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(54) **METHOD AND APPARATUS FOR DETERMINING TUNEAWAY TIME IN OPEN STATE IN WIRELESS COMMUNICATION SYSTEM**

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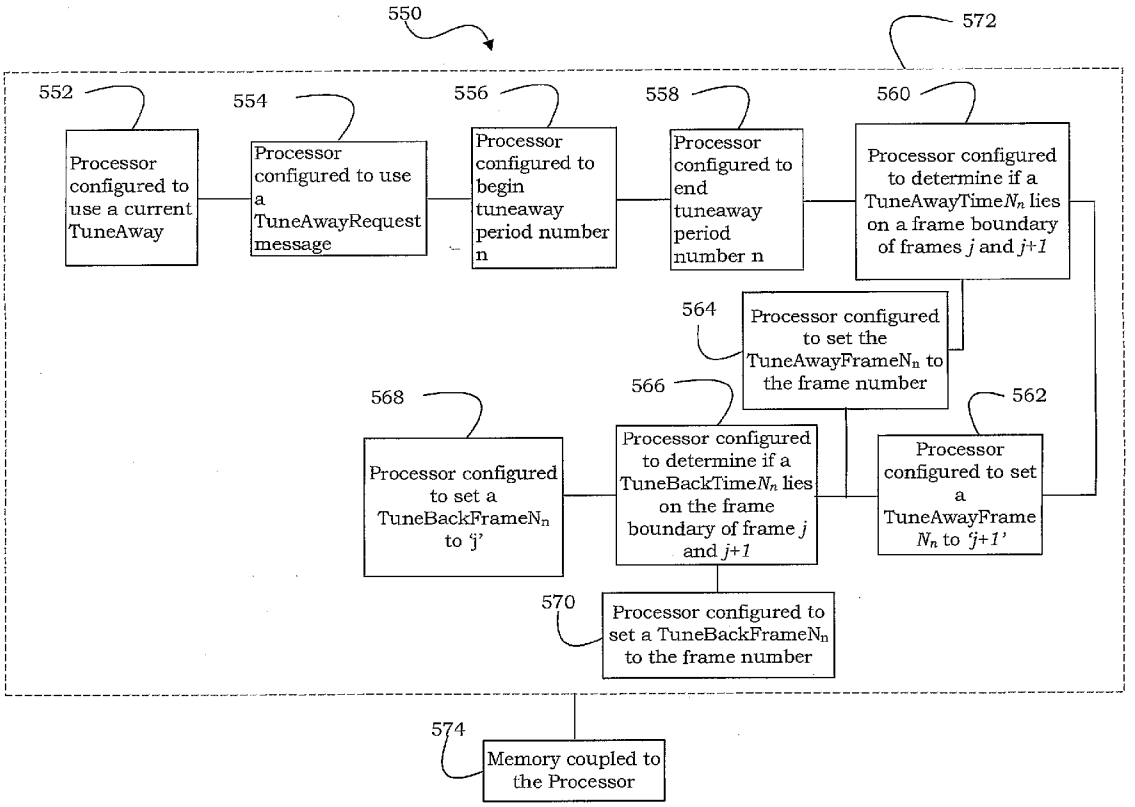
(57) **ABSTRACT**

A method and apparatus for determining TuneAway time in a wireless communication system is described. A current TuneAway attribute is and a TuneAwayRequest message having a MessageSequence matching the last received TuneAwayResponse is used. A tuneaway period number n for a sector with given sectorOffset is began at TuneAwayTimeNn, wherein the TuneAwayTimeNn is a function of t0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN. The tuneaway period number n for a sector with given sectorOffset is ended at TuneBackTimeNn, wherein the TuneBackTimeNn is a functions of TuneAwayTimeNn and TuneAwayDurationNn and if a TuneAwayTimeNn lies on a frame boundary of frames j and j+1 is determined.



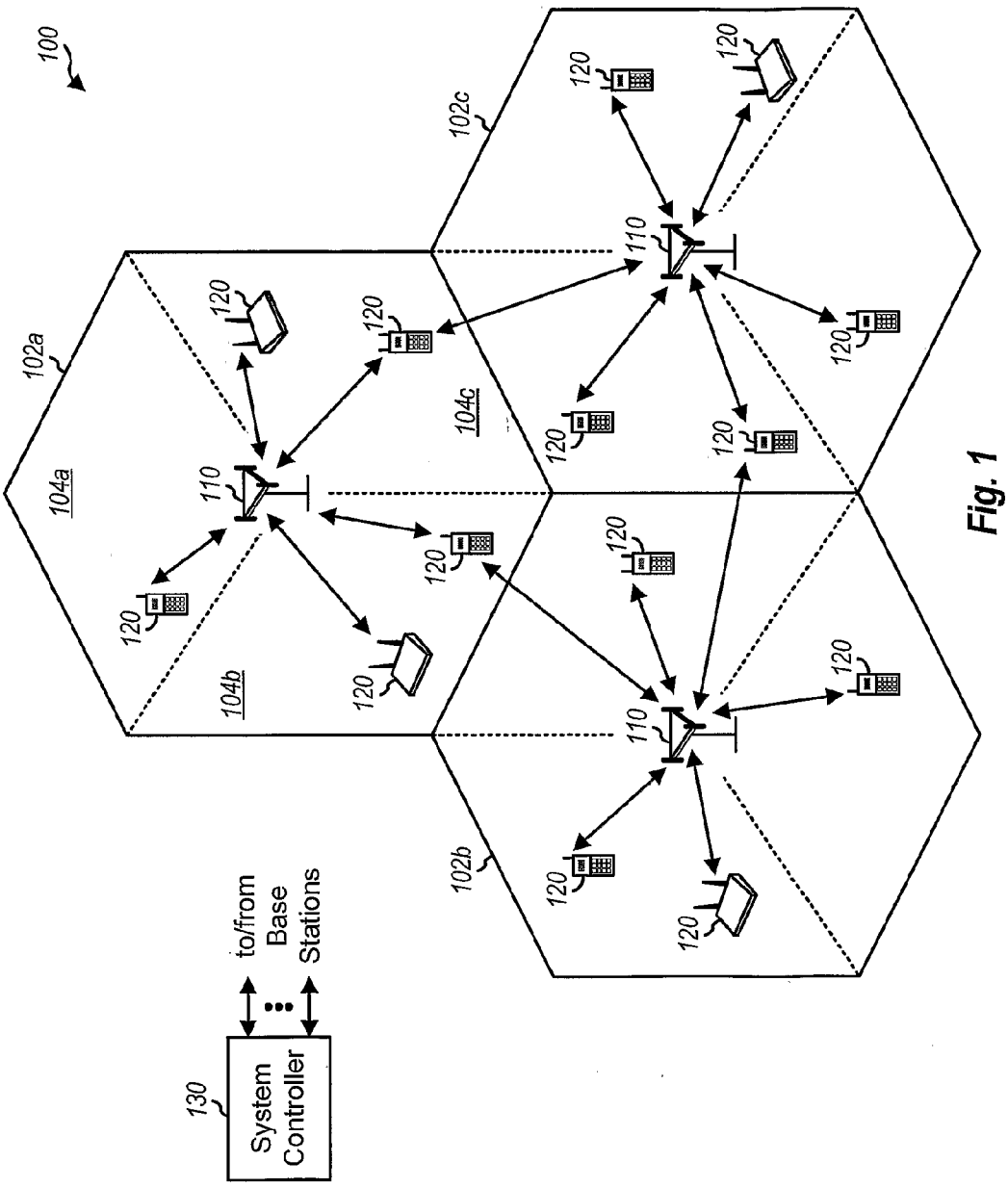

100
102a
102b
102c
104a
104b
104c
110
120
130
System Controller
to/from Base Stations

Fig. 1

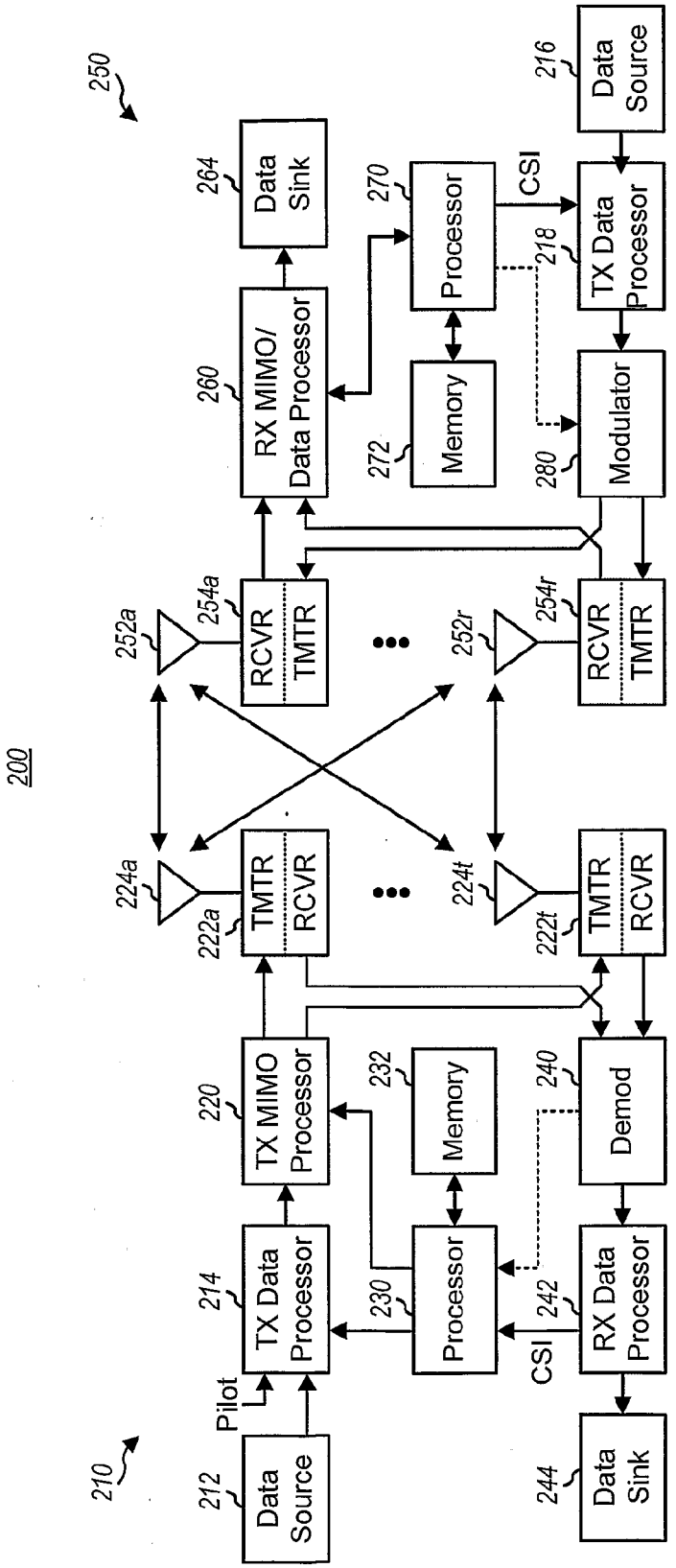

200
210
212 Data Source
Pilot
214 TX Data Processor
220 TX MIMO Processor
222a TMTR RCVR
224a
224t
222t TMTR RCVR
230 Processor
232 Memory
240 Demod
242 RX Data Processor
CSI
244 Data Sink
252a
254a RCVR TMTR
252r
254r RCVR TMTR
260 RX MIMO/ Data Processor
264 Data Sink
270 Processor
272 Memory
280 Modulator
218 TX Data Processor
CSI
216 Data Source
250

Fig 2

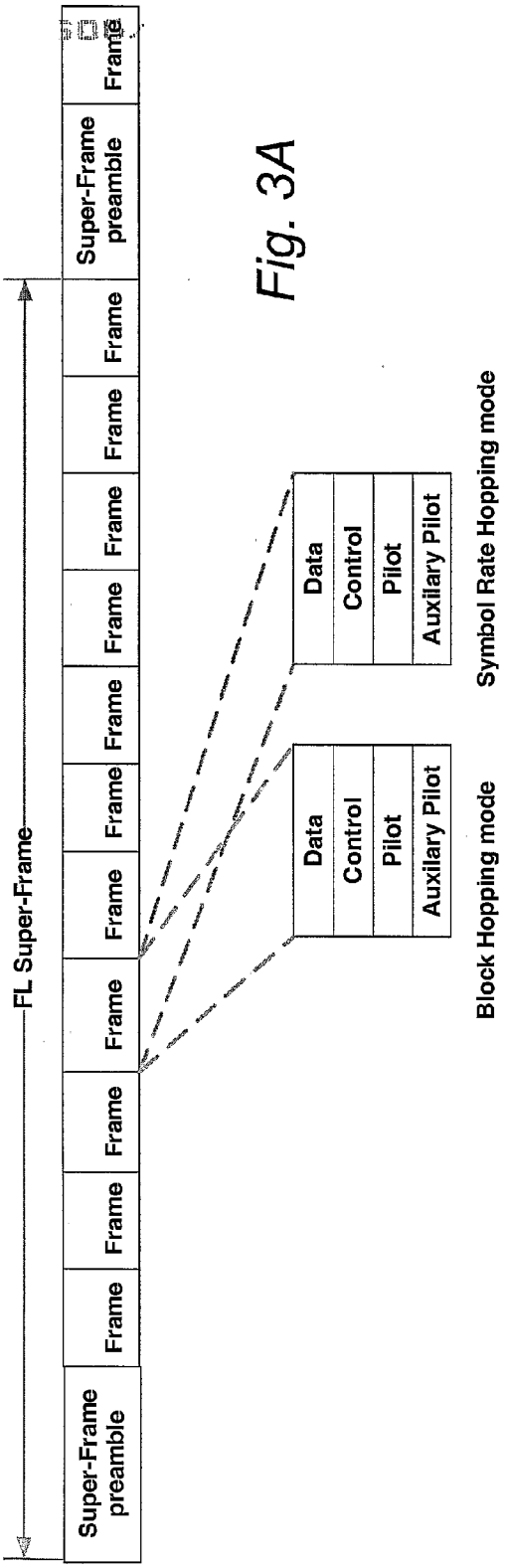

FL Super-Frame
Super-Frame preamble
Frame
Data
Control
Pilot
Auxilary Pilot
Block Hopping mode
Symbol Rate Hopping mode

Fig. 3A

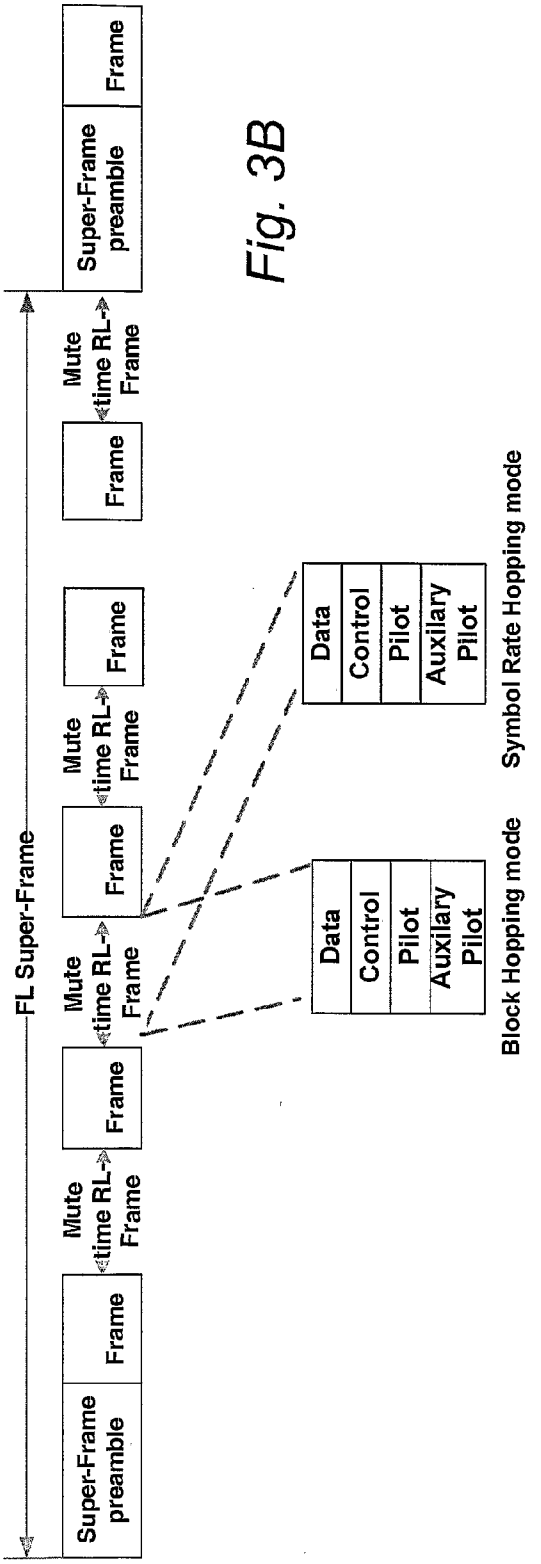

FL Super-Frame
Super-Frame preamble
Frame
Mute time RL-Frame
Data
Control
Pilot
Auxilary Pilot
Block Hopping mode
Symbol Rate Hopping mode

Fig. 3B

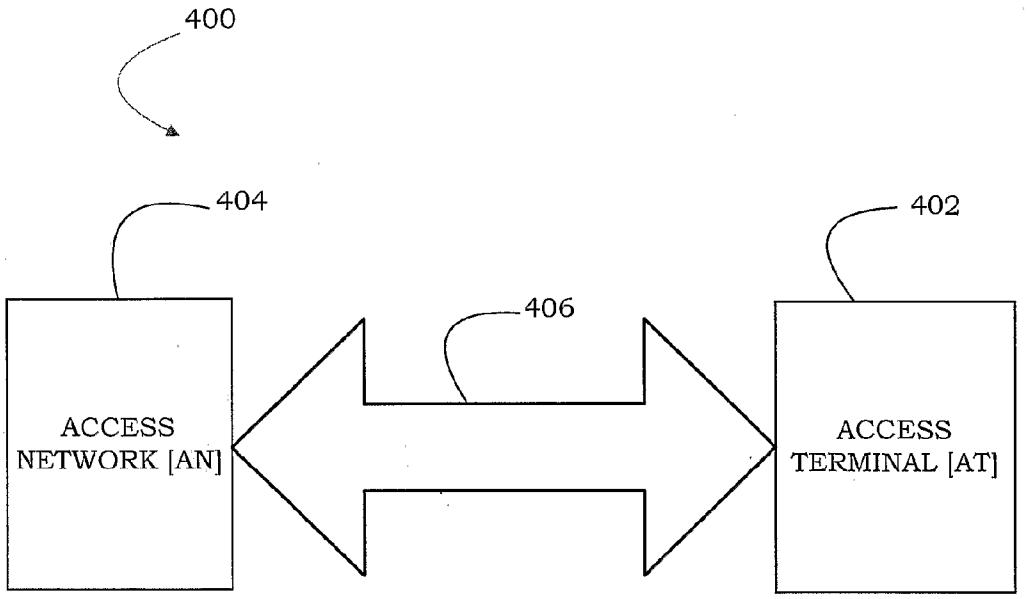


Fig. 4

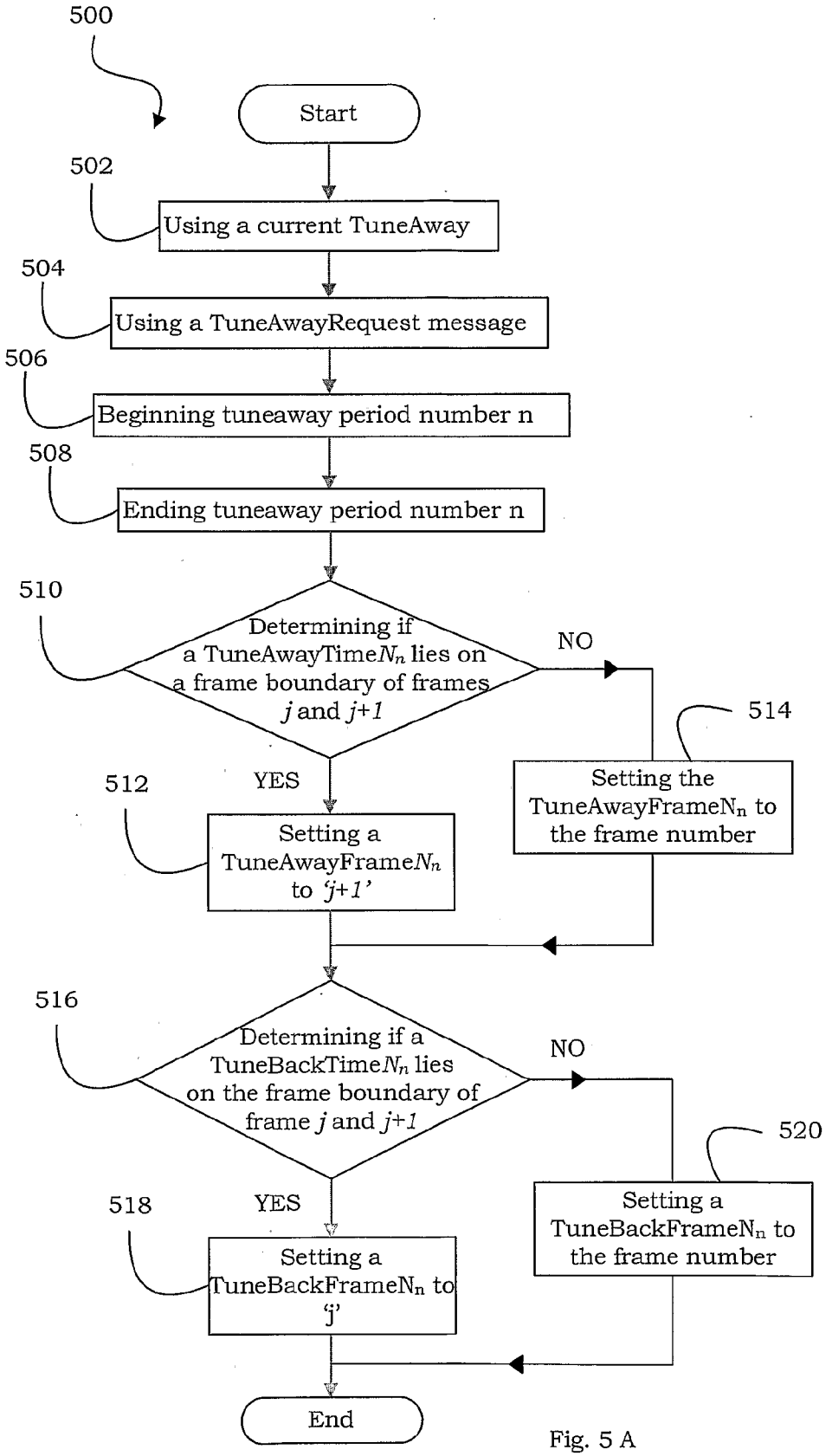

500
Start
502
Using a current TuneAway
504
Using a TuneAwayRequest message
506
Beginning tuneaway period number n
508
Ending tuneaway period number n
510
Determining if a TuneAwayTimeN_n lies on a frame boundary of frames j and $j+1$
NO
514
Setting the TuneAwayFrameN$_n$ to the frame number
YES
512
Setting a TuneAwayFrameN_n to '$j+1$'
516
Determining if a TuneBackTimeN_n lies on the frame boundary of frame j and $j+1$
NO
520
Setting a TuneBackFrameN$_n$ to the frame number
YES
518
Setting a TuneBackFrameN$_n$ to 'j'
End

Fig. 5 A

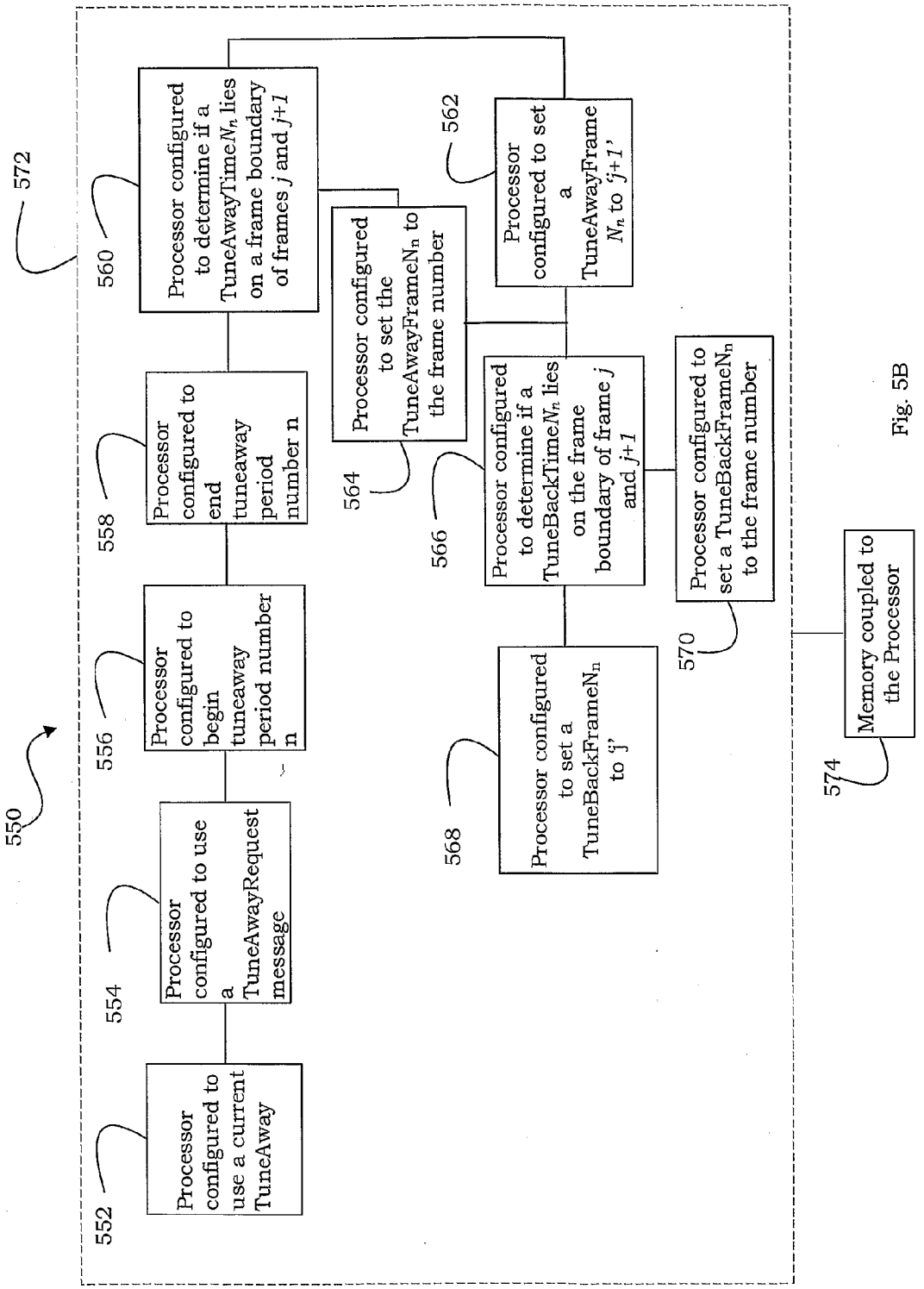

550
552
Processor configured to use a current TuneAway
554
Processor configured to use a TuneAwayRequest message
556
Processor configured to begin tuneaway period number n
558
Processor configured to end tuneaway period number n
560
Processor configured to determine if a TuneAwayTimeN_n lies on a frame boundary of frames j and $j+1$
562
Processor configured to set a TuneAwayFrame N_n to '$j+1$'
564
Processor configured to set the TuneAwayFrameNn to the frame number
566
Processor configured to determine if a TuneBackTimeN_n lies on the frame boundary of frame j and $j+1$
568
Processor configured to set a TuneBackFrameNn to 'j'
570
Processor configured to set a TuneBackFrameNn to the frame number
572
574
Memory coupled to the Processor

Fig. 5B

METHOD AND APPARATUS FOR DETERMINING TUNEAWAY TIME IN OPEN STATE IN WIRELESS COMMUNICATION SYSTEM

CLAIM OF PRIORITY UNDER 35 U.S.C. § 119

[0001] The present Application for Patent claims priority to Provisional Application Ser. No. 60/731,126 entitled "METHODS AND APPARATUS FOR PROVIDING MOBILE BROADBAND WIRELESS LOWER MAC", filed Oct. 27, 2005, assigned to the assignee hereof, and expressly incorporated herein by reference.

BACKGROUND

[0002] 1. Field

[0003] The present disclosure relates generally to wireless communication and more particularly to methods and apparatus for determining TuneAway time in open state.

[0004] 2. Background

[0005] Wireless communication systems have become a prevalent means by which a majority of people worldwide have come to communicate. Wireless communication devices have become smaller and more powerful in order to meet consumer needs and to improve portability and convenience. The increase in processing power in mobile devices such as cellular telephones has lead to an increase in demands on wireless network transmission systems. Such systems typically are not as easily updated as the cellular devices that communicate there over. As mobile device capabilities expand, it can be difficult to maintain an older wireless network system in a manner that facilitates fully exploiting new and improved wireless device capabilities.

[0006] Wireless communication systems generally utilize different approaches to generate transmission resources in the form of channels. These systems may be code division multiplexing (CDM) systems, frequency division multiplexing (FDM) systems, and time division multiplexing (TDM) systems. One commonly utilized variant of FDM is orthogonal frequency division multiplexing (OFDM) that effectively partitions the overall system bandwidth into multiple orthogonal subcarriers. These subcarriers may also be referred to as tones, bins, and frequency channels. Each subcarrier can be modulated with data. With time division based techniques, each subcarrier can comprise a portion of sequential time slices or time slots. Each user may be provided with a one or more time slot and subcarrier combinations for transmitting and receiving information in a defined burst period or frame. The hopping schemes may generally be a symbol rate hopping scheme or a block hopping scheme.

[0007] Code division based techniques typically transmit data over a number of frequencies available at any time in a range. In general, data is digitized and spread over available bandwidth, wherein multiple users can be overlaid on the channel and respective users can be assigned a unique sequence code. Users can transmit in the same wide-band chunk of spectrum, wherein each user's signal is spread over the entire bandwidth by its respective unique spreading code. This technique can provide for sharing, wherein one or more users can concurrently transmit and receive. Such sharing can be achieved through spread spectrum digital modulation, wherein a user's stream of bits is encoded and spread across a very wide channel in a pseudo-random fashion. The receiver is designed to recognize the associated unique sequence code and undo the randomization in order to collect the bits for a particular user in a coherent manner.

[0008] A typical wireless communication network (e.g., employing frequency, time, and/or code division techniques) includes one or more base stations that provide a coverage area and one or more mobile (e.g., wireless) terminals that can transmit and receive data within the coverage area. A typical base station can simultaneously transmit multiple data streams for broadcast, multicast, and/or unicast services, wherein a data stream is a stream of data that can be of independent reception interest to a mobile terminal. A mobile terminal within the coverage area of that base station can be interested in receiving one, more than one or all the data streams transmitted from the base station. Likewise, a mobile terminal can transmit data to the base station or another mobile terminal. In these systems the bandwidth and other system resources are assigned utilizing a scheduler.

[0009] The signals, signal formats, signal exchanges, methods, processes, and techniques disclosed herein provide several advantages over known approaches. These include, for example, reduced signaling overhead, improved system throughput, increased signaling flexibility, reduced information processing, reduced transmission bandwidth, reduced bit processing, increased robustness, improved efficiency, and reduced transmission power.

SUMMARY

[0010] The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

[0011] According to one embodiment, a method is provided for determining TuneAway time in a wireless communication system, the method comprising using a current TuneAway attribute, using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse, beginning tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN, ending tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$ and determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1.

[0012] According to another embodiment, a computer readable medium is described having a first set of instructions for using a current TuneAway attribute, a second set of instructions for using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse, a third set of instructions for beginning tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN, a fourth set of instructions for ending tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$ and a fifth set of instructions for determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1.

[0013] According to yet another embodiment, an apparatus operable in a wireless communication system, the apparatus comprising means for using a current TuneAway attribute, means for using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse, means for beginning tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$, is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN, means for ending tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$ and means for determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1.

[0014] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative aspects of the one or more aspects. These aspects are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed and the described aspects are intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** illustrates aspects of a multiple access wireless communication system;

[0016] FIG. **2** illustrates aspects of a transmitter and receiver in a multiple access wireless communication system;

[0017] FIGS. **3**A and **3**B illustrate aspects of superframe structures for a multiple access wireless communication system;

[0018] FIG. **4** illustrates aspect of a communication between an access terminal and an access network;

[0019] FIG. **5**A illustrates a flow diagram of a process used by an access terminal and an access network; and

[0020] FIG. **5**B illustrates one or more processors configured for determining TuneAway time.

DETAILED DESCRIPTION

[0021] Various aspects are now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more aspects. It may be evident, however, that such aspect(s) may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing one or more aspects.

[0022] Referring to FIG. **1**, a multiple access wireless communication system according to one aspect is illustrated. A multiple access wireless communication system **100** includes multiple cells, e.g. cells **102**, **104**, and **106**. In the aspect of FIG. **1**, each cell **102**, **104**, and **106** may include an access point **150** that includes multiple sectors. The multiple sectors are formed by groups of antennas each responsible for communication with access terminals in a portion of the cell. In cell **102**, antenna groups **112**, **114**, and **116** each correspond to a different sector. In cell **104**, antenna groups **118**, **120**, and **122** each correspond to a different sector. In cell **106**, antenna groups **124**, **126**, and **128** each correspond to a different sector.

[0023] Each cell includes several access terminals which are in communication with one or more sectors of each access point. For example, access terminals **130** and **132** are in communication base **142**, access terminals **134** and **136** are in communication with access point **144**, and access terminals **138** and **140** are in communication with access point **146**.

[0024] Controller **130** is coupled to each of the cells **102**, **104**, and **106**. Controller **130** may contain one or more connections to multiple networks, e.g. the Internet, other packet based networks, or circuit switched voice networks that provide information to, and from, the access terminals in communication with the cells of the multiple access wireless communication system **100**. The controller **130** includes, or is coupled with, a scheduler that schedules transmission from and to access terminals. In other aspects, the scheduler may reside in each individual cell, each sector of a cell, or a combination thereof.

[0025] As used herein, an access point may be a fixed station used for communicating with the terminals and may also be referred to as, and include some or all the functionality of, a base station, a Node B, or some other terminology. An access terminal may also be referred to as, and include some or all the functionality of, a user equipment (UE), a wireless communication device, terminal, a mobile station or some other terminology.

[0026] It should be noted that while FIG. **1**, depicts physical sectors, i.e. having different antenna groups for different sectors, other approaches may be utilized. For example, utilizing multiple fixed "beams" that each cover different areas of the cell in frequency space may be utilized in lieu of, or in combination with physical sectors. Such an approach is depicted and disclosed in co-pending U.S. patent application Ser. No. 11/260,895, entitled "Adaptive Sectorization in Cellular System."

[0027] Referring to FIG. **2**, a block diagram of an aspect of a transmitter system **210** and a receiver system **250** in a MIMO system **200** is illustrated. At transmitter system **210**, traffic data for a number of data streams is provided from a data source **212** to transmit (TX) data processor **214**. In an aspect, each data stream is transmitted over a respective transmit antenna. TX data processor **214** formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0028] The coded data for each data stream may be multiplexed with pilot data using OFDM, or other orthogonalization or non-orthogonalization techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on one or more particular modulation schemes (e.g., BPSK, QSPK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed on provided by processor **230**.

[0029] The modulation symbols for all data streams are then provided to a TX processor **220**, which may further process the modulation symbols (e.g., for OFDM). TX processor **220** then provides N_T modulation symbol streams to N_T transmitters (TMTR) **222***a* through **222***t*. Each transmitter **222** receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (e.g., amplifies, filters, and upconverts) the analog signals to

provide a modulated signal suitable for transmission over the MIMO channel. N_T modulated signals from transmitters **222***a* through **222***t* are then transmitted from N_T antennas **224***a* through **224***t*, respectively.

[0030] At receiver system **250**, the transmitted modulated signals are received by N_R antennas **252***a* through **252***r* and the received signal from each antenna **252** is provided to a respective receiver (RCVR) **254**. Each receiver **254** conditions (e.g., filters, amplifies, and downconverts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0031] An RX data processor **260** then receives and processes the N_R received symbol streams from N_R receivers **254** based on a particular receiver processing technique to provide N_T "detected" symbol streams. The processing by RX data processor **260** is described in further detail below. Each detected symbol stream includes symbols that are estimates of the modulation symbols transmitted for the corresponding data stream. RX data processor **260** then demodulates, deinterleaves, and decodes each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor **218** is complementary to that performed by TX processor **220** and TX data processor **214** at transmitter system **210**.

[0032] RX data processor **260** may be limited in the number of subcarriers that it may simultaneously demodulate, e.g. 512 subcarriers or 5 MHz, and such a receiver should be scheduled on a single carrier. This limitation may be a function of its FFT range, e.g. sample rates at which the processor **260** may operate, the memory available for FFT, or other functions available for demodulation. Further, the greater the number of subcarriers utilized, the greater the expense of the access terminal.

[0033] The channel response estimate generated by RX processor **260** may be used to perform space, space/time processing at the receiver, adjust power levels, change modulation rates or schemes, or other actions. RX processor **260** may further estimate the signal-to-noise-and-interference ratios (SNRs) of the detected symbol streams, and possibly other channel characteristics, and provides these quantities to a processor **270**. RX data processor **260** or processor **270** may further derive an estimate of the "operating" SNR for the system. Processor **270** then provides channel state information (CSI), which may comprise various types of information regarding the communication link and/or the received data stream. For example, the CSI may comprise only the operating SNR. In other aspects, the CSI may comprise a channel quality indicator (CQI), which may be a numerical value indicative of one or more channel conditions. The CSI is then processed by a TX data processor **278**, modulated by a modulator **280**, conditioned by transmitters **254***a* through **254***r*, and transmitted back to transmitter system **210**.

[0034] At transmitter system **210**, the modulated signals from receiver system **250** are received by antennas **224**, conditioned by receivers **222**, demodulated by a demodulator **240**, and processed by a RX data processor **242** to recover the CSI reported by the receiver system. The reported CSI is then provided to processor **230** and used to (1) determine the data rates and coding and modulation schemes to be used for the data streams and (2) generate various controls for TX data processor **214** and TX processor **220**. Alternatively, the CSI may be utilized by processor **270** to determine modulation schemes and/or coding rates for transmission, along with other information. This may then be provided to the transmitter which uses this information, which may be quantized, to provide later transmissions to the receiver.

[0035] Processors **230** and **270** direct the operation at the transmitter and receiver systems, respectively. Memories **232** and **272** provide storage for program codes and data used by processors **230** and **270**, respectively.

[0036] At the receiver, various processing techniques may be used to process the N_R received signals to detect the N_T transmitted symbol streams. These receiver processing techniques may be grouped into two primary categories (i) spatial and space-time receiver processing techniques (which are also referred to as equalization techniques); and (ii) "successive nulling/equalization and interference cancellation" receiver processing technique (which is also referred to as "successive interference cancellation" or "successive cancellation" receiver processing technique).

[0037] While FIG. **2** discusses a MIMO system, the same system may be applied to a multi-input single-output system where multiple transmit antennas, e.g. those on a base station, transmit one or more symbol streams to a single antenna device, e.g. a mobile station. Also, a single output to single input antenna system may be utilized in the same manner as described with respect to FIG. **2**.

[0038] The transmission techniques described herein may be implemented by various means. For example, these techniques may be implemented in hardware, firmware, software, or a combination thereof. For a hardware implementation, the processing units at a transmitter may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, electronic devices, other electronic units designed to perform the functions described herein, or a combination thereof. The processing units at a receiver may also be implemented within one or more ASICs, DSPs, processors, and so on.

[0039] For a software implementation, the transmission techniques may be implemented with modules (e.g., procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in a memory (e.g., memory **230**, **272***x* or **272***y* in FIG. **2**) and executed by a processor (e.g., processor **232**, **270***x* or **270***y*). The memory may be implemented within the processor or external to the processor.

[0040] It should be noted that the concept of channels herein refers to information or transmission types that may be transmitted by the access point or access terminal. It does not require or utilize fixed or predetermined blocks of subcarriers, time periods, or other resources dedicated to such transmissions.

[0041] Referring to FIGS. **3**A and **3**B, aspects of superframe structures for a multiple access wireless communication system are illustrated. FIG. **3**A illustrates aspects of superframe structures for a frequency division duplexed (FDD) multiple access wireless communication system, while FIG. **3**B illustrates aspects of superframe structures for a time division duplexed (TDD) multiple access wireless communication system. The superframe preamble may be transmitted separately for each carrier or may span all of the carriers of the sector.

[0042] In both FIGS. **3**A and **3**B, the forward link transmission is divided into units of superframes. A superframe may

consist of a superframe preamble followed by a series of frames. In an FDD system, the reverse link and the forward link transmission may occupy different frequency bandwidths so that transmissions on the links do not, or for the most part do not, overlap on any frequency subcarriers. In a TDD system, N forward link frames and M reverse link frames define the number of sequential forward link and reverse link frames that may be continuously transmitted prior to allowing transmission of the opposite type of frame. It should be noted that the number of N and M may be vary within a given superframe or between superframes.

[0043] In both FDD and TDD systems each superframe may comprise a superframe preamble. In certain aspects, the superframe preamble includes a pilot channel that includes pilots that may be used for channel estimation by access terminals, a broadcast channel that includes configuration information that the access terminal may utilize to demodulate the information contained in the forward link frame. Further acquisition information such as timing and other information sufficient for an access terminal to communicate on one of the carriers and basic power control or offset information may also be included in the superframe preamble. In other cases, only some of the above and/or other information may be included in this superframe preamble.

[0044] As shown in FIGS. **3**A and **3**B, the superframe preamble is followed by a sequence of frames. Each frame may consist of a same or a different number of OFDM symbols, which may constitute a number of subcarriers that may simultaneously utilized for transmission over some defined period. Further, each frame may operate according to a symbol rate hopping mode, where one or more non-contiguous OFDM symbols are assigned to a user on a forward link or reverse link, or a block hopping mode, where users hop within a block of OFDM symbols. The actual blocks or OFDM symbols may or may not hop between frames.

[0045] FIG. **4** illustrates communication between an access terminal **402** and an access network **404** using a communication link **406** with respect to Tune Away. Tune Away, discussed here but applicable to all of the embodiments, defines a repetitive set of time periods during which the access terminal and access network do not exchange any transmission. The beginning and end of tune away may be determined by the TuneAway attribute and the TuneAwayRequest and TuneAwayResponse messages. Further, the access terminal and access network may operate on multiple tune away schedules. The communication link may be implemented using communication protocols/standards such as World Interoperability for Microwave Access (WiMAX), infrared protocols such as Infrared Data Association (IrDA), short-range wireless protocols/technologies, Bluetooth® technology, ZigBee® protocol, ultra wide band (UWB) protocol, home radio frequency (HomeRF), shared wireless access protocol (SWAP), wideband technology such as a wireless Ethernet compatibility alliance (WECA), wireless fidelity alliance (Wi-Fi Alliance), 802.11 network technology, public switched telephone network technology, public heterogeneous communications network technology such as the Internet, private wireless communications network, land mobile radio network, code division multiple access (CDMA), wideband code division multiple access (WCDMA), universal mobile telecommunications system (UMTS), advanced mobile phone service (AMPS), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal frequency division multiple (OFDM), orthogonal frequency division multiple access (OFDMA), orthogonal frequency division multiple FLASH (OFDM-FLASH), global system for mobile communications (GSM), single carrier (1×) radio transmission technology (RTT), evolution data only (EV-DO) technology, general packet radio service (GPRS), enhanced data GSM environment (EDGE), high speed downlink data packet access (HSPDA), analog and digital satellite systems, and any other technologies/protocols that may be used in at least one of a wireless communications network and a data communications network.

[0046] FIG. **5**A illustrates a flow diagram of process **500**, according to an embodiment. At **502**, a current TuneAway attribute is used. At **504**, a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse is used. At **506**, tuneaway period number n for a sector with given sectorOffset is began at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TUneAwayPeriodicityN. At **508**, tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, is ended wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$. At **510**, it is determined if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1. In one embodiment, at **512**, a $TuneAwayFrameN_n$ is set to 'j+1'. In another embodiment, at **514**, the $TuneAwayFrameN_n$ is set to the frame number of a reverse link frame that contains time instance $TuneAwayTimeN_n$. At **516**, it is determined if a $TuneBackTimeN_n$ lies on the frame boundary of frames j and j+1. In one embodiment, at **518**, a $TuneBackFrameN_n$ is set to 'j'. In another embodiment, at **520**, the $TuneBackFrameN_n$ is set to the frame number of a reverse link frame that contains time instance $TuneBackTimeN_n$. Determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1 increases access terminals and access network efficiency such that one or more of the aforementioned embodiments need not occur.

[0047] FIG. **5**B illustrates a processor **550** for determining TuneAway time. The processor referred to may be electronic devices and may comprise one or more processors configured for determining TuneAway time. Processor **552** is configured to use a current TuneAway attribute. Processor **554** is configured to use a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse. Processor **556** is configured to begin tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN. Processor **558** is configured to end tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$. Processor **560** is configured to determine if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1. In one embodiment, processor **562** is configured to set a $TuneAwayFrameN_n$ to 'j+1'. In another embodiment, processor **564** is configured to set the $TuneAwayFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneAwayTimeN_n$. Processor **566** is configured to determine if a $TuneBackTimeN_n$ lies on the frame boundary of frames j and j+1. In one embodiment, processor **568** is configured to set a $TuneBackFrameN_n$ to 'j'. In another embodiment, processor **570** is configured to set the $TuneBackFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneBackTimeN_n$. Determining if a $TuneAwayTimeN_n$ lies on a frame boundary of

frames j and j+1 increases access terminal and access network efficiency such that one or more of the aforementioned embodiments need not occur. The functionality of the discrete processors **552** to **570** depicted in the figure may be combined into a single processor **572**. A memory **574** is also coupled to the processor **572**.

[0048] In an embodiment, an apparatus is described which comprises means for using a current TuneAway attribute, means for using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse, means for beginning tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN, means for ending tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$ and means for determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1. Means are also provided for setting a $TuneAwayFrameN_n$ to 'j+1', setting the $TuneAwayFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneAwayTimeN_n$, determining if a $TuneBackTimeN_n$ lies on the frame boundary of frames j and j+1, setting a $TuneBackFrameN_n$ to 'j' and setting $TuneBackFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneBackTimeN_n$. The means described herein may comprise one or more processors.

[0049] Furthermore, embodiments may be implemented by hardware, software, firmware, middleware, microcode, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program code or code segments to perform the necessary tasks may be stored in a machine readable medium such as a separate storage(s) not shown. A processor may perform the necessary tasks. A code segment may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

[0050] Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the description is not intended to be limited to the aspects shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

We claim:

1. A method of determining TuneAway time in a wireless communication system, characterized in that:

using a current TuneAway attribute;

using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse;

beginning tuneaway period number n for a sector with given sectorOffset at $TuneAwayTimeN_n$, wherein the $TuneAwayTimeN_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN;

ending tuneaway period number n for a sector with given sectorOffset at $TuneBackTimeN_n$, wherein the $TuneBackTimeN_n$ is a functions of $TuneAwayTimeN_n$ and $TuneAwayDurationN_n$; and

determining if a $TuneAwayTimeN_n$ lies on a frame boundary of frames j and j+1.

2. The method as claimed in claim **1**, characterized in that setting a $TuneAwayFrameN_n$ to 'j+1'.

3. The method as claimed in claim **1**, characterized in that setting the $TuneAwayFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneAwayTimeN_n$.

4. The method as claimed in claim **1**, characterized in that determining if a $TuneBackTimeN_n$ lies on the frame boundary of frames j and j+1.

5. The method as claimed in claim **4**, characterized in that setting a $TuneBackFrameN_n$ to 'j'.

6. The method as claimed in claim **4**, characterized in that setting $TuneBackFrameN_n$ to the frame number of a reverse link frame that contains time instance $TuneBackTimeN_n$.

7. The method as claimed in claim **1**, characterized in that determining if no valid TuneAwayResponse message is received.

8. The method as claimed in claim **7**, characterized in that determining if a TuneAwayRequest message with the TuneAwayEnabledN field set to '0' is sent.

9. The method as claimed in claim **8**, characterized in that entering a disabled state for a tune away schedule N.

10. The method as claimed in claim **1**, characterized in that determining if the TuneAwayResponse message is received with the TuneAwayEnabledN field set to '1'.

11. The method as claimed in claim **10**, characterized in that determining it is the beginning of frame number $TuneBackFrameN_n$.

12. The method as claimed in claim **11**, characterized in that entering a camped state for a tune away schedule N.

13. The method as claimed in claim **1**, characterized in that determining if it is the end of frame number $TuneAwayFrameN_n-1$.

14. The method as claimed in claim **13**, characterized in that entering a TuneAway state for a tune away schedule N.

15. The method as claimed in claim **1**, characterized in that determining if no valid TuneAwayResponse message is received.

16. The method as claimed in claim **15**, characterized in that determining if a TuneAwayRequest message with the TuneAwayEnabledN field set to '0' is sent.

17. The method as claimed in claim **16**, characterized in that entering a disabled state for a tune away schedule N.

18. The method as claimed in claim **17**, characterized in that determining if the TuneAwayResponse message is received with the TuneAwayEnabledN field set to '1'.

19. The method as claimed in claim **1**, characterized in that determining it is the beginning of frame number $TuneBackFrameN_n$.

20. The method as claimed in claim **19**, characterized in that entering a camped state for a tune away schedule N.

21. The method as claimed in claim **20**, characterized in that determining if it is the end of frame number $TuneAwayFrameN_n-1$.

22. The method as claimed in claim **21**, characterized in that entering a TuneAway state for a tune away schedule N.

23. A computer readable medium including instructions stored thereon, characterized in that:

a first set of instructions for using a current TuneAway attribute;

a second set of instructions for using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse;

a third set of instructions for beginning tuneaway period number n for a sector with given sectorOffset at TuneAwayTimeN$_n$, wherein the TuneAwayTimeN$_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN;

a fourth set of instructions for ending tuneaway period number n for a sector with given sectorOffset at TuneBackTimeN$_n$, wherein the TuneBackTimeN$_n$ is a functions of TuneAwayTimeN$_n$ and TuneAwayDurationN$_n$; and

a fifth set of instructions for determining if a TuneAwayTimeN$_n$ lies on a frame boundary of frames j and j+1.

23. An apparatus operable in a wireless communication system, characterized in that:

means for using a current TuneAway attribute;

means for using a TuneAwayRequest message having a MessageSequence matching a last received TuneAwayResponse;

means for beginning tuneaway period number n for a sector with given sectorOffset at TuneAwayTimeN$_n$, wherein the TuneAwayTimeN$_n$ is a function of t_0, StartOffsetN, SectorOffset, n and TuneAwayPeriodicityN;

means for ending tuneaway period number n for a sector with given sectorOffset at TuneBackTimeN$_n$, wherein the TuneBackTimeN$_n$ is a functions of TuneAwayTimeN$_n$ and TuneAwayDurationN$_n$; and

means for determining if a TuneAwayTimeN$_n$ lies on a frame boundary of frames j and j+1.

24. The apparatus as claimed in claim **23**, characterized in that means for setting a TuneAwayFrameN$_n$ to 'j+1'.

25. The apparatus as claimed in claim **23**, characterized in that means for setting the TuneAwayFrameN$_n$ to the frame number of a reverse link frame that contains time instance TuneAwayTimeN$_n$.

26. The apparatus as claimed in claim **23**, characterized in that means for determining if a TuneBackTimeN$_n$ lies on the frame boundary of frames j and j+1.

27. The apparatus as claimed in claim **26**, characterized in that means for setting a TuneBackFrameN$_n$ to 'j'.

28. The apparatus as claimed in claim **26**, characterized in that means for setting TuneBackFrameN$_n$ to the frame number of a reverse link frame that contains time instance TuneBackTimeN$_n$.

29. The apparatus as claimed in claim **23**, characterized in that means for determining if no valid TuneAwayResponse message is received.

30. The apparatus as claimed in claim **29**, characterized in that means for determining if a TuneAwayRequest message with the TuneAwayEnabledN field set to '0' is sent.

31. The apparatus as claimed in claim **30**, characterized in that means for entering a disabled state for a tune away schedule N.

32. The apparatus as claimed in claim **23**, characterized in that means for determining if the TuneAwayResponse message is received with the TuneAwayEnabledN field set to '1'.

33. The apparatus as claimed in claim **32**, characterized in that means for determining it is the beginning of frame number TuneBackFrameN$_n$.

34. The apparatus as claimed in claim **33**, characterized in that means for entering a camped state for a tune away schedule N.

35. The apparatus as claimed in claim **23**, characterized in that means for determining if it is the end of frame number TuneAwayFrameN$_n$−1.

36. The apparatus as claimed in claim **35**, characterized in that means for entering a TuneAway state for a tune away schedule N.

37. The apparatus as claimed in claim **23**, characterized in that means for determining if no valid TuneAwayResponse message is received.

38. The apparatus as claimed in claim **37**, characterized in that means for determining if a TuneAwayRequest message with the TuneAwayEnabledN field set to '0' is sent.

39. The apparatus as claimed in claim **38**, characterized in that means for entering a disabled state for a tune away schedule N.

40. The apparatus as claimed in claim **39**, characterized in that means for determining if the TuneAwayResponse message is received with the TuneAwayEnabledN field set to '1'.

41. The apparatus as claimed in claim **23**, characterized in that means for determining it is the beginning of frame number TuneBackFrameN$_n$.

42. The apparatus as claimed in claim **41**, characterized in that means for entering a camped state for a tune away schedule N.

43. The apparatus as claimed in claim **42**, characterized in that means for determining if it is the end of frame number TuneAwayFrameN$_n$−1.

44. The apparatus as claimed in claim **43**, characterized in that means for entering a TuneAway state for a tune away schedule N.

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