

Exhibit 4

(12) **United States Patent**
Li et al.

(10) **Patent No.:** **US 10,447,450 B2**
(45) **Date of Patent:** ***Oct. 15, 2019**

(54) **METHOD AND SYSTEM FOR MULTI-CARRIER PACKET COMMUNICATION WITH REDUCED OVERHEAD**

H04L 1/00 (2006.01)
H04W 72/04 (2009.01)
H04J 11/00 (2006.01)
H04W 52/14 (2009.01)

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(52) **U.S. Cl.**
CPC *H04L 5/0053* (2013.01); *H04J 11/005* (2013.01); *H04L 1/0003* (2013.01); *H04L 1/0009* (2013.01); *H04L 1/0029* (2013.01); *H04L 5/006* (2013.01); *H04L 5/0007* (2013.01); *H04L 5/0044* (2013.01); *H04L 27/2601* (2013.01); *H04W 52/146* (2013.01); *H04W 72/04* (2013.01); *H04W 72/048* (2013.01); *H04L 5/0094* (2013.01)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(58) **Field of Classification Search**
CPC *H04L 5/0053*; *H04L 1/0003*; *H04J 11/005*
See application file for complete search history.

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(21) Appl. No.: **15/676,421**

(57) **ABSTRACT**

(22) Filed: **Aug. 14, 2017**

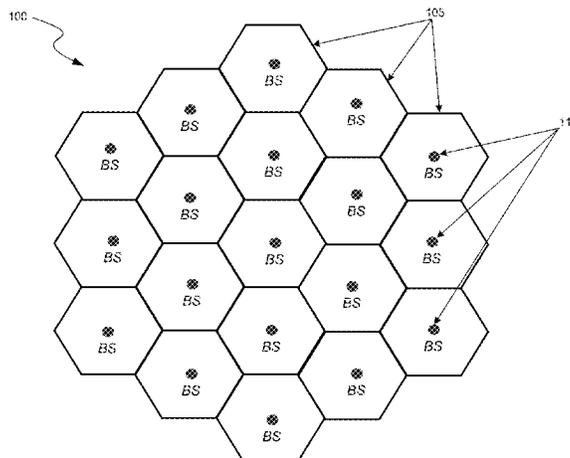
A method and system for minimizing the control overhead in a multi-carrier wireless communication network that utilizes a time-frequency resource is disclosed. In some embodiments, one or more zones in the time-frequency resource are designated for particular applications, such as a zone dedicated for voice-over-IP (VoIP) applications. By grouping applications of a similar type together within a zone, a reduction in the number of bits necessary for mapping a packet stream to a portion of the time-frequency resource can be achieved. In some embodiments, modular coding schemes associated with the packet streams may be selected that further reduce the amount of necessary control information. In some embodiments, packets may be classified for transmission in accordance with application type, QoS parameters, and other properties. In some embodiments, improved control messages may be constructed to facilitate the control process and minimize associated overhead.

(65) **Prior Publication Data**
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Related U.S. Application Data
(63) Continuation of application No. 14/720,554, filed on May 22, 2015, now Pat. No. 9,735,944, which is a continuation of application No. 14/248,243, filed on Apr. 8, 2014, now Pat. No. 9,042,337, which is a continuation of application No. 13/115,055, filed on May 24, 2011, now Pat. No. 8,693,430, which is a continuation of application No. 11/908,257, filed as (Continued)

(51) **Int. Cl.**
H04L 5/00 (2006.01)
H04L 27/26 (2006.01)

18 Claims, 12 Drawing Sheets



Related U.S. Application Data

application No. PCT/US2006/038149 on Sep. 28, 2006, now Pat. No. 7,948,944.

- (60) Provisional application No. 60/721,451, filed on Sep. 28, 2005.

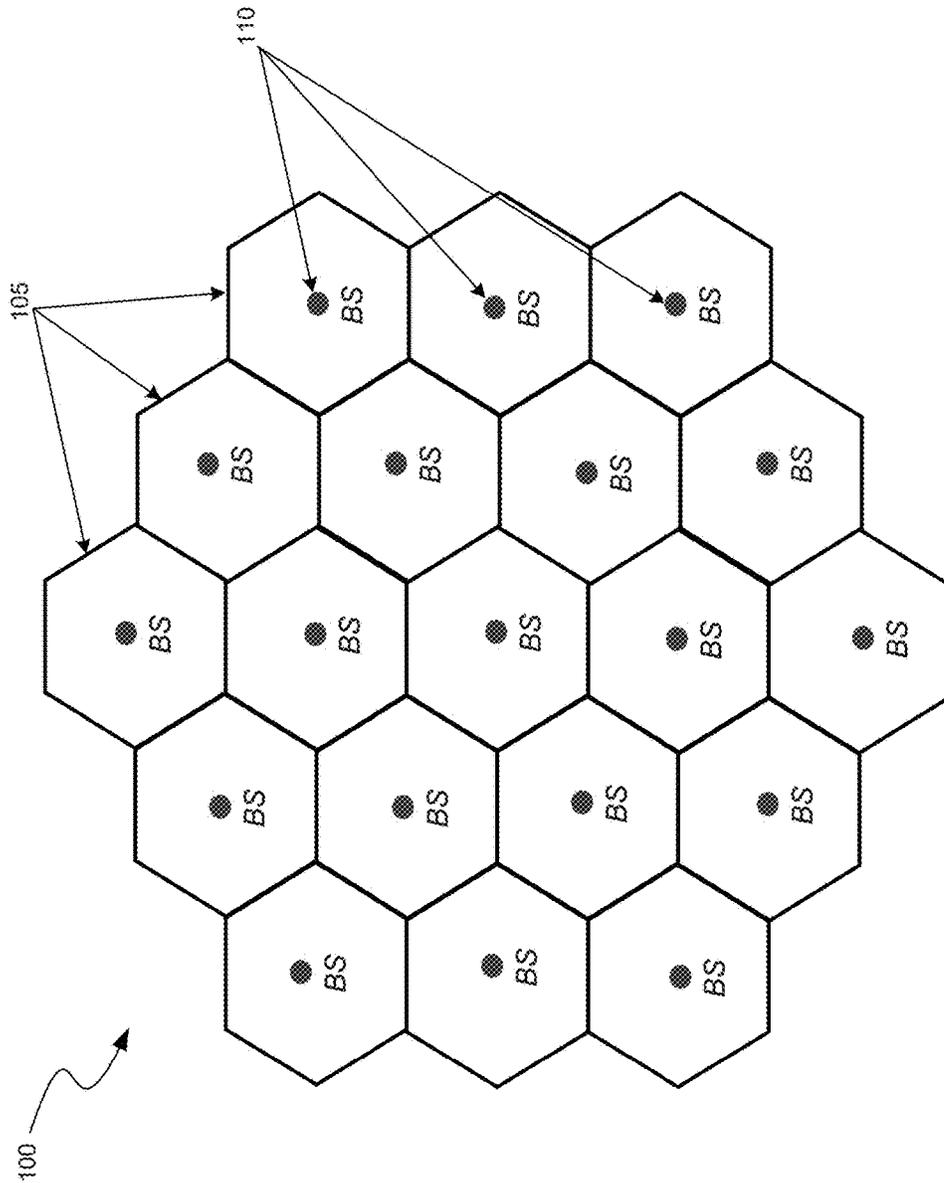


FIG. 1

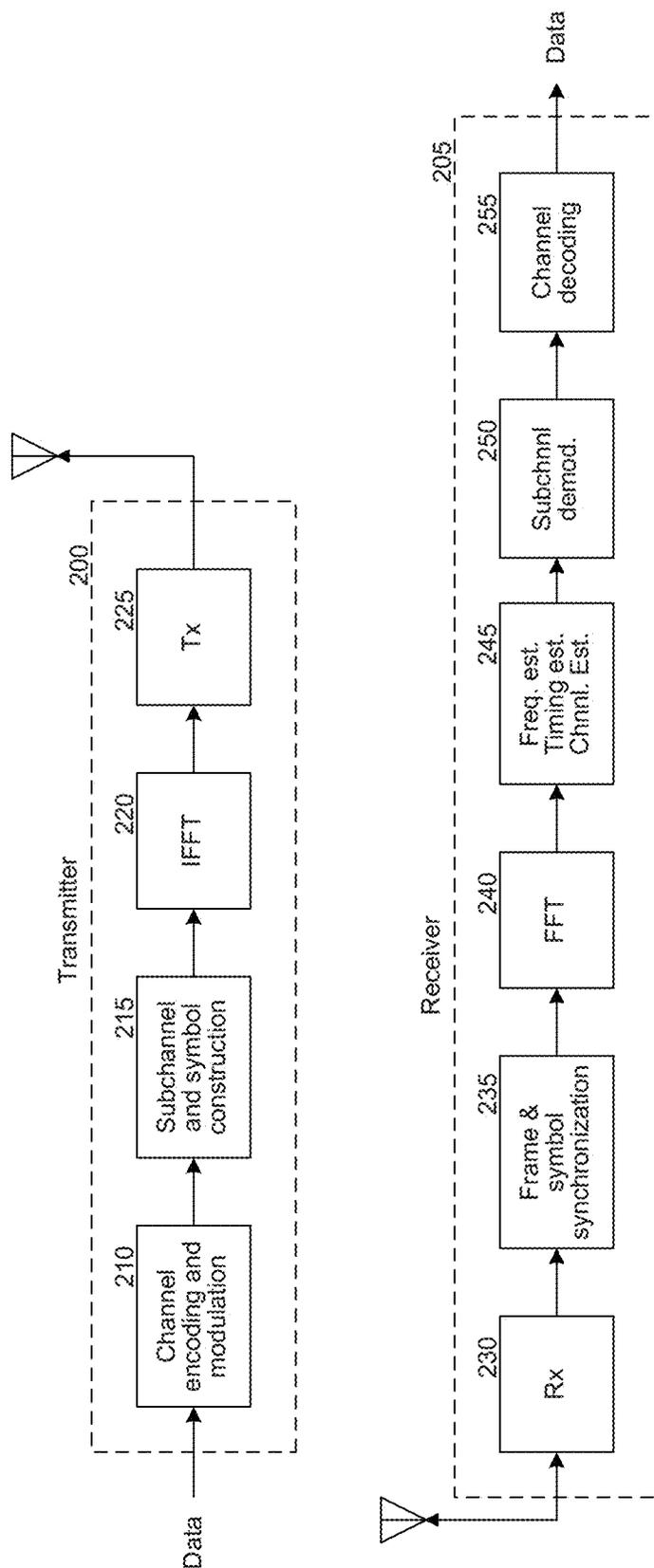


FIG. 2

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