



US006625219B1

(12) **United States Patent**
Stopler

(10) **Patent No.:** US 6,625,219 B1
(45) **Date of Patent:** Sep. 23, 2003

- (54) **METHOD AND APPARATUS FOR ENCODING/FRAMING FOR MODULATED SIGNALS OVER IMPULSIVE CHANNELS**
- (75) Inventor: **Daniel Stopler**, Holon (IL)
- (73) Assignee: **Tioga Technologies, Ltd.**, Tel Aviv (IL)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **09/258,650**
- (22) Filed: **Feb. 26, 1999**
- (51) **Int. Cl.**⁷ **H03M 13/00**
- (52) **U.S. Cl.** **375/240.27; 714/758**
- (58) **Field of Search** **375/260, 240.24, 375/240.27, 267; 714/755, 758; 370/468, 479, 480**

- (56) **References Cited**
- U.S. PATENT DOCUMENTS**
- 5,923,679 A * 7/1999 Itoh et al. 714/752
- 6,004,028 A * 12/1999 Bottomley 714/758
- 6,034,996 A * 3/2000 Herzberg 375/265
- 6,405,338 B1 * 6/2002 Sinha et al. 714/752

OTHER PUBLICATIONS

Michael Grimwood and Paul Richardson, "S-CDMA as High-Capacity Upstream Physical Layer," *IEEE*, 802.14A/98-016, Jun. 15, 1998.

* cited by examiner

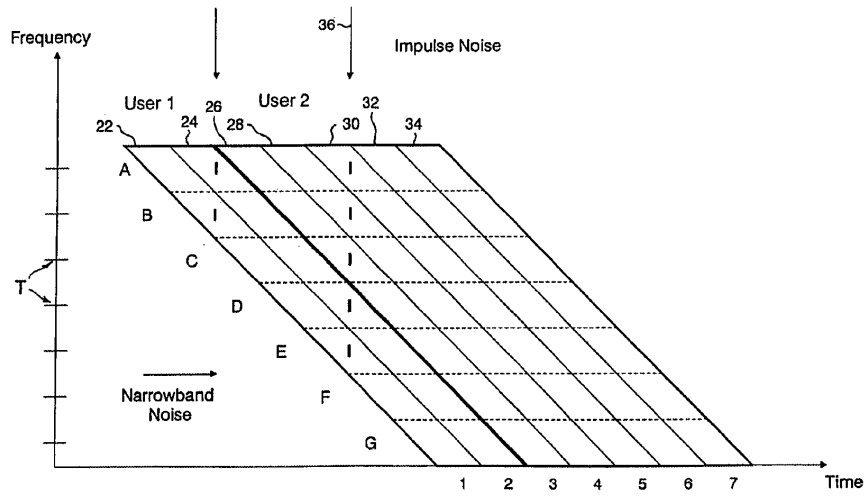
Primary Examiner—Stephen Chin
Assistant Examiner—Kevin Kim

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

An encoding/framing scheme for multitone modulation over impulsive channels which allows efficient operation in multipoint to point channels which are affected by ingress (narrowband noise) and impulsive (burst) interference. The coding is achieved using a concatenated approach, with the inner code being Trellis Coded Modulation (TCM), using, for example, convolutional coding, and the outer code being a Reed Solomon (RS) code. Two dimensional interleaving is performed, with one dimension being time, and the other dimension being frequency (tones or sub-channels). The TCM coding provided by the present invention is quite effective in dealing with impulse noise effects. The interleaving may be applied in two levels. According to one embodiment, user data is RS encoded, and a portion of the RS encoded data is interleaved and filled along columns for transmission using a multitone transmission system. The remaining portion of the RS encoded user data is then TCM encoded, interleaved and effectively filled along rows for subsequent transmission. In another embodiment, a portion of the user data is RS encoded, interleaved and filled along columns for transmission, while the remaining portion of the user data is instead TCM encoded, interleaved and effectively filled along rows for subsequent transmission. A diagonalization scheme is also used to provide immunity against impulse noise, while at the same time allowing for a simple method of utilizing tones of different loading. According to the diagonalization principle, data packets are spread over time in a diagonal fashion, such that an impulse noise affects more than one user's packets, with the effect on each being reduced. In this way, a code having lower redundancy can be used since the amount of corruption expected in one user's data packet will be reduced.

42 Claims, 6 Drawing Sheets



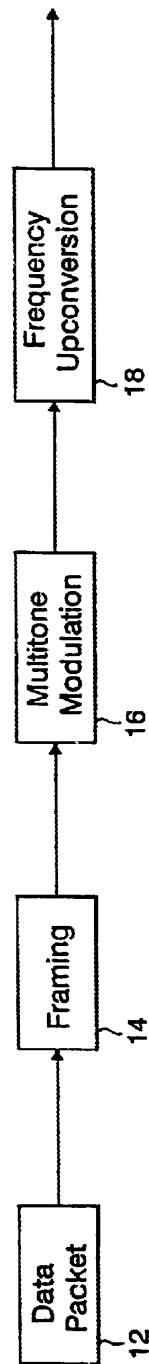


FIG. 1
PRIOR ART

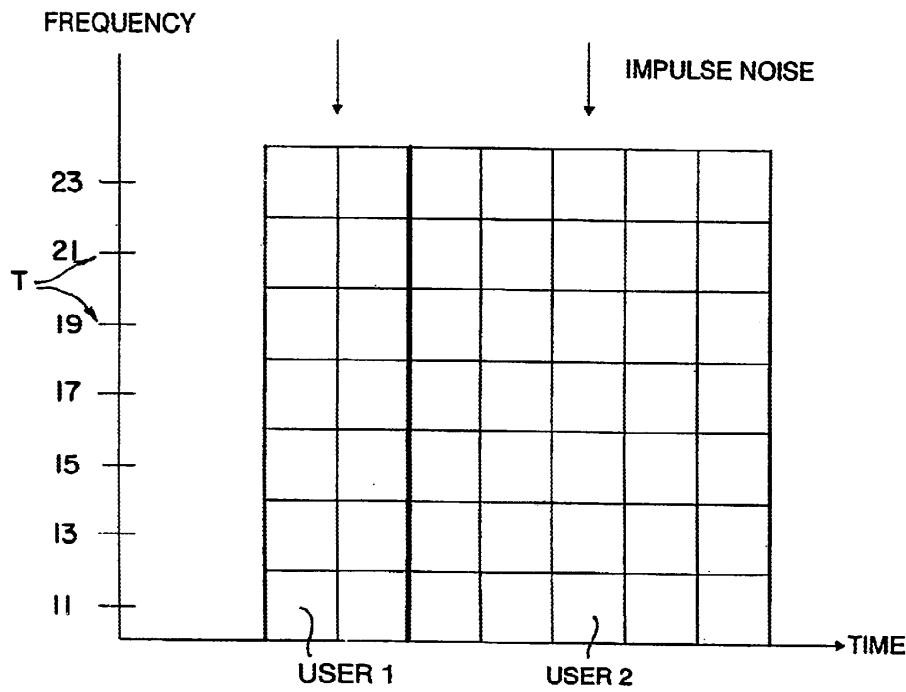


FIG. 2
PRIOR ART

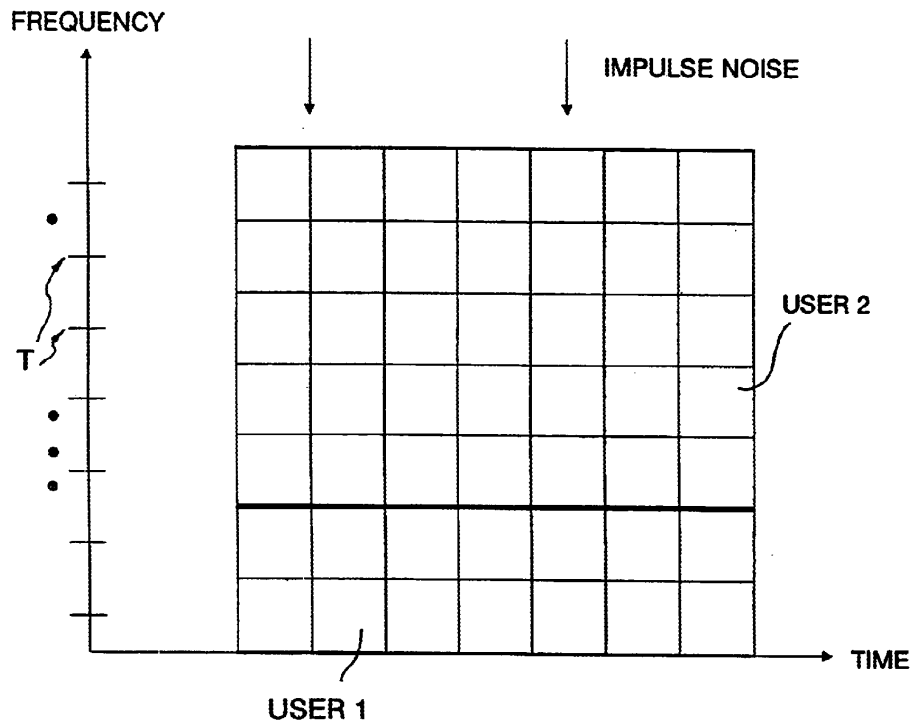


FIG. 3A
PRIOR ART

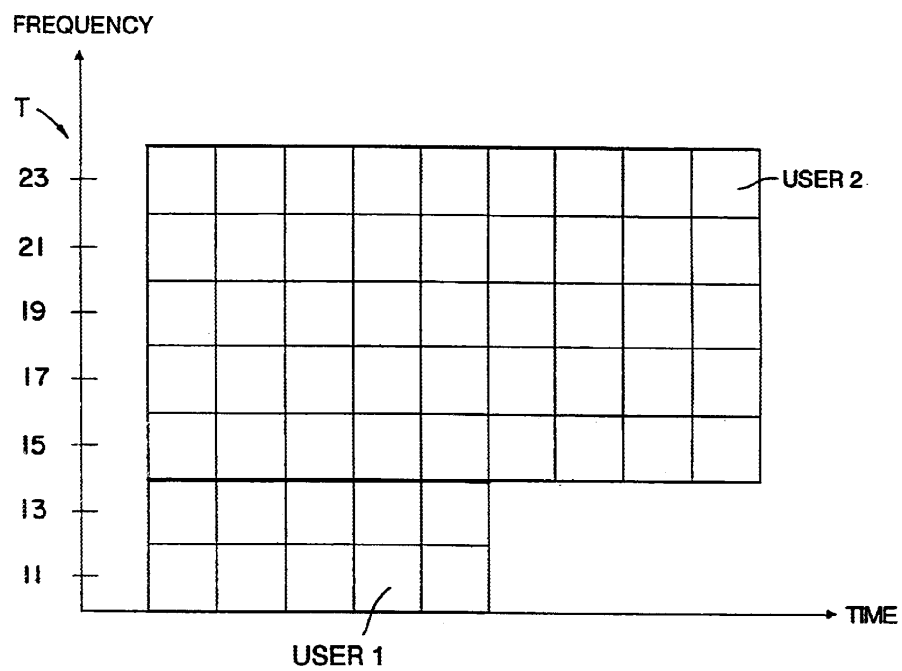


FIG. 3B
PRIOR ART

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.