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Additional inventors are being named on the ____________ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Method and Apparatus for Multi-Carrier Packet Communication with Reduced Overhead

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 11 ☐ CD(s), Number ____

☒ Drawing(s) *Number of Sheets* 13 ☐ Other (specify) ____

☐ Application Data Sheet. See 37 CFR 1.76

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Respectfully submitted,

SIGNATURE [signature]

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Date 09/27/2005

REGISTRATION NO. ____
(if appropriate)
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Method and Apparatus for Multi-Carrier Packet Communication with Reduced Overhead

Xiaodong Li, Haiming Huang, Titus Lo, and Ruifeng Wang

1 Background of the Invention

Bandwidth efficiency is one of the most important system performance factors for wireless communication systems. In packet based data communication, where the mixed traffic has a bursty and irregular pattern, application payloads are of different sizes and with different quality of service (QoS) requirements. In order to accommodate different applications, a wireless communication system should be able to provide a high degree of flexibility. However, in order to support such flexibility, additional overhead are usually required. For example, in a wireless system based on the IEEE 802.16 standard, multiple service flows are established for each mobile station to support different applications. At the medium access control (MAC) layer, each service flow is mapped into a wireless connection. The MAC scheduler allocates wireless air link resources to these connections. Special scheduling messages, DL-MAP and UL-MAP are defined to broadcast the scheduling decisions to the mobile stations.

In the MAP message in IEEE802.16, there is a significant overhead. First of all, each connection is identified by a 16 bits connection ID (CID). The CID is included in the MAP to identify the mobile station. The maximum number of connections that a system can support is therefore 65,536. Each mobile station has minimal two management connections for control and management messages and various number of traffic connections for application data traffic. Secondly, the airlink resource allocation can be correspondent to any time/frequency region. It is identified by the time domain scale with start symbol offset (8 bits) and symbol length (7 bits) and the frequency domain scale with start logical subchannel offset (6 bits) and numbers of allocated subchannels (6 bits). Due to the fact that different application has different resource requirement, the allocated resource region is irregular from connection to connection. Thirdly, the modulation and coding scheme is identified by MCS code, called as either downlink interval usage code (DIUC) or uplink interval usage code (UIUC), which is 4 bits. Another 2 bits are used to indicate the coding repetition in addition to 3 bits for power control. Overall, the overhead of a MAP element is 52 bits. For applications such as voice over IP, the payload of an 8Kbps voice codec is 20 bytes in every 20ms. The overhead of the MAP element alone can be as much as 32.5%, thereby resulting in a relatively low spectral efficiency.

The present invention describes the method and apparatus to reduce overhead in a multi-carrier packet communication system, thereby improve the spectral efficiency of the system.

2 Summary of the Invention

In this invention are described method and apparatus for a multi-carrier packet communication

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system with reduced overhead. A specific area in the time-frequency resource is designated for certain applications, such as VoIP. Adaptive modulation and coding method with modular resource utilization is designed to improve transmission spectral efficiency, while minimizing the control overhead. Method and apparatus are designed to take advantage of the special characteristics of the applications to minimize the number of bits to identify the destination of the packets. A control message is sent prior to the transmission of an application packet to indicate the packet destination, the radio resource utilized by the packet, and the modulation and coding method for the packet.

The system mentioned in this invention can be of any special formats such as Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access (OFDMA), or Multi-Carrier Code Division Multiple Access (MC-CDMA). Without loss of generality, OFDMA is taken as an example to illustrate the present invention. In addition, without loss of generality, voice applications are used as example applications to illustrate the present invention.

The subtitles are introduced for illustrating the aspects of the invention, and should not be interpreted as limiting the aspects of the invention.

3 Brief Description of the Drawings

The present invention will be thoroughly understood from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

Figure 1: A basic multi-carrier wireless communication system consists of a transmitter and a receiver, which consist of the necessary functions for transmission and reception, respectively.

Figure 2: A cellular wireless network is comprised of a plurality of cells, in each of which the coverage is provided by a base station (BS). Within each coverage area, there are distributed mobile stations. A base station is connected to the backbone of the network via a dedicated link and also provides radio links to the mobile stations within its coverage.

Figure 3: The radio resource is divided into small units in both the frequency and time domains: subchannels and time slots. Subchannels are formed by subcarriers. The basic structure of a multi-carrier signal in the time domain is made up of time slots.

Figure 4: The relationship is shown between the sampling frequency, the channel bandwidth, and the usable subcarriers. For a given bandwidth of a spectral band or channel (B_{ch}), the number of usable subcarriers is finite and limited, whose value depends on the size of the FFT and the sampling frequency (f_s).

Figure 5: The basic structure of a multi-carrier signal in the frequency domain is made up of subcarriers. Data subcarriers can be grouped into subchannels in a particular way. Each subchannel may be set at a different power level.

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