non-wireless communication elements include routers, switches, or both routers and switches.

21. A method as in claim 16, wherein the first set of values and the second set of values are adjusted independently of each other.

22. A method as in claim 16, wherein the first set of values and the second set of values include values for media access control and physical layer parameters.

23. A method as in claim 16, wherein the first set of values and the second set of values include values for quality of service parameters.

24. A method as in claim 16, wherein the step of adaptively adjusting the first set of values and the second set of values further comprises:

sending first information using the first set of values;

obtaining second information regarding characteristics of the wireless communication link in response to a result of the step of sending;

adjusting one or more of said first values and said second values in conjunction in response to said second information.

25. A base station, including:

a transmitter and receiver that transmits and receives wireless communication;

an interface to non-wireless communication; and

a controller that causes the base station to perform steps including the steps of (a) performing the wireless communication using a first set of values for parameters of an OSI model communication system, (b) performing the non-wireless communication using a second set of values for parameters of an OSI model communication system, with the second set of values including values for one or more non-wireless communication elements including at least one router or switch in the OSI model communication system, and (c) adaptively adjusting the first set of values and the second set of values.

26. A base station as in claim 25, wherein the wireless communication includes communication to access points within a cell that in turn communicate wirelessly with customer premises equipment in the call.

27. A base station as in claim 25, wherein the non-wireless communication includes a backhaul capability.

28. A base station as in claim 25, wherein the non-wireless communication includes communication over a computer communication network.

29. A base station as in claim 25, wherein the non-wireless communication elements include routers, switches, or both routers and switches.

30. A base station as in claim 25, wherein the first set of values and the second set of values are adjusted independently of each other.

31. A base station as in claim 25, wherein the first set of values and the second set of values include values for media access control and physical layer parameters.

32. A base station as in claim 25, wherein the first set of values and the second set of values include values for quality of service parameters.

33. A base station as in claim 25, wherein the step of adaptively adjusting the first set of values and the second set of values further comprises:

sending first information using the first set of values;

obtaining second information regarding characteristics of the wireless communication link in response to a result of the step of sending;

adjusting one or more of said first values and said second values in conjunction in response to said second information.

34. A memory storing information including instructions executable by a processor to control wireless communication and non-wireless communication by a base station, the instructions including the steps of (a) performing the wireless communication using a first set of values for parameters of an OSI model communication system, (b) performing the non-wireless communication using a second set of values for parameters of an OSI model communication system, with the second set of values including values for one or more non-wireless communication elements including at least one router or switch in the OSI model communication system, and (c) adaptively adjusting the first set of values and the second set of values.

35. A memory as in claim 34, wherein the wireless communication includes communication to access points within a cell that in turn communicate wirelessly with customer premises equipment in the call.

36. A memory as in claim 34, wherein the non-wireless communication includes a backhaul capability.

37. A memory as in claim 34, wherein the non-wireless communication includes communication over a computer communication network.

38. A memory as in claim 34, wherein the non-wireless communication elements include routers, switches, or both routers and switches.

39. A memory as in claim 34, wherein the first set of values and the second set of values are adjusted independently of each other.

40. A memory as in claim 34, wherein the first set of values and the second set of values include values for media access control and physical layer parameters.

41. A memory as in claim 34, wherein the first set of values and the second set of values include values for quality of service parameters.

42. A memory as in claim 34, wherein the step of adaptively adjusting the first set of values and the second set of values further comprises:

sending first information using the first set of values;

obtaining second information regarding characteristics of the wireless communication link in response to a result of the step of sending;

adjusting one or more of said first values and said second values in conjunction in response to said second information.

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