



US007126536B2

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

(10) **Patent No.:** **US 7,126,536 B2**

(45) **Date of Patent:** ***Oct. 24, 2006**

(54) **POSITION LOCATION USING
TERRESTRIAL DIGITAL VIDEO
BROADCAST TELEVISION SIGNALS**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,555,707 A 11/1985 Connelly

(Continued)

FOREIGN PATENT DOCUMENTS

GB 2 222 922 A 3/1990

(Continued)

OTHER PUBLICATIONS

(75) Inventors: **Matthew Rabinowitz**, Palo Alto, CA
(US); **James J Spilker, Jr.**, Woodside,
CA (US)

(73) Assignee: **Rosum Corporation**, Mountain View,
CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1280 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **09/932,010**

(22) Filed: **Aug. 17, 2001**

(65) **Prior Publication Data**

US 2002/0144294 A1 Oct. 3, 2002

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/887,158,
filed on Jun. 21, 2001, now abandoned.

(60) Provisional application No. 60/265,675, filed on Feb.
2, 2001, provisional application No. 60/281,270, filed
on Apr. 3, 2001, provisional application No. 60/281,
269, filed on Apr. 3, 2001, provisional application No.
60/293,812, filed on May 25, 2001, provisional applica-
tion No. 60/293,813, filed on May 25, 2001, pro-
visional application No. 60/293,646, filed on May 25,
2001.

(51) **Int. Cl.**
G01S 3/02 (2006.01)

(52) **U.S. Cl.** **342/464**

(58) **Field of Classification Search** 342/357.01,
342/357.06, 453, 463, 464

See application file for complete search history.

Li, X., et al., "Indoor Geolocation Using OFDM Signals In
HIPERLAN/2 Wireless LANS," 11th IEEE International Sympo-
sium on Personal Indoor and Mobile Radio Communications,
PIMRC 2000, Proceedings (Cat. No. 00TH8525), Proceedings of
11th International Symposium on Personal Indoor and Mobile Radio
Communication, London, UK, Sep. 18-21, pp. 1449-1453, vol. 2,
XPO10520871, 2000, Piscatawat, NJ, USA, IEEE, USA, ISBN:
9-7803-6463-5, Chapter I and III.

(Continued)

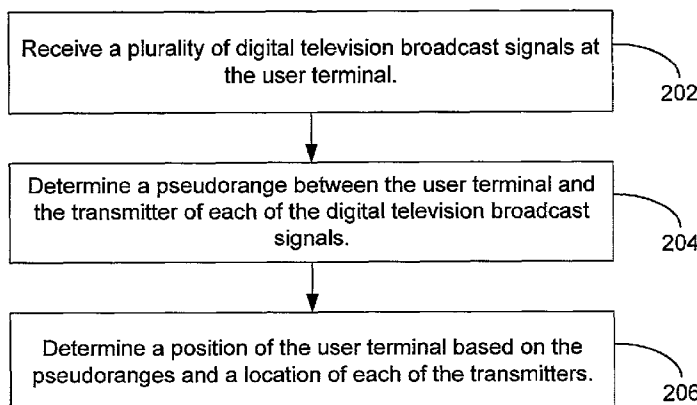
Primary Examiner—Dao L. Phan

(74) *Attorney, Agent, or Firm*—Richard A. Dunning, Jr.

(57) **ABSTRACT**

A method and computer program product for determining
the position of a user terminal includes receiving at the user
terminal a plurality of digital television (DTV) broadcast
signals from a plurality of DTV transmitters, wherein each
of the DTV signals is a European Telecommunications
Standards Institute (ETSI) Digital Video Broadcasting-Ter-
restrial (DVB-T) signal; determining a pseudo-range
between the user terminal and each DTV transmitter based
on the DTV broadcast signals based on a known component
in the DTV signals; and determining a position of the user
terminal based on the pseudo-ranges and a location of each
of the DTV transmitters.

87 Claims, 17 Drawing Sheets



U.S. PATENT DOCUMENTS

4,652,884 A 3/1987 Starker
 4,894,662 A 1/1990 Counselman
 5,045,861 A 9/1991 Duffett-Smith 342/457
 5,157,686 A 10/1992 Omura et al.
 5,166,952 A 11/1992 Omura et al.
 5,271,034 A 12/1993 Abaunza
 5,323,322 A 6/1994 Mueller et al.
 5,398,034 A 3/1995 Spilker, Jr.
 5,481,316 A 1/1996 Patel
 5,504,492 A 4/1996 Class et al.
 5,510,801 A 4/1996 Engelbrecht et al. 342/457
 5,604,765 A 2/1997 Bruno et al.
 5,648,982 A 7/1997 Durrant et al.
 5,774,829 A 6/1998 Cisneros et al.
 5,920,284 A 7/1999 Victor 342/357.01
 5,952,958 A 9/1999 Speasl et al.
 5,953,311 A 9/1999 Davies et al.
 6,016,119 A 1/2000 Krasner
 6,078,284 A 6/2000 Levanon 342/357.16
 6,094,168 A 7/2000 Duffett-Smith et al. 342/463
 6,107,959 A 8/2000 Levanon 342/357
 6,137,441 A 10/2000 Dai et al. 342/357.16
 6,215,778 B1 4/2001 Lomp et al.
 6,317,452 B1 11/2001 Durrant et al.
 6,317,500 B1 11/2001 Murphy
 6,373,432 B1 4/2002 Rabinowitz et al.
 6,374,177 B1 4/2002 Lee et al.
 6,433,740 B1 8/2002 Gilhousen
 6,590,529 B1 7/2003 Schwogler

6,806,830 B1 * 10/2004 Panasik et al. 342/464
 6,952,182 B1 * 10/2005 Spilker et al. 342/464
 2003/0122711 A1 7/2003 Panasik et al.
 2003/0156063 A1 8/2003 Spilker et al.

FOREIGN PATENT DOCUMENTS

GB 2 254 508 A 10/1992

OTHER PUBLICATIONS

Rabinowitz, M., et al., "Positioning Using the ATSC Digital Television Signal," Rosum whitepaper, Online! 2001, XP002235053, Retrieved from the Internet on Mar. 13, 2003 at URL www.rosum.com/whitepaper 8-7-01.pdf.
 EP Abstract/Zusammenfassung/Abrege, 02102666.1.
 JP Abstract/vol. 007, No. 241 (P-232), Oct. 26, 1983 & JP58 129277 A (Nihon Musen KK) Aug. 2, 1983.
 Parkinson, B.W., et al., "Autonomous GPS Integrity Monitoring Using the Pseudorange Residual," *Journal of the Institute of Navigation* (1988), vol. 35, No. 2, pp. 255-274.
 Rabinowitz, M., "A Differential Carrier Phase Navigation System Combining GPS with Low Earth Orbit Satellites for Rapid Resolution of Integer Cycle Ambiguities," *PhD Thesis for Department of Electrical Engineering, Stanford University* (Dec. 2000), pp. 59-73.
 Spilker, Jr., J.J., Jr., "Fundamentals of Signal Tracking Theory," *Global Positioning System: Theory and Applications* (1994), vol. 1, Chapter 7, pp. 245-327.
 Van Dierendonck, A.J., "GPS Receivers," *Global Positioning System: Theory and Applications* (1995), vol. 1, Chapter 8, pp. 329-407.

* cited by examiner

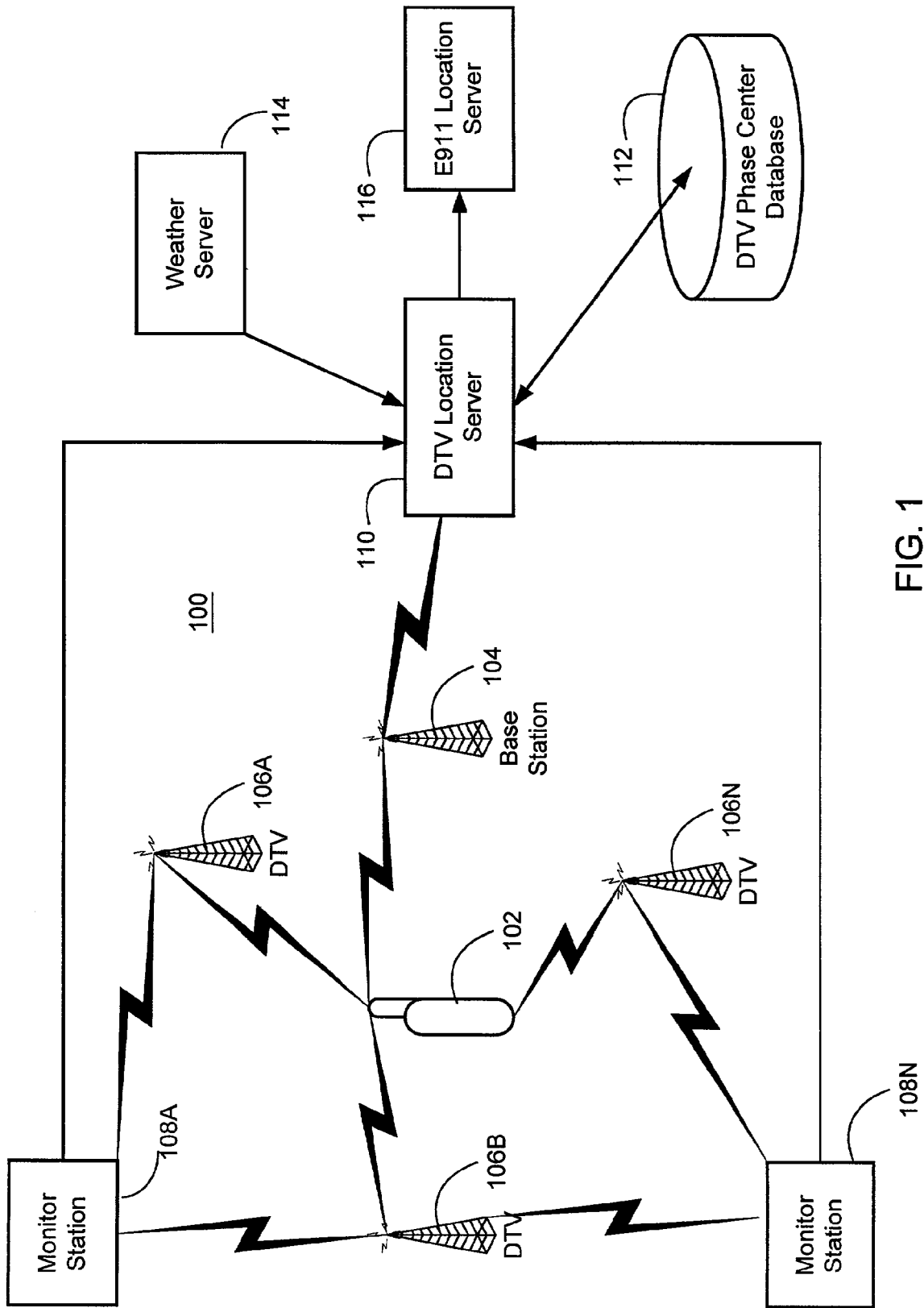


FIG. 1

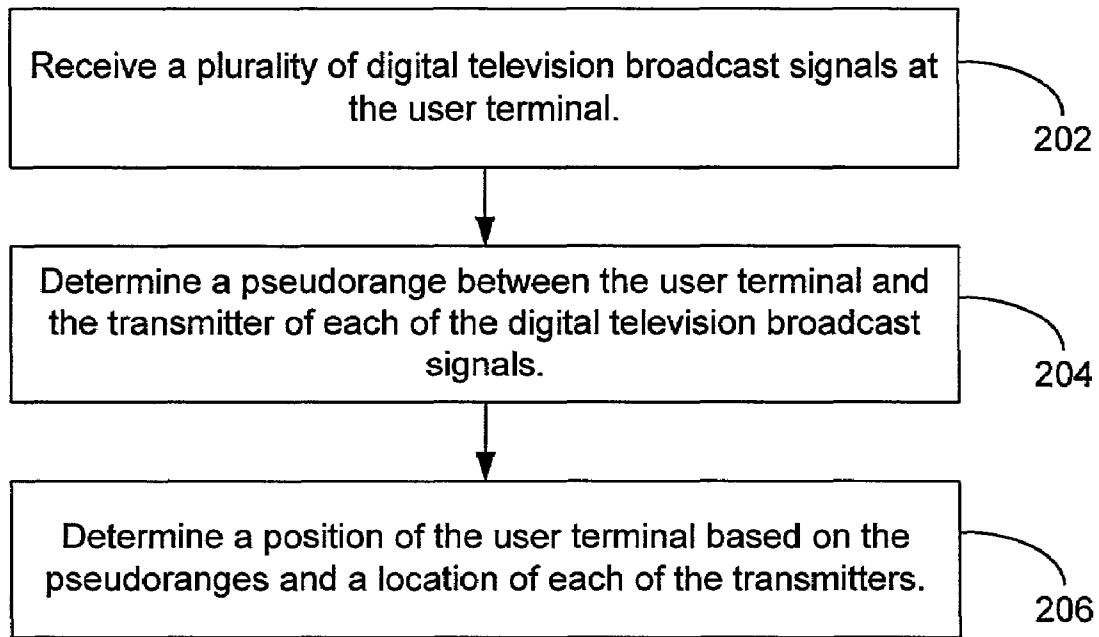


FIG. 2

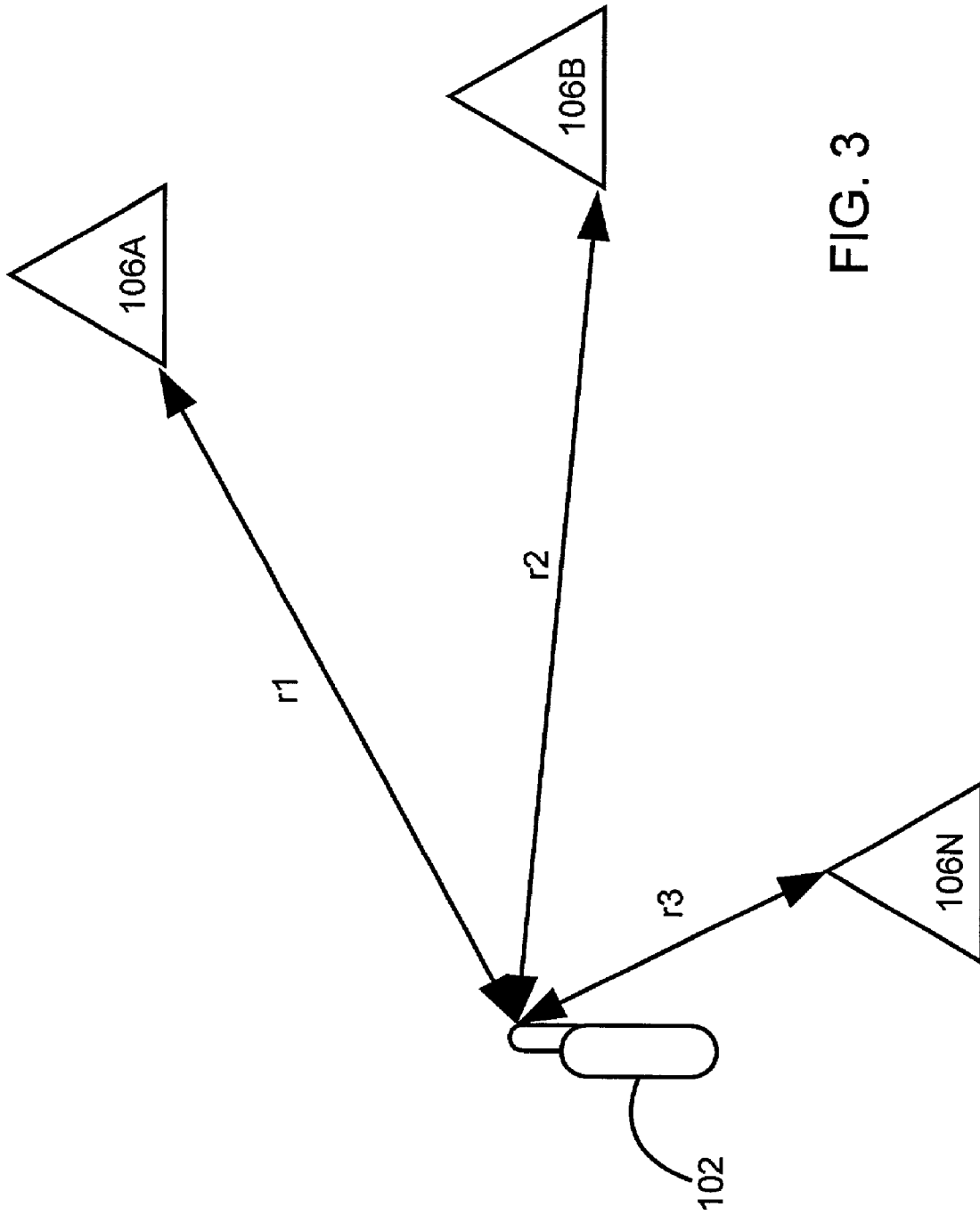


FIG. 3

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.