

APPARATUS AND METHODS FOR TRANSMITTING MULTICAST BROADCAST SERVICE IN WIRELESS COMMUNICATION SYSTEMS

TECHNICAL FIELD

[0001] The present disclosure relates generally to the field of wireless communications and more particularly to methods and related systems for multicast broadcast service (MBS) with reduced channel overhead and efficient coding gains.

BACKGROUND

[0002] Wireless access networks can be used for transmitting content, as provided by television broadcasts and the Internet. A standard for such distributions has been published. See IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems, IEEE New York, NY, February, 2006.

[0003] In MBS, a service flow of content is transferred between one base station (single-BS access) or multiple base stations (multi-BS access) and associated mobile stations (MSs) in a multicast communication. A multicast communication is a method for transmitting content directed to a specific group of users or MSs for receiving that content or services. Further, a MS may operate using multi-BS access with multiple base stations (BSs) over a network in a multicast communication.

[0004] Content transferred in a MBS between one or more BSs and MSs comprises signaling information and data transferred along a carrier. The signaling information is overhead in relation to the data transmitted by the base station(s) and received by the mobile station or subscriber station (SS). Other overhead such as MBS MAP resource allocation information is provided in downlink (DL) MAP content transmitted between the BSs and MSs. An amount of overhead information transferred between the BSs and MSs can be substantial in relation to data transferred in the service flows.

SUMMARY OF THE INVENTION

[0005] To achieve one of the above intentions, the present invention provides a method of providing multicast broadcast service (MBS) in a wireless access network, comprising: creating a MBS zone of a plurality of base stations and mobile stations; generating MBS control channel information, the MBS control channel (MCCH) information comprising physical layer transmission parameters for each of a plurality of MBS data bursts; jointly coding the MBS control channel information; establishing a MBS transmission period; and transmitting the MBS control channel information and the MBS data in the MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period.

[0006] The present invention further provides a system, comprising: a core service network; and an access service network to receive multicast data from the core service network, the access service network comprising: a multicast broadcast service controller (MBSC) to create a multicast broadcast service (MBS) zone comprising a plurality of base stations and mobile stations; and a MBS agent (MBSA) within each of the base stations to transmit MBS control channel information and MBS data in a MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period. A machine accessible medium that provides instructions is also provided, which when accessed, cause an access service network to perform operations comprising: creating a MBS zone comprising a plurality of base stations and mobile stations; generating MBS control channel information, the MBS control channel (MCCH) information comprising physical layer transmission parameters for each of a plurality of MBS data bursts; jointly coding the MBS control channel information; establishing a MBS transmission period; and transmitting MBS control channel information and MBS data in the MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS

transmission period.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention however, both as to organization and method of operation, together with objects features and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings in which

[0008] Figure 1 is a broadband wireless access network in accordance with some embodiments of the invention;

[0009] Figure 2 is a block diagram of an embodiment of a jointly coded MBS transmission period;

[0010] Figure 3 is a block diagram of an embodiment of a frame structure for a mixed carrier comprising MBS and unicast traffic;

[0011] Figure 4 is a block diagram of an embodiment of a frame structure for a dedicated carrier;

[0012] Figure 5 is a block diagram of another embodiment of a frame structure for a dedicated carrier;

[0013] Figure 6 is a block diagram of an embodiment of a MBS transmission period with physical layer parameters inserted in data;

[0014] Figure 7 is a block diagram of an embodiment of a pilot pattern for multi-base station access with normal cell range;

[0015] Figure 8 is a block diagram of an embodiment of a pilot pattern for multi-base station access with large cell range; and

[0016] Figure 9 is a flowchart that describes an embodiment of a method for transmitting multicast broadcast service in a wireless access network.

[0017] It will be appreciated that for simplicity and clarity of illustration, elements illustrated in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to

other elements for clarity. Further, where considered appropriate, reference numerals have been repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION

[0018] In the following detailed description, numerous specific details for providing wireless multicast broadcast service are set forth to provide a thorough understanding of the invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components and circuits have not been described in detail so as not to obscure the present invention.

[0019] It would be an advance in the art to provide methods for reducing overhead transmitted over a carrier and for providing methods to increase the coding efficiency of MBS content. A reduction in channel overhead relating to MBS content can reduce the amount of power associated with the tasks of transmitting and receiving of the MBS content. Further, a decrease in overhead associated with the transmission of MBS content can increase throughput of the desired data, such as an electronic file or multimedia stream being transferred in a MBS to one or more access points, subscriber stations and/or mobile stations.

[0020] Now turning to the figures, Figure 1 illustrates a broadband wireless access network in accordance with some embodiments of the invention. Wireless access network 100 comprises core service network (CSN) 110 and access service network (ASN) 120. Among other things, wireless access network 100 may receive content from one or more content servers 112 and may provide the content to one or more access points (AP), subscriber stations or mobile stations (MS) 102. ASN 120 may include one or more gateways (GW) 108, illustrated as ASN GW 1 and ASN GW 2, and a plurality of base stations (BS) 104, illustrated as BS 1 through BS7. CSN110 may include authentication, authorization and accounting (AAA) server 111 which, among other things, may handle requests for access, among other

things.

[0021] In accordance with embodiments, gateways 108 may include a multicast broadcast service controller (MBSC) 118. Each MBSC 118 may create one or more multicast broadcast service (MBS) zones 106, and each MBS zone 106 may comprise a plurality of base stations 104. MBSCs 118 may create MBS zones 106 by establishing specific time and frequency parameters for simultaneous multicast downlink transmissions to mobile stations 102 within a particular one of MBS zones 106. In these embodiments, base stations 104 may include MBS agents (MBSA) 114 to cause and/or instruct base stations 104 to synchronously transmit identical content within MBS regions of downlink subframes. As described below, the MBSA within each of the base stations may be used to transmit MBS control channel information and MBS data in a MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period. The identical MBS regions may include multicast broadcast content identified by multicast connection identifiers (CIDs). Multicast broadcast services that may be provided by wireless access network 100 are discussed in more detail below.

[0022] In some embodiments, wireless access network 100 may operate as a single-frequency network (SFN). In these embodiments, base stations 104 of a common MBS zone 106 may have their downlink and/or uplink subframes synchronized in both time and frequency allowing mobile stations 102 to receive multicast broadcast content from any base station 104 of a particular MBS zone 106 without having to perform handover operations within an MBS zone. In these embodiments, mobile stations 102 may take advantage of diversity gain achieved by receiving signals concurrently from more than one base station 104 of a MBS zone 106 which may result in an improved signal-to-noise ratio (SNR) at the mobile station 102. In these embodiments, multicast broadcast content may be provided within identical MBS regions of downlink subframes allowing mobile stations 102 to receive broadcast content from any one or more of base stations 104

of a MBS zone 106. In some embodiments, one or more non single-frequency network (non-SFN) base stations (not illustrated) outside MBS zone 106 may transmit the multicast data non-synchronously, although the scope of the invention is not limited in this respect.

[0023] Figure 2 is a block diagram of some embodiments of a jointly coded MBS transmission period 201 of a MBS in the wireless access network 100. In this example the MBS transmission period 201 is a period within which each MBS is transmitted once. In one embodiment, the MBS transmission period 201 is 500 milliseconds (ms) in duration, resulting in a set of twenty-five 20 ms superframes. In another embodiment (not shown), the MBS transmission period 201 is 20 ms in duration, or one superframe as a minimum. In a further embodiment, the MBS transmission period 201 may result in an integer ranging between 2 and 24 superframes. An advantage to employing a longer MBS transmission period 201 is that the longer MBS transmission period 201 may result in enhanced power saving capabilities for the MS 102.

[0024] In an example where a mixed carrier is used for transmission of the MBS, content may be delivered by a plurality of superframes. In this example, each superframe is 20 ms in duration and is divided into four equally sized five ms radio frames. MBS is transmitted in downlink (DL) subframes, though each subframe may be designated as either DL or uplink (UL) subframes. In one embodiment, each subframe contains six orthogonal frequency-division multiplexing (OFDM) symbols, each symbol representing one or several bits of data. For a 10 megahertz (MHz) bandwidth, 1024 point fast Fourier transform (FFT) is used. In another example, a dedicated carrier is used for transmission of the MBS.

[0025] For service cells with a large radius (e.g. 10 km cell radius), an appropriate cyclic prefix (CP) length may be applied to correct for a delay spread within a composite channel. A size of the FFT may be sized according to the CP length to control CP overhead. For example, in a 10 MHz bandwidth environment, support of 2,048 point FFT results in 3 OFDM symbols per subframe. In another

example, support of 4,096 point FFT results in 3 OFDM symbols every two subframes.

[0026] The embodiment of Figure 2 further illustrates MBS control channel (MCCH) 210 information that is distributed or transmitted at the beginning at each MBS transmission period 201 in a MBS zone 106. The MCCH 210 information comprises MBS related control information, such as physical layer transmission parameters for each service, using joint coding. As illustrated in Figure 2, the MBS control channel 210 transmits MBS related control information for a first data burst 215, a second data burst 220, a third data burst 225 and a nth data burst 230 in a MBS transmission period T 201 of a MBS service. Transmission of MCCH 210 to the data bursts such as data burst 1 215 and data burst N 230 obviates the need for MCCH 210 to be decoded at each superframe. Instead, the MCCH can be decoded at each MBS transmission period T 201 which comprises a plurality of superframes in this example. As indicated in this embodiment, the MCCH indicates resource allocation for each data burst (e.g. Data Burst 1 215, Data Burst 2 220, etc.) in the MBS transmission period 201.

[0027] For the mixed carrier case, MBS and unicast traffic are time division multiplexed (TDM) on a subframe basis. In this example, a secondary broadcast channel (SBCH) 205 can provide information relating to a MBS zone. Further, the SBCH 205 can also indicate the physical layer parameters of MCCH 210 for the MBS transmission period 201.

[0028] Figure 3 is a block diagram embodiment of the MCCH 210 described in Figure 2 illustrating some embodiments of a frame structure for a mixed carrier comprising MBS and unicast traffic with MBS subframes allocated in a fixed pattern across superframes. In an alternate embodiment (not shown), the MBS subframes may be allocated in a varied pattern across the superframes.

[0029] As illustrated in Figure 3, a series of superframes including superframe A 301 and a superframe n 303 are transferred in a mixed carrier. The superframe A 301 comprises a synchronization channel (SCH) 305 and/or a preamble and the

secondary broadcast channel (SBCH) 205 along with MBS and/or unicast traffic in a frame 1 310. MBS and/or unicast traffic is also transmitted in a frame 2 320, a frame 3 330, a frame 4 340 and in frames of subsequent superframes in a MBS transmission period 201. In one embodiment, duration of the superframe A 301 is 20 ms and each of the frames 310 through 340 are 5 ms in duration. In this embodiment, the SBCH 205 on the mixed carrier indicates essential information about a dedicated carrier such as a frequency band and FFT size.

[0030] Each frame may be further subdivided into subframes 322 and MBS Single Frequency Network (MBSFN) subframe 324, each of the subframes 322 and MBSFN subframe 324 comprising one or more symbols. In this embodiment, each subframe 322 is assigned for unicast traffic. The frame 2 320 comprises a MBSFN subframe 324 wherein the MBSFN subframe 324 contains MBS data, which may be differentiated based upon information transmitted by the SBCH 205. A portion of the MBSFN subframe 324 comprises MBS control channel 210 parameters, as previously discussed in Figure 2. The frame 3 330 also comprises a plurality of subframes 322 including a MBSFN subframe 324. The MBSFN subframe 324 of Frame 3 330 may contain MBS control channel parameters 210 originating from the beginning of a MBS transmission period 201 in an embodiment where the MBS control channel parameters 210 are not contained in the MBSFN subframe 324 of Frame 2 320. Figure 3 further illustrates two of four frames of the superframe n 303 (two frames not shown), also comprising the subframes 322 and the MBSFN subframe 324 in a frame 9 350 and a frame 10 360.

[0031] In an alternate embodiment of the MCCH 210 allocation described in Figure 2, Figure 4 is a block diagram illustrating a frame structure in a dedicated carrier for transmission of a MBS. In this embodiment, one or more mobile stations 102 of Figure 1 tune to a dedicated carrier to receive MBS traffic in a MBS transmission period 201. The MBS transmission period 201 represents a time period necessary to broadcast all or a portion of MBS content. The mobile stations 102 read information in a secondary broadcast channel 205 on a mixed carrier and

then tune to the dedicated carrier. In this embodiment, a hybrid subframe 424 of frame 2 420 comprises the superframe control header 305 and the MBS control channel 210 information and subframes 322 comprise MBS traffic in the dedicated carrier.

[0032] Figure 5 is a block diagram of another embodiment of a frame structure for a dedicated carrier for transmission of MBS content or traffic. In this embodiment the secondary broadcast channel (SBCH) 205 on a dedicated carrier transmits or provides physical layer parameters of MBS control channel (MCCH) 210. If one or more mobile stations 102 tune to the dedicated carrier to receive MBS data, the one or more mobile stations 102 can synchronize to the dedicated carrier directly, read the SBCH 205 and read the MCCH 210 before reading the MBS traffic of superframes 301 and 303 including frames 510 through 560 of period T 201. Application of one or more of these embodiments may provide additional coding gains that allow for power efficiency and data traffic enhancements.

[0033] Figure 6 is a block diagram of some embodiments of a MBS transmission period n 601 with physical layer parameters inserted in MBS traffic for a subsequent period n+1 603. The physical layer parameters may be provided by MBS data as an alternative to reading the MBS control channel 210. In one embodiment, a portion of data burst 1 615 consists of private MAP 610 to provide physical layer parameters to the private map 1 610 in the subsequent period n+1 603. Providing physical layer parameter information in the MBS data traffic allows the one or more mobile stations 102 to determine physical layer parameter information without decoding the MCCH 210 as a way to increase power savings in the wireless access network 100. In this example, MBS data provided by private MAP 1 610 in a data burst 1 615 and private MAP N 620 in a data burst N 625 is captured in the period n+1 603. For resource allocation, DL distributed allocation may be used across subframes 322 with the same permutation sequence as mapping subcarriers to data retrieval units (DRU).

[0034] Figure 7 is a block diagram of an embodiment of pilot patterns for multi-base station access in the wireless access network 100. A first multi BS pilot symbol 710 and a second multi BS pilot symbol 720 in this embodiment provides a two-stream pilot pattern for multiple base station 104 communication. The block diagram of Figure 7 illustrates an OFDM symbol index increasing from left to right along rows and a sub-carrier index increasing from top to bottom along columns. A two dimensional grid of slots are provided in each pilot pattern for symbols, each symbol representing one or several bits of data in a plurality of subchannels. The pilot symbols, such as a first single BS pilot symbol 710 and a second single BS pilot symbol 720 are arranged in a non-overlapping pattern to provide channel estimation of two streams. Implementation may provide pilot boosting to increase a channel estimation performance, such as for MBS transmission in a downlink (DL). The pilot symbols may also be used to determine quality of service indicators such as frequency offset estimation and signal to interference plus noise ratio (SINR), among other channel quality indicators.

[0035] Figure 8 is a block diagram of an embodiment of a pilot pattern of a pilot symbol 810 for a dedicated carrier. Figure 8 also illustrates an OFDM symbol index increasing from left to right along rows and a sub-carrier index increasing from top to bottom along columns. In this embodiment, three OFDM symbols are allocated per subframe to provide a pilot pattern with a 1/9 pilot overhead.

[0036] Figure 9 is a flowchart that describes an embodiment of a method for transmitting multicast broadcast service in a wireless access network 100. In element 900, multicast broadcast zones 106 are determined wherein each multicast broadcast zone 106 comprises a plurality of base stations 104 and mobile stations 102. MBS traffic transmitted in each of the multicast broadcast zones 106 may provide the same MBS to each mobile station 102 in the multicast broadcast zone 106. Secondary broadcast channel (SBCH) data may be used to indicate or provide information regarding positioning of one or more multicast broadcast zones 106 in addition to MBS control channel (MCCH) information. Unicast data may be

transmitted in a unicast transmission and the MCCH information and MBS data or MBS traffic may be transmitted in a MBS transmission. Further, the MBS transmission and the unicast transmission may be multiplexed, for instance using time division multiplexing (TDM), using subframes 322. The MCCH, the MBS data and unicast data may alternately be multiplexed using TDM, frequency division multiplexing (FDM), or using another multiplexing algorithm.

[0037] In element 910, MBS control channel information is generated wherein the MBS control channel information comprises physical layer transmission parameters. The MBS control channel information is jointly coded in element 920 and a MBS transmission period 201 is established in element 930. Pilot symbols such as the pilot symbol 710 for small and large cell or the pilot symbol 810 for large cell size may be inserted in the MBS data to form one or more MBS data packets. The pilot symbols may be used to determine quality of service indicators such as frequency offset estimation and signal to interference plus noise ratio (SINR), among other channel quality indicators.

[0038] The MBS control channel information and MBS data are transmitted in the MBS transmission period in element 940. Physical layer transmission parameters may be inserted in the MBS data prior to transmission. The MBS control channel information is transmitted at the beginning of the MBS transmission period in this embodiment.

[0039] Embodiments may be described herein with reference to data such as instructions, functions, procedures, data structures, application programs configuration settings, etc. For purposes of this disclosure, the term “program” covers a broad range of software components and constructs, including applications, drivers, processes, routines, methods, modules and subprograms. The term “program” can be used to refer to a complete compilation unit (i.e., a set of instructions that can be compiled independently), a collection of compilation units, or a portion of a compilation unit. Thus, the term “program” may be used to refer to any collection of instructions which, when executed by the wireless access network

100, performs a desired transmission of multicast broadcast service. The programs in the wireless access network 100 may be considered components of a software environment.

[0040] The operation discussed herein may be generally facilitated via execution of appropriate firmware or software embodied as code instructions on the host processor and microcontroller of the access service network 120, the authentication accounting server 111, the content server 112, the base station 104, and/or the mobile station 102, as applicable. Thus, embodiments of the invention may include sets of instructions executed on some form of processing core or otherwise implemented or realized upon or within a machine-readable medium. A machine-readable medium includes any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computer). For example, a machine-readable medium can include an article of manufacture such as a read only memory (ROM); a random access memory (RAM); a magnetic disk storage media; an optical storage media and a flash memory device, etc. In addition, a machine-readable medium may include propagated signals such as electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.).

[0041] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

What is claimed is:

1. A method of providing multicast broadcast service (MBS) in a wireless access network, comprising:

creating a MBS zone of a plurality of base stations and mobile stations;

generating MBS control channel information, the MBS control channel (MCCH) information comprising physical layer transmission parameters for each of a plurality of MBS data bursts;

jointly coding the MBS control channel information;

establishing a MBS transmission period; and

transmitting the MBS control channel information and the MBS data in the MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period.

2. The method of claim 1, further comprising transmitting secondary broadcast channel (SBCH) data to indicate a MBS zone position and the MBS control channel information (MCCH).

3. The method of claim 2, further comprising transmitting unicast data in a unicast transmission and transmitting the MBS control channel (MCCH) and MBS data in a MBS transmission.

4. The method of claim 3, further comprising time division multiplexing (TDM) the MBS transmission and the unicast transmission using subframes.

5. The method of claim 1, further comprising multiplexing the MBS control channel information, the MBS data and unicast data.

6. The method of claim 1, further comprising inserting pilot symbols into the MBS data to form a MBS data packet.

7. The method of claim 1, further comprising inserting the physical layer transmission parameters into the MBS data.

8. A system, comprising:

a core service network; and

an access service network to receive multicast data from the core service network, the access service network comprising:

a multicast broadcast service controller (MBSC) to create a multicast broadcast service (MBS) zone comprising a plurality of base stations and mobile stations; and

a MBS agent (MBSA) within each of the base stations to transmit MBS control channel information and MBS data in a MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period.

9. The system of claim 8, wherein the MBSA transmits secondary broadcast channel (SBCH) data to indicate a MBS zone position and the MBS control channel information (MCCH).

10. The system of claim 9, further comprising transmitting unicast data in a unicast transmission and transmitting the MBS control channel (MCCH) and MBS data in a MBS transmission from the MBSA.

11. The system of claim 10, further comprising time division multiplexing (TDM) the MBS transmission and the unicast transmission in subframes with a host processor.

12. The system of claim 8, further comprising using the MBSA to multiplex the MBS control channel information, the MBS data and unicast data.

13. The system of claim 8, further comprising using the MBSA to insert pilot symbols into the MBS data to form a MBS data packet.

14. The system of claim 8, further comprising using the MBSA to insert the physical layer transmission parameters into the MBS data.

15. A machine accessible medium that provides instructions, which when accessed, cause an access service network to perform operations comprising:

creating a MBS zone comprising a plurality of base stations and mobile stations;

generating MBS control channel information, the MBS control channel

(MCCH) information comprising physical layer transmission parameters for each of a plurality of MBS data bursts;

jointly coding the MBS control channel information;

establishing a MBS transmission period; and

transmitting MBS control channel information and MBS data in the MBS transmission period, wherein the MBS control channel information is transmitted at the beginning of the MBS transmission period.

16. The machine accessible medium of claim 15, further comprising transmitting secondary broadcast channel (SBCH) data to indicate a MBS zone position and the MBS control channel information (MCCH).

17. The machine accessible medium of claim 16, further comprising transmitting unicast data in a unicast transmission and transmitting the MBS control channel (MCCH) and MBS data in a MBS transmission.

18. The machine accessible medium of claim 17, further comprising time division multiplexing (TDM) the MBS transmission and the unicast transmission using subframes.

19. The machine accessible medium of claim 15, further comprising multiplexing the MBS control channel information, the MBS data and unicast data.

20. The machine accessible medium of claim 15, further comprising inserting pilot symbols into the MBS data to form a MBS data packet.