US005299198A

United States Patent [19]

Kay et al.

[11] Patent Number: 5,299,198

[45] Date of Patent: Mar. 29, 1994

[54] **METHOD AND APPARATUS FOR EXPLOITATION OF VOICE INACTIVITY TO INCREASE THE CAPACITY OF A TIME DIVISION MULTIPLE ACCESS RADIO COMMUNICATIONS SYSTEM**

[75] Inventors: **Stanley E. Kay**, Rockville, Md.; **John E. Corrigan, III**, Washington, D.C.; **Daniel Wendling**, Darnstown; **Ashok Mehta**, Gaithersburg, both of Md.; **Michael Parr**, San Diego, Calif.

[73] Assignee: **Hughes Aircraft Company**, Los Angeles, Calif.

[21] Appl. No.: **622,232**

[22] Filed: **Dec. 6, 1990**

[51] **Int. Cl.**[5] **H04J 3/16**

[52] **U.S. Cl.** **370/95.3**; 455/33.1

[58] **Field of Search** 370/95.3, 77, 104.1, 370/60, 94.1; 455/33, 103, 214, 33.1, 33.2, 33.3, 33.4

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,009,344	2/1977	Flemming	179/15 BS
4,009,345	2/1977	Flemming	179/15 BA
4,009,346	2/1977	Parker	179/15 AQ
4,009,347	2/1977	Fleming	179/15 BS
4,128,809	12/1978	Kage	325/324
4,253,193	2/1981	Kennard et al.	455/101
4,419,758	12/1983	Dorey	375/38
4,596,024	6/1986	Thomson	375/100
4,616,364	10/1986	Lee	375/1
4,621,368	11/1986	Onoe et al.	375/40
4,782,485	11/1988	Gollub	370/94.1
4,783,780	11/1988	Alexis	370/95.3
4,809,296	2/1989	Braun et al.	375/1
4,817,089	3/1989	Paneth et al.	370/95
5,018,136	5/1991	Gollub	370/94.1
5,088,108	2/1992	Uddenfeldt et al.	455/33
5,121,387	6/1992	Gerhardt et al.	370/95.3

OTHER PUBLICATIONS

Al-Salihi et al., "The Application of Time Assignment Speech Interpolation (TASI) to the Radiophone Service", *Colloquium on Radio System Organisation & Control*, 1980, pp. 5/1-5/5.

Campanella, "Digital Speech Interpolation", *COMSAT Technical Review*, vol. 6, No. 1, Spring 1976, pp. 127-158.

Chien et al., "Cellular Access Network (CADN): Wireless Access to Networks of the Future", *IEEE Communications Magazine*, Jun. 1987, vol. 25, No. 6, pp. 22-31.

Choudhury et al., "Diversity ALOHA—A Random Access Scheme for Satellite Communications", *IEEE Transactions on Communications*, vol. COM-31, No. 3, Mar. 1983, pp. 450-457, Comments: Su et al., vol. COM-32, No. 10, Oct. 1984, pp. 1143-1145.

Cooper et al., "Cellular Mobile Technology: The Great Multiplier", *IEEE Spectrum*, Jun. 1983, pp. 30-37.

D'Avella et al., "An Adaptive MLSE Receiver for TDMA Digital Mobile Radio", *IEEE Journal on Selected Areas in Communications*, vol. 7, No. 1, Jan. 1989, pp. 122-129.

Everitt et al., "Performance Analysis of Cellular Mobile Communication Systems with Dynamic Channel As-

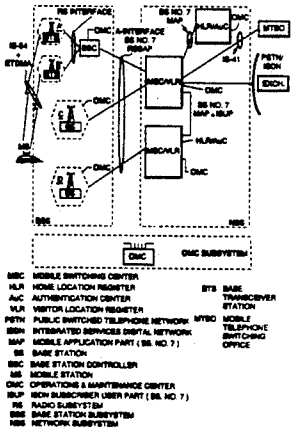
(List continued on next page.)

Primary Examiner—Douglas W. Olms
Assistant Examiner—Shick Hom
Attorney, Agent, or Firm—Gordon R. Lindeen, III; Wanda K. Denson-Low

[57] **ABSTRACT**

A mobile telephone system multiplexes plural voice traffic channels on a single carrier using a TDMA protocol. The capacity of the mobile telephone system is increased by assigning voice traffic capacity, not on a conversation basis, but on a speech spurt basis. In order to avoid compromising the voice transmission capacity, control signals (for the allocation and deallocation of both forward and reverse traffic channels) are sent using multiple diversity, i.e. both time and frequency. In addition, to increase the number of available control channels, a control channel comprises a sub-divided portion of an otherwise equivalent voice traffic slot. For reverse allocation requests, which are transmitted over a contention access channel, power diversity is used in addition to time and frequency diversity.

69 Claims, 33 Drawing Sheets



OTHER PUBLICATIONS

signment", *IEEE Journal on Selected Areas in Communications,* vol. 7, No. 8, Oct. 1989, pp. 1172–1180.

Fisher, "Dual Mode Mobile Unit for Next Generation Digital Narrow Channel Cellular Telephone System", *38th IEEE Vehicular Technology Conference,* 1988, pp. 543–547.

Goodman et al., "Packet Reservation Multiple Access for Local Wireless Communications", *IEEE Transactions on Communications,* vol. 37, No. 8, Aug. 1989, pp. 885–889.

Gupta et al., "Land Mobile Radio Systems—A Tutorial Exposition", *IEEE Communications Magazine,* Jun. 1985, vol. 23, No. 6, pp. 34–45.

Lee, "Cellular Operators Feel the Squeeze", *Telephony,* May 30, 1988, pp. 22–23.

Li, "Multiple Access Communications Networks", *IEEE Communications Magazine,* Jun. 1987, vol. 25, No. 6, pp. 41–48.

Mahmoud et al., "An Integrated Voice/Data System for VHF/UHF Mobile Radio", *IEEE Journal on Selected Areas in Communications,* vol. SAC-1, No. 6, Dec. 1983, pp. 1098–1111.

Nguyen et al., "Access Strategies for D-TASI Over Mobile Radio Chennels", *IEEE Vehicular Technology Conference,* 1986, pp. 311–318.

Riordon et al., "Demand Time-Assigned Speech Interpolation for Land Mobile Systems", *International Conference on Mobile Radio Systems and Techniques,* 1984, pp. 150–154.

Schoute, "Dynamic Frame Length ALOHA", *IEEE Transactions on Communications,* vol. COM-31, No. 4, Apr. 1983, pp. 565–568.

Sheikh et al., "Performance of Access Strategies for D-TASI Over Mobile Radio Fading Channels", *Journal of the Institution of Electronic and Radio Engineers,* vol. 57, No. 6 (Supplement), Nov./Dec. 1987, pp. S304–S310.

Uddenfeldt et al., "Digital Technologies in Cellular Radio", *38th IEEE Vehicular Technology Conference,* 1988, pp. 516–519.

Yan, "Performance Analysis of Replication ALOHA for Fading Mobile Communications Channels", *IEEE Transactions on Communications,* vol. COM-34, No. 12, Dec. 1986, pp. 1256–1259.

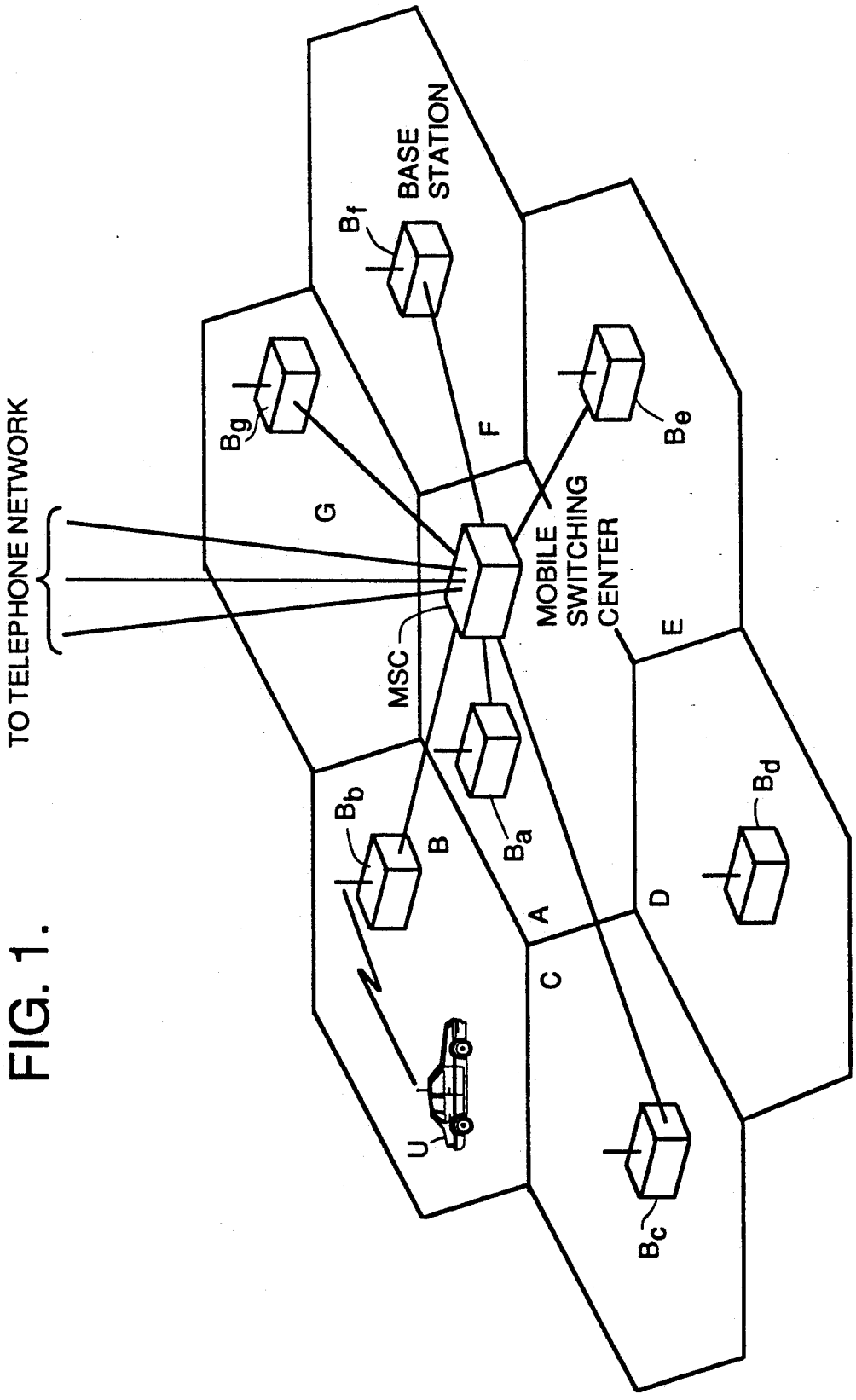


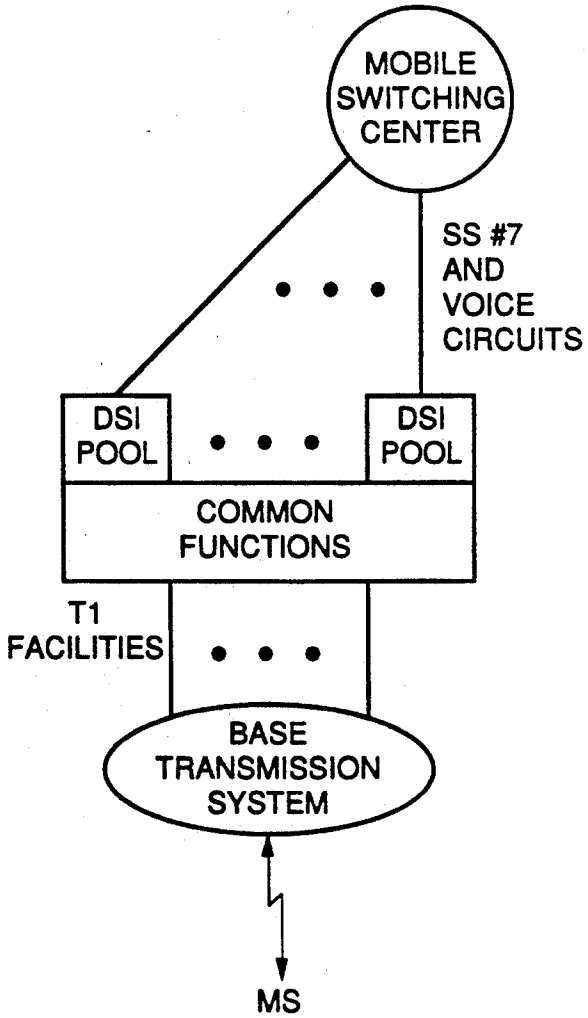
FIG. 1.

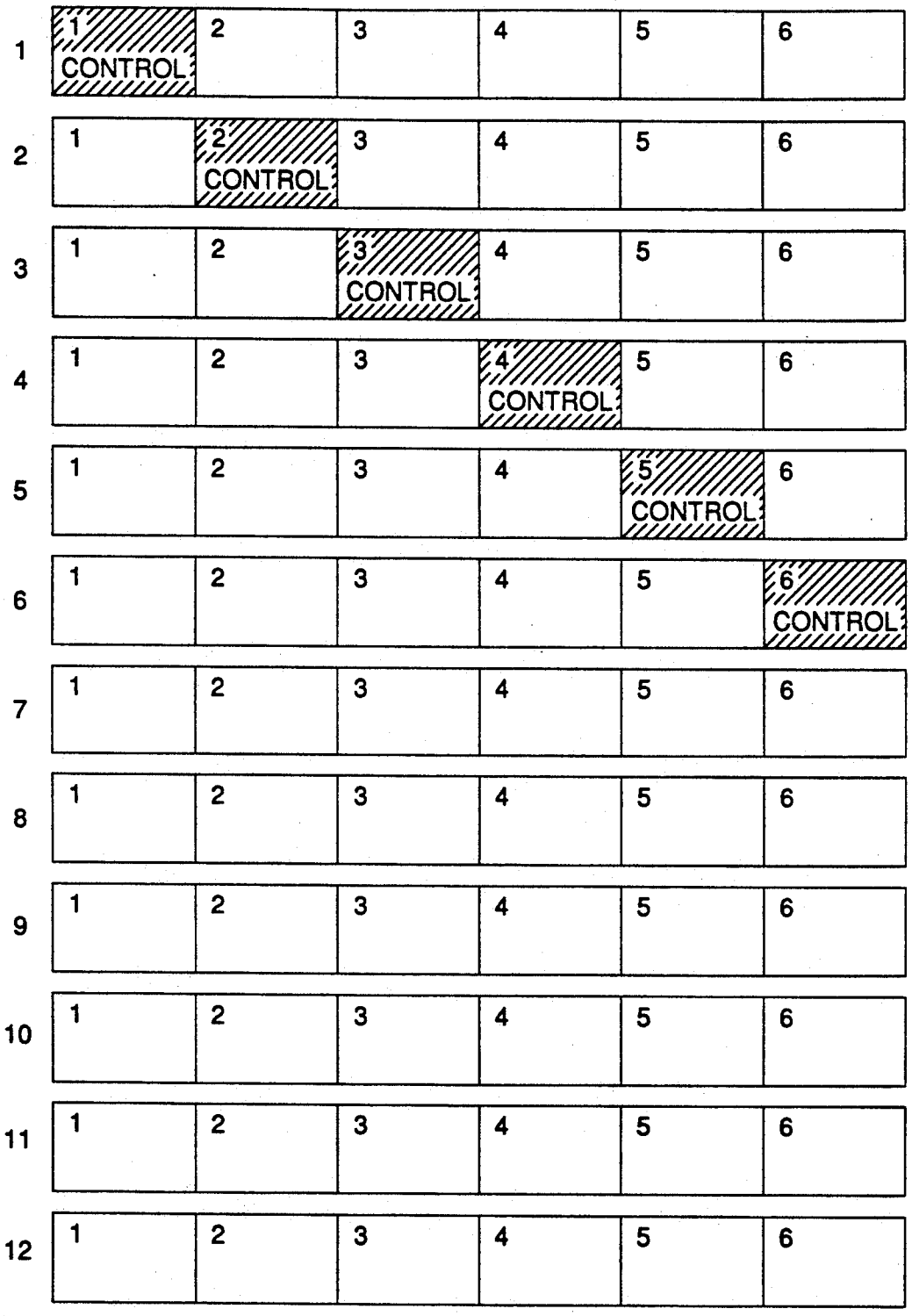
FORWARD FRAMES

	SLOT 1	SLOT 2	SLOT 3	SLOT 4	SLOT 5	SLOT 6
FRAME 1	MS 15	MS 11	MS 21	MS 4	MS 1	MS 22
2	MS 15	MS 11	MS 21	MS 4		MS 22
3	MS 15	MS 11	MS 21	MS 4	MS 19	MS 22
4	MS 15		MS 21	MS 4	MS 19	MS 22
5	MS 15	MS 8	MS 21	MS 4	MS 19	MS 22
6	MS 15	MS 8		MS 4	MS 19	
7	MS 2	MS 8		MS 4	MS 19	
8	MS 2	MS 8	MS 32	MS 4	MS 19	
9	MS 2	MS 8	MS 32	MS 4	MS 19	MS 15

FIG. 2.

FIG. 3.





ONE DSI GROUP
12 RF CHANNELS
72 SLOTS
6 CONTROL SLOTS
66 USER SLOTS

FIG. 4.

DOCKET ALARM

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.