Exhibit H

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Additional inventors are being named on the 1 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

METHODS AND APPRATUS FOR OVERLAYING MULTI-CARRIER AND DIRECT-SEQUENCE SPREAD SPECTRUM SIGNALS IN A BROADBAND WIRELESS COMMUNICATION SYSTEM

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ENCLOSED APPLICATION PARTS ***(check all that apply)***

☒ Specification *Number of Pages* 11
☒ Drawing(s) *Number of Sheets* 18
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☐ Other (specify)

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Respectfully submitted,
SIGNATURE [signature]
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Date 1/30/2004
REGISTRATION NO.
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Methods and Apparatus for Overlaying Multi-Carrier and Direct Sequence Spread Spectrum Signals in a Broadband Wireless Communication System

1 Background of the Invention

In broadband wireless communications, Direct Sequence Spread Spectrum (DSSS) and Multi-Carrier (MC) techniques are commonly used. Both the DSSS and MC schemes have their own advantages. For instance, DSSS is inherently capable of supporting multi-cell and multi-user access applications through the use of orthogonal spreading codes. By its nature of interference averaging, initial access of the physical channel and frequency planning are relatively easier to be done in DSSS system. From here on, we will use SS to refer to DSSS.

As one example of MC, Orthogonal Frequency Division Multiplexing (OFDM) with cyclic prefix insertion mitigates inter-symbol interference (ISI) by extending the signal period as the data is multiplexed on orthogonal sub-carriers. As such, it converts a frequency selective channel into a number of parallel flat fading channels which can be easily equalized with simple one-tap equalizers. The (de)modulator can be executed efficiently via the fast Fourier transform (FFT) with much lower cost. In general, MC is capable of supporting broadband application with a higher spectral efficiency and at the same time not severely impacted by multi-path propagation in wireless environment.

On the other hand, both of them have their weaknesses. For example, wideband spread spectrum systems with orthogonal spreading codes suffer severely due to the loss of orthogonality by multi-path propagation therefore yielding low spectral efficiency, while multi-carrier systems need to be carefully designed to operate in a multi-user and multi-cell environment.

2 Summary of the Invention

This invention is an advanced scheme that coordinates MC and SS signaling in one system where both signals are intentionally overlaid together in both time and frequency domains. It takes advantages of both MC and SS techniques while mitigating their weaknesses. The MC signal is used to carry broadband data signal due to its high spectral efficiency, while the SS signal is used for special purpose processing, such as initial random access, channel probing, and short messaging, in which cases properties such as signal simplicity, self synchronization, and performance under severe interference are more important. The system is designed in such a way that both the MC signal and the SS signal are distinguishable in normal operations, i.e., the interferences between the two signals do not degrade their respective expected performance.

Unlike a typical CDMA system where the signals are designed to be orthogonal in code domain, or a typical OFDM system where the signals are designed to be orthogonal in frequency domain, this invention intentionally overlay the MC signal, which has no spreading or a very low spreading factor to achieve high spectrum efficiency, and the SS signal, which has a much lower power level than that of the MC signal.

In one embodiment, the MC signal is modulated on subcarriers in the frequency domain while the SS signal is modulated in the time domain. A special case is that the modulation symbol on the SS sequence is 1; that is, the sequence is unmodulated. Correspondingly, the MC signal is demodulated in the frequency domain and the SS signal is demodulated in the time domain.

This invention further provides the apparatus or means to implement the aforesaid design process and methods in a broadband wireless multi-access and multi-cell network using advanced techniques, such as transmit power control, spreading signal design, and iterative cancellation.

The multi-carrier system mentioned in this invention can be of any special formats such as OFDM, or Multi-Carrier Code Division Multiple Access (MC-CDMA). The invention can be applied to downlink, uplink, or both, where the duplexing technique can be either Time Division Duplexing (TDD) or Frequency Division Duplexing (FDD).

3 Brief Description of the Drawings

The present invention will be understood clearly 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: The basic structure of a multi-carrier signal in the frequency domain is made up of subcarriers. Data subcarriers can be grouped into subchannels.

Figure 2: The radio resource is divided into small units in both the frequency and time domains: subchannels and time slots. The basic structure of a multi-carrier signal in the time domain is made up of time slots.

Figure 3: Frame structure of an exemplary OFDM system. A 20ms frame is divided into four 5ms subframes. One subframe consists of six time slots and two special periods.

Figure 4: Three examples of the subframe structure in the exemplary OFDM system: one symmetric configuration and two asymmetric configurations.

Figure 5: Slot structure of the OFDM system and the overlay system. One 800 us time slot is comprised of 8 OFDM symbols. It is overlaid by SS signals in time domain. Two guard periods GP1 and GP2 are allocated for the SS signal.

Figure 6: The illustration of MC signals overlaid with SS signals in the frequency domain where the power level of the SS signal is much lower than that of the MC

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