

Exhibit 4



US010075941B2

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

(10) **Patent No.:** **US 10,075,941 B2**
(45) **Date of Patent:** **Sep. 11, 2018**

(54) **METHODS AND APPARATUS FOR MULTI-CARRIER COMMUNICATION SYSTEMS WITH ADAPTIVE TRANSMISSION AND FEEDBACK**

H04L 27/26 (2006.01)
H04B 7/0413 (2017.01)
H04L 1/00 (2006.01)
H04W 52/26 (2009.01)

(71) Applicant: **Neocific, Inc.**, Bellevue, WA (US)

(52) **U.S. Cl.**
CPC *H04W 72/0406* (2013.01); *H04B 7/0413* (2013.01); *H04L 1/0026* (2013.01); *H04L 1/0029* (2013.01); *H04L 1/0068* (2013.01); *H04L 1/0073* (2013.01); *H04L 5/006* (2013.01); *H04L 5/0007* (2013.01); *H04L 5/0046* (2013.01); *H04L 5/0048* (2013.01); *H04L 27/2608* (2013.01); *H04W 72/044* (2013.01); *H04L 1/0003* (2013.01); *H04L 1/0009* (2013.01); *H04L 5/0091* (2013.01); *H04W 52/26* (2013.01)

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(73) Assignee: **Neocific, Inc.**, Bellevue, WA (US)

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

(58) **Field of Classification Search**
CPC .. *H04W 72/044*; *H04B 7/0413*; *H04L 1/0026*; *H04L 1/0029*; *H04L 1/0068*; *H04L 5/006*; *H04L 5/0046*
USPC 370/310, 328, 349, 350, 431, 436, 458
See application file for complete search history.

(21) Appl. No.: **15/082,878**

(22) Filed: **Mar. 28, 2016**

(65) **Prior Publication Data**
US 2017/0055245 A1 Feb. 23, 2017

(56) **References Cited**
U.S. PATENT DOCUMENTS
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Related U.S. Application Data

(63) Continuation of application No. 14/539,917, filed on Nov. 12, 2014, now Pat. No. 9,301,296, which is a continuation of application No. 13/246,677, filed on Sep. 27, 2011, now abandoned, which is a continuation of application No. 12/755,313, filed on Apr. 6, 2010, now Pat. No. 8,027,367, which is a continuation of application No. 10/583,529, filed as application No. PCT/US2005/004601 on Feb. 14, 2005, now Pat. No. 7,693,032.

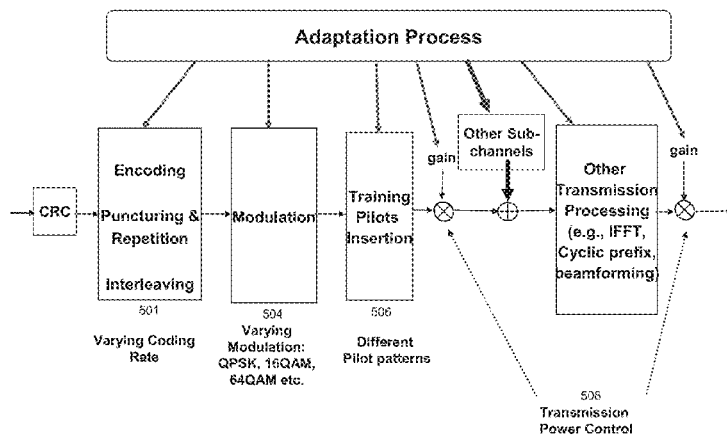
* cited by examiner
Primary Examiner — Dmitry H Levitan
(74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(60) Provisional application No. 60/544,521, filed on Feb. 13, 2004.

(51) **Int. Cl.**
H04B 7/00 (2006.01)
H04W 72/04 (2009.01)
H04L 5/00 (2006.01)

(57) **ABSTRACT**
An arrangement is disclosed where in a multi-carrier communication system, the modulation scheme, coding attributes, training pilots, and signal power may be adjusted to adapt to channel conditions in order to maximize the overall system capacity and spectral efficiency without wasting radio resources or compromising error probability performance, etc.

14 Claims, 8 Drawing Sheets



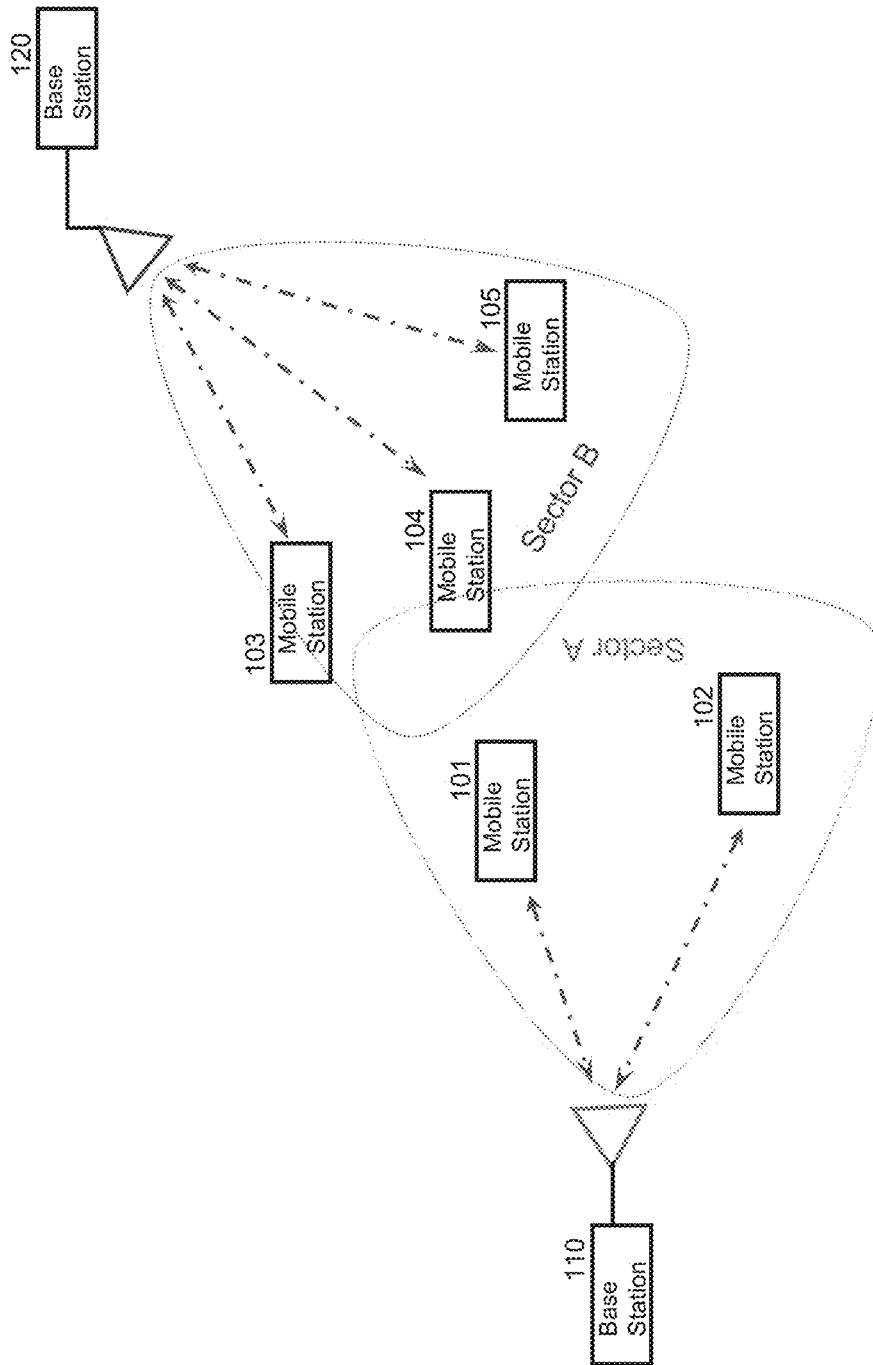


FIG. 1

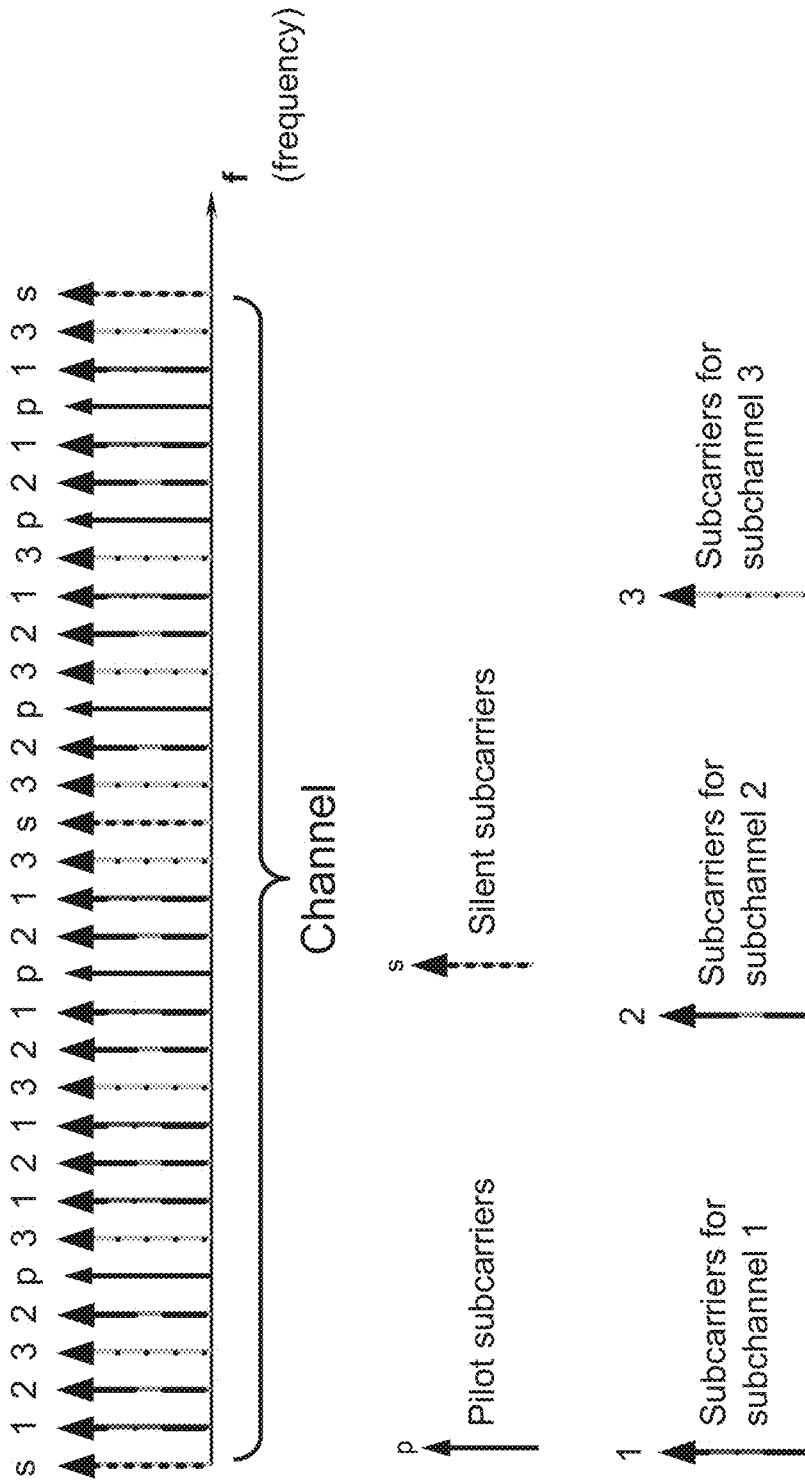


FIG. 2

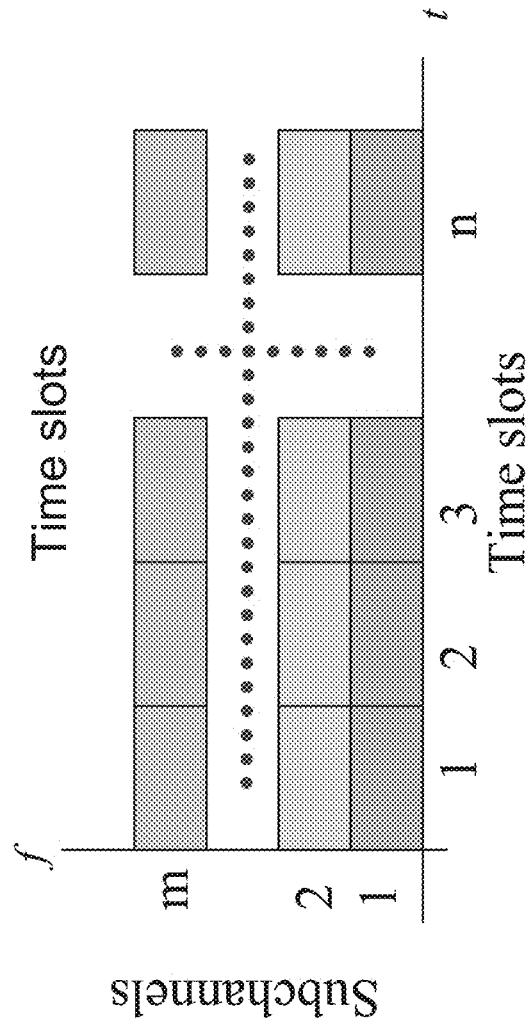


FIG. 3

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