



US008238412B2

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

(10) **Patent No.:** **US 8,238,412 B2**
(45) **Date of Patent:** ***Aug. 7, 2012**

(54) **MULTICARRIER MODULATION MESSAGING FOR POWER LEVEL PER SUBCHANNEL INFORMATION**

(75) Inventors: **David M. Krinsky**, Acton, MA (US);
Robert Edmund Pizzano, Stoneham, MA (US)

(73) Assignee: **Aware, Inc.**, Bedford, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 194 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/779,660**

(22) Filed: **May 13, 2010**

(65) **Prior Publication Data**

US 2010/0226418 A1 Sep. 9, 2010

Related U.S. Application Data

(60) Continuation of application No. 12/477,742, filed on Jun. 3, 2009, now Pat. No. 7,835,430, which is a continuation of application No. 10/619,691, filed on Jul. 16, 2003, now Pat. No. 7,570,686, which is a division of application No. 09/755,173, filed on Jan. 8, 2001, now Pat. No. 6,658,052.

(60) Provisional application No. 60/224,308, filed on Aug. 10, 2000, provisional application No. 60/174,865, filed on Jan. 7, 2000.

(51) **Int. Cl.**
H04B 1/38 (2006.01)

(52) **U.S. Cl.** **375/219**

(58) **Field of Classification Search** 375/222, 375/224-225, 227, 220, 284; 370/241, 252, 370/282; 379/22.02, 22.04, 27.01, 27.03

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,385,384 A 5/1983 Rosbury et al.
4,566,100 A 1/1986 Mizuno et al.
5,128,619 A 7/1992 Bjork et al.
5,361,293 A 11/1994 Czerwicz
5,608,643 A 3/1997 Wichter et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0889615 1/1999

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 13/004,254, filed Jan. 11, 2011, Krinsky et al.

(Continued)

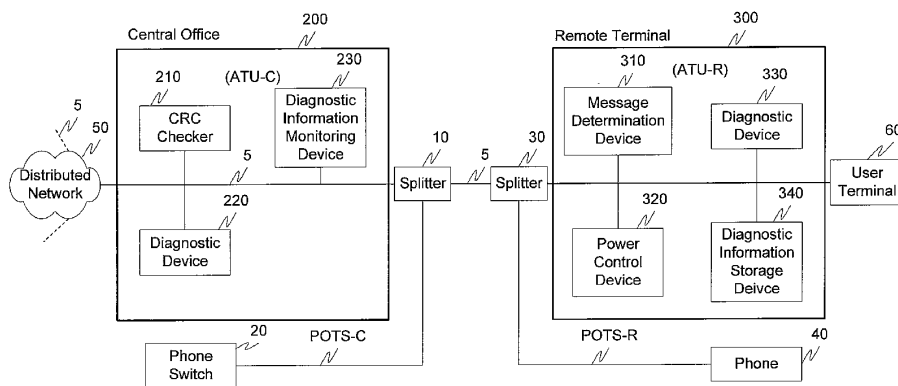
Primary Examiner — Khanh C Tran

(74) *Attorney, Agent, or Firm* — Jason H. Vick; Sheridan Ross, PC

(57) **ABSTRACT**

Upon detection of a trigger, such as the exceeding of an error threshold or the direction of a user, a diagnostic link system enters a diagnostic information transmission mode. This diagnostic information transmission mode allows for two modems to exchange diagnostic and/or test information that may not otherwise be exchangeable during normal communication. The diagnostic information transmission mode is initiated by transmitting an initiate diagnostic link mode message to a receiving modem accompanied by a cyclic redundancy check (CRC). The receiving modem determines, based on the CRC, if a robust communications channel is present. If a robust communications channel is present, the two modems can initiate exchange of the diagnostic and/or test information. Otherwise, the transmission power of the transmitting modem is increased and the initiate diagnostic link mode message re-transmitted to the receiving modem until the CRC is determined to be correct.

21 Claims, 2 Drawing Sheets



U.S. PATENT DOCUMENTS

5,612,960	A	3/1997	Stevens et al.
5,864,602	A	1/1999	Needle
5,964,891	A	10/1999	Caswell et al.
6,073,179	A	6/2000	Liu et al.
6,075,821	A	6/2000	Kao et al.
6,175,934	B1	1/2001	Hershey et al.
6,219,378	B1	4/2001	Wu
6,249,543	B1	6/2001	Chow
6,404,774	B1	6/2002	Jenness
6,411,678	B1	6/2002	Tomlinson, Jr. et al.
6,445,773	B1	9/2002	Liang et al.
6,449,307	B1	9/2002	Ishikawa et al.
6,512,789	B1	1/2003	Mirfakhraei
6,631,120	B1	10/2003	Milbrandt
6,633,545	B1	10/2003	Milbrandt
6,636,603	B1	10/2003	Milbrandt
6,658,052	B2	12/2003	Krinsky et al.
6,725,176	B1	4/2004	Long et al.
6,781,513	B1	8/2004	Korkosz et al.
7,570,686	B2	8/2009	Krinsky et al.
2009/0238254	A1	9/2009	Krinsky et al.

FOREIGN PATENT DOCUMENTS

GB	2303032	2/1997
JP	Hei6(1994)-003956	1/1994
JP	A-Hei10(1998)-513622	12/1998
JP	A-Hei11(1999)-508417	7/1999
JP	A-Hei11(1999)-261665	9/1999
JP	A-Hei11(1999)-317723	11/1999
WO	WO 86/07223	12/1986
WO	WO 97/01900	1/1997
WO	WO 99/20027	4/1999
WO	WO 99/26375	5/1999
WO	WO 99/63427	12/1999
WO	WO 99/67890	12/1999
WO	WO 00/64130	10/2000

OTHER PUBLICATIONS

Official Action for U.S. Appl. No. 10/619,691, mailed Oct. 31, 2006, 14 pages.

Official Action for U.S. Appl. No. 10/619,691, mailed Mar. 30, 2007, 11 pages.

Official Action for U.S. Appl. No. 10/619,691, mailed Jun. 13, 2008, 7 pages.

Official Action for U.S. Appl. No. 10/619,691, mailed Oct. 20, 2008, 11 pages.

Notice of Allowance for U.S. Appl. No. 10/619,691, mailed May 15, 2009, 9 pages.

Notice of Allowance for U.S. Appl. No. 10/619,691, mailed Jul. 6, 2009, 5 pages.

Official Action for U.S. Appl. No. 12/779,708, mailed Sep. 29, 2010, 6 pages.

Official Action for U.S. Appl. No. 12/779,708, mailed Dec. 15, 2010, 6 pages.

Notice of Allowance for U.S. Appl. No. 12/779,708, mailed Jan. 3, 2011, 6 pages.

ITU-T Recommendation G.992.2, "Splitterless asymmetric digital subscriber line (ADSL) transceivers," International Telecommunication Union, Jun. 1999, 179 pages.

ITU-T Recommendation G.994.1, "Handshake procedures for digital subscriber line (DSL) transceivers," International Telecommunication Union, Jun. 1999, 56 pages.

Notice of Acceptance for Australian Patent Application No. 2004203321, dated Aug. 7, 2008.

Examination Report for Australian Patent Application No. 2009222537, dated Mar. 21, 2011.

Examination Report for Australian Patent Application No. 2009222537, dated May 27, 2011.

Communication Under Rule 71(3) EPC for European Patent Application No. EP 06022008, dated Apr. 4, 2011.

Official Action (including translation) for Japanese Patent Application No. 2001-552611, mailed Mar. 28, 2011.

Notice of Allowance for Japanese Patent Application No. 2008-190051, mailed Mar. 14, 2011.

Official Action for U.S. Appl. No. 09/755,173, mailed Jun. 20, 2002.

Official Action for U.S. Appl. No. 09/755,173, mailed Sep. 24, 2002.

Official Action for U.S. Appl. No. 09/755,173, mailed Mar. 14, 2003.

Notice of Allowance for U.S. Appl. No. 09/755,173, mailed Jul. 1, 2003.

U.S. Appl. No. 12/779,708, filed May 13, 2010, Krinsky et al.

Boets P. et al.: "Modeling Aspect of Transmission Line Networks" Proceedings of the Instrumentation and Measurement Technology Conference, US, New York, IEEE, May 12, 1992, pp. 137-141, XP000343913 ISBN: 0-7803-0640-6.

Cioffi, John M., ADSL Maintenance with DMT, T1E1.4 ADSL Project, Amati Communications Corporation, Dec. 1, 1992, pp. 1-14.

Lewis L. et al. "Extending Trouble Ticket System to Fault Diagnostics" IEEE Network, IEEE Inc. New York, US, Nov. 1, 1993, pp. 44-51, XP 000575228.

International Search Report for PCT/US01/00418 dated Jul. 16, 2001, 4 pages.

Written Opinion for International (PCT) Patent Application No. PCT/US01/00418, completed Mar. 9, 2002.

International Preliminary Examination Report for International (PCT) Patent Application No. PCT/US01/00418, completed Mar. 9, 2002.

PCT International Search Report dated Oct. 9, 2002 for PCT/US01/41653.

Examiner's First Report for Australian Patent Application No. 27669/01, mailed Apr. 2, 2004.

Notice of Acceptance for Australian Patent Application No. 27669/01, mailed Aug. 6, 2004.

Examiner's First Report for Australian Patent Application No. 2004203321, mailed Nov. 16, 2006.

Examiner's First Report for Australian Patent Application No. 2008203520, mailed Mar. 9, 2009.

Notice of Acceptance for Australian Patent Application No. 2008203520, mailed Jul. 9, 2009.

Official Action for Canadian Patent Application No. 2,394,491, mailed Nov. 24, 2009.

Official Action for European Patent Application No. 01901808.4, mailed Dec. 1, 2004.

Official Action for European Patent Application No. 01901808.4, mailed Sep. 14, 2005.

Communication about intention to grant a European patent for European Patent Application No. 01901808.4, mailed May 15, 2006.

European Search Report for European Patent Application No. EP 06022008 completed Jan. 8, 2007.

Official Action for European Patent Application No. EP 06022008, mailed Apr. 23, 2010.

Notification of Reasons (including translation) for Refusal for Japanese Patent Application No. 2001-552611, Dispatched Date: Dec. 7, 2009.

Decision to Grant Patent (including translation) for Korean Patent Application No. 10-2002-7008794, dated Dec. 1, 2006.

Official Action for U.S. Appl. No. 12/477,742, mailed Jun. 8, 2010.

Notice of Acceptance for Australian Patent Application No. 2009222537, dated Aug. 25, 2011.

Official Action for Canadian Patent Application No. 2,726,826, dated Jun. 30, 2011.

"Asymmetric Digital Subscriber Line (ADSL) Transceivers," ITU-T G.992.1, Jun. 1999, pp. 91-117, 125, 126, 131, 132.

Notice of Allowance for Canadian Patent Application No. 2,394,491, dated Jul. 16, 2010.

Official Action for European Patent Application No. EP 06022008, mailed Jul. 7, 2010.

Official Action (including translation) for Japanese Patent Application No. 2001-552611, mailed Aug. 2, 2010.

Official Action (including translation) for Japanese Patent Application No. 2008-191051, mailed Jul. 26, 2010.

Official Action for U.S. Appl. No. 12/477,742, mailed Aug. 16, 2010.

Notice of Allowability for U.S. Appl. No. 12/477,742, mailed Sep. 7, 2010.

Notice of Allowance for Canadian Patent Application No. 2,726,826, dated Mar. 1, 2012.

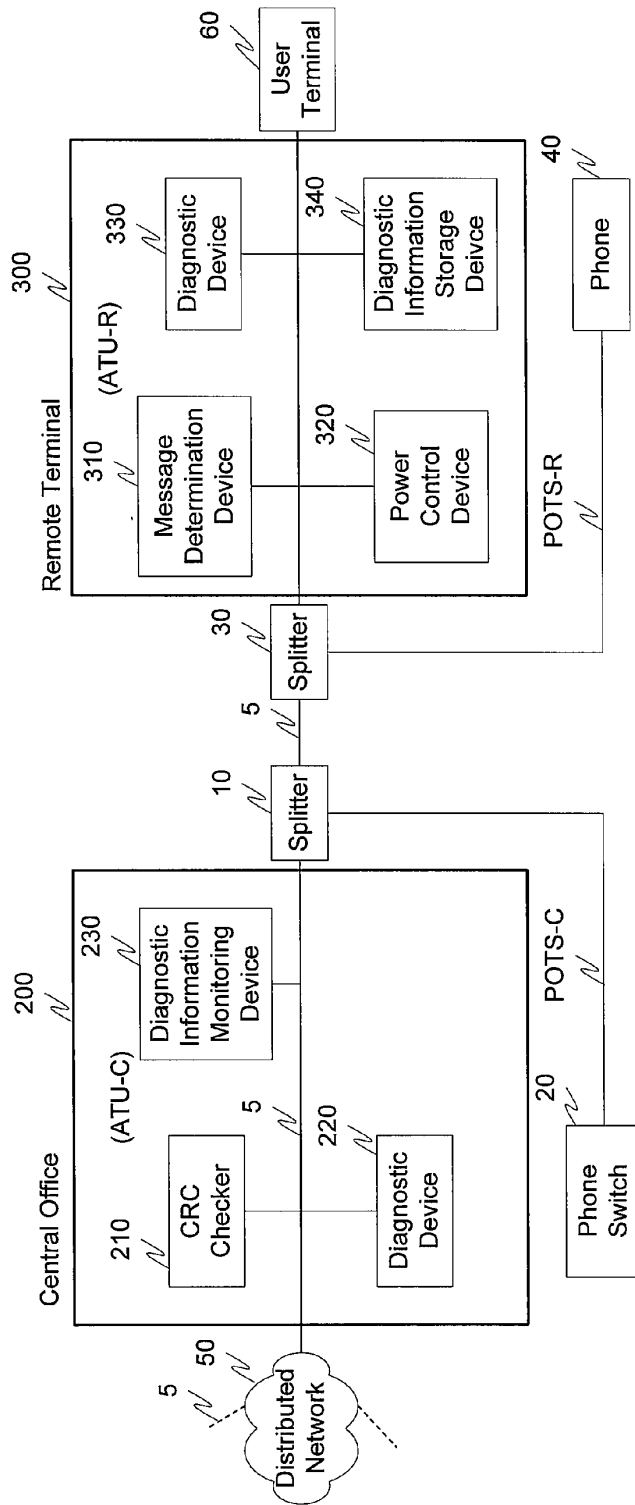


Fig. 1

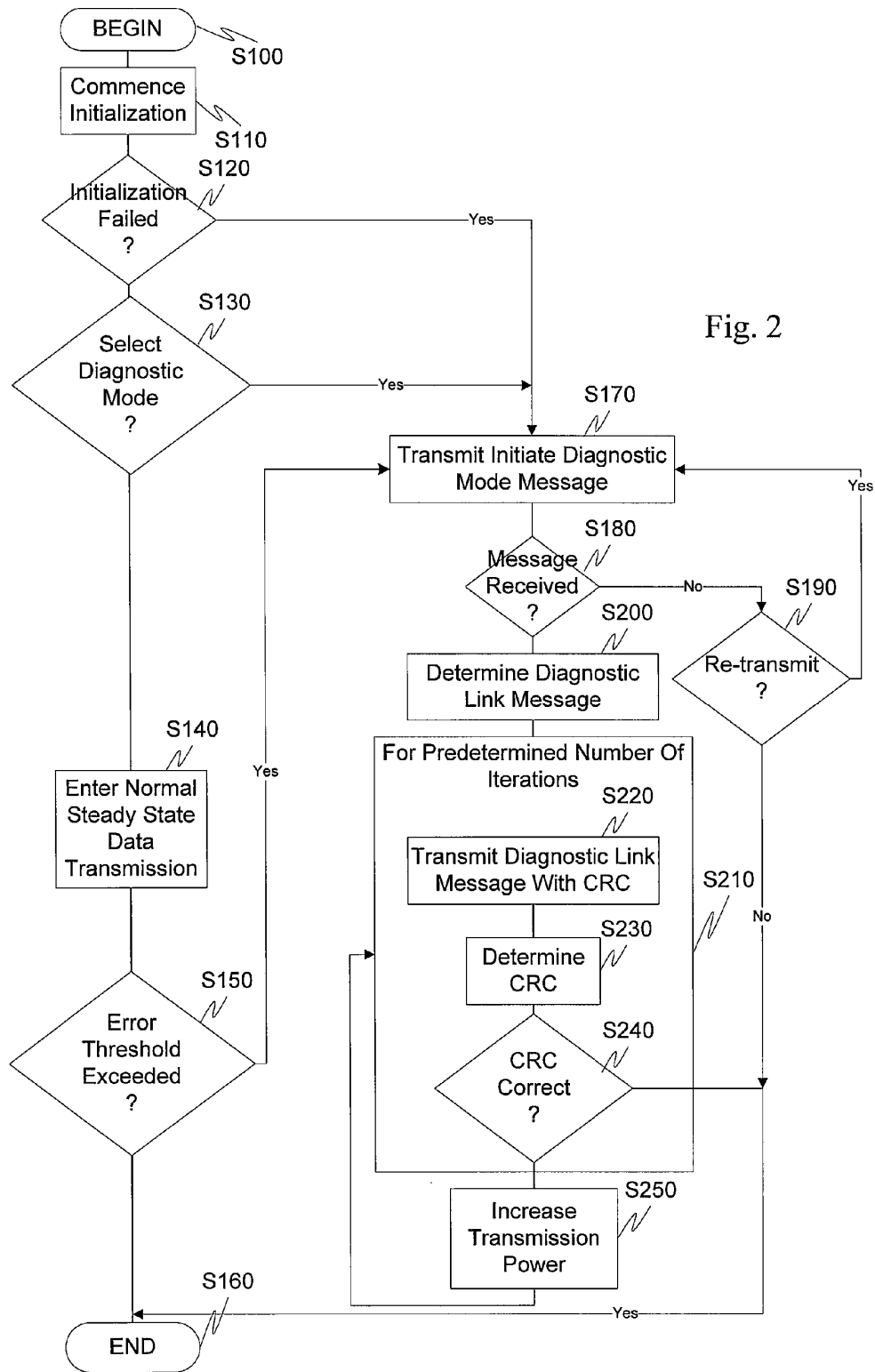


Fig. 2

1

**MULTICARRIER MODULATION
MESSAGING FOR POWER LEVEL PER
SUBCHANNEL INFORMATION**

RELATED APPLICATION DATA

This application is a continuation of U.S. application Ser. No. 12/477,742, filed Jun. 3, 2009, which is a continuation of U.S. application Ser. No. 10/619,691, filed Jul. 16, 2003, now U.S. Pat. No. 7,570,686, which is a divisional of U.S. application Ser. No. 09/755,173, filed Jan. 8, 2001, now U.S. Pat. No. 6,658,052, which claims the benefit of and priority under 35 U.S.C. §119(e) to U.S. Provisional Application No. 60/224,308, filed Aug. 10, 2000 entitled "Characterization of transmission lines using broadband signals in a multi-carrier DSL system," and U.S. Provisional Application No. 60/174,865, filed Jan. 7, 2000 entitled "Multicarrier Modulation System with Remote Diagnostic Transmission Mode", each of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

This invention relates to test and diagnostic information. In particular, this invention relates to a robust system and method for communicating diagnostic information.

BACKGROUND OF THE INVENTION

The exchange of diagnostic and test information between transceivers in a telecommunications environment is an important part of a telecommunications, such as an ADSL, deployment. In cases where the transceiver connection is not performing as expected, for example, where the data rate is low, where there are many bit errors, or the like, it is necessary to collect diagnostic and test information from the remote transceiver. This is performed by dispatching a technician to the remote site, e.g., a truck roll, which is time consuming and expensive.

In DSL technology, communications over a local subscriber loop between a central office and a subscriber premises is accomplished by modulating the data to be transmitted onto a multiplicity of discrete frequency carriers which are summed together and then transmitted over the subscriber loop. Individually, the carriers form discrete, non-overlapping communication subchannels of limited bandwidth. Collectively, the carriers form what is effectively a broadband communications channel. At the receiver end, the carriers are demodulated and the data recovered.

DSL systems experience disturbances from other data services on adjacent phone lines, such as, for example, ADSL, HDSL, ISDN, T1, or the like. These disturbances may commence after the subject ADSL service is already initiated and, since DSL for internet access is envisioned as an always-on service, the effect of these disturbances must be ameliorated by the subject ADSL transceiver.

SUMMARY OF THE INVENTION

The systems and methods of this invention are directed toward reliably exchanging diagnostic and test information between transceivers over a digital subscriber line in the presence of voice communications and/or other disturbances. For simplicity of reference, the systems and methods of the invention will hereafter refer to the transceivers generically as modems. One such modem is typically located at a customer premises such as a home or business and is "downstream" from a central office with which it communicates. The other

2

modem is typically located at the central office and is "upstream" from the customer premises. Consistent with industry practice, the modems are often referred to as "ATU-R" ("ADSL transceiver unit, remote," i.e., located at the customer premises) and "ATU-C" ("ADSL transceiver unit, central office" i.e., located at the central office). Each modem includes a transmitter section for transmitting data and a receiver section for receiving data, and is of the discrete multitone type, i.e., the modem transmits data over a multiplicity of subchannels of limited bandwidth. Typically, the upstream or ATU-C modem transmits data to the downstream or ATU-R modem over a first set of subchannels, which are usually the higher-frequency subchannels, and receives data from the downstream or ATU-R modem over a second, usually smaller, set of subchannels, commonly the lower-frequency subchannels. By establishing a diagnostic link mode between the two modems, the systems and methods of this invention are able to exchange diagnostic and test information in a simple and robust manner.

In the diagnostic link mode, the diagnostic and test information is communicated using a signaling mechanism that has a very high immunity to noise and/or other disturbances and can therefore operate effectively even in the case where the modems could not actually establish an acceptable connection in their normal operational mode.

For example, if the ATU-C and/or ATU-R modem fail to complete an initialization sequence, and are thus unable to enter a normal steady state communications mode, where the diagnostic and test information would normally be exchanged, the modems according to the systems and methods of this invention enter a robust diagnostic link mode. Alternatively, the diagnostic link mode can be entered automatically or manually, for example, at the direction of a user. In the robust diagnostic link mode, the modems exchange the diagnostic and test information that is, for example, used by a technician to determine the cause of a failure without the technician having to physically visit, i.e., a truckroll to, the remote site to collect data.

The diagnostic and test information can include, for example, but is not limited to, signal to noise ratio information, equalizer information, programmable gain setting information, bit allocation information, transmitted and received power information, margin information, status and rate information, telephone line condition information, such as the length of the line, the number and location of bridged taps, a wire gauge, or the like, or any other known or later developed diagnostic or test information that may be appropriate for the particular communications environment. For example, the exchanged diagnostic and test information can be directed toward specific limitations of the modems, to information relating to the modem installation and deployment environment, or to other diagnostic and test information that can, for example, be determined as needed which may aid in evaluating the cause of a specific failure or problem. Alternatively, the diagnostic and test information can include the loop length and bridged tap length estimations as discussed in U.S. patent application Ser. No. 09/755,172, now U.S. Pat. No. 6,865,221, filed herewith and incorporated herein by reference in its entirety.

For example, an exemplary embodiment of the invention illustrates the use of the diagnostic link mode in the communication of diagnostic information from the remote terminal (RT) transceiver, e.g., ATU-R, to the central office (CO) transceiver, e.g., ATU-C. Transmission of information from the remote terminal to the central office is important since a typical ADSL service provider is located in the central office and would therefore benefit from the ability to determine

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.