

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMCAST CABLE COMMUNICATIONS, LLC,
Petitioner,

v.

ENTROPIC COMMUNICATIONS, LLC,
Patent Owner.

Patent No. 7,295,518
Filing Date: December 18, 2002
Issue Date: November 13, 2007
Title: BROADBAND NETWORK FOR COAXIAL CABLE USING MULTI-
CARRIER MODULATION

Inter Partes Review No.: IPR2024-00431

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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EXHIBITS

- Ex. 1001: U.S. Pat. No. 7,295,518 (“the ’518 patent”)
- Ex. 1002: Expert Declaration of James Bertonis
- Ex. 1003: *Reserved*
- Ex. 1004: Certified Prosecution History of the ’518 patent
- Ex. 1005: Certified Prosecution History of the U.S. Appl. No. 10/230,687 (“the ’687 application “)
- Ex. 1006: U.S. Pub. No. 2006/0218593 (“Afshary”)
- Ex. 1007: EP Pub. No. 1087586A2 (“Mirfakhraei”)
- Ex. 1008: U.S. Pub. No. 2001/0031016 (“Seagraves”)
- Ex. 1009: Bingham, John A.C., “Multicarrier Modulation for Data Transmission: An Idea Whose Time Has Come,” *IEEE Communication Magazine*, vol. 28, no. 5, pp. 5-14, May 1990 (“Bingham”)
- Ex. 1010: Jacobsen, Krista S., “Synchronized Discrete Multi-Tone (SDMT) Modulation for Cable Modems: Making the Most of the Scarce Reverse Channel Bandwidth,” *IEEE, WESCON/97 Conference Proceedings*, November 6, 1997 (“Jacobsen 97”)
- Ex. 1011: Wu, Yiyan et al., “Orthogonal Frequency division Multiplexing: A Multi-Carrier Modulation Scheme,” *IEEE Transactions on Consumer Electronics*, vol. 41, no. 3, August 1995 (“Wu”)
- Ex. 1012: U.S. Pat. No. 6,807,146 (“McFarland”)
- Ex. 1013: U.S. Pat. No. 6,456,653 (“Sayeed”)
- Ex. 1014: R. Baines, “Line Code Debates,” *Electronic Design*, vol. 45, no. 6, pp. 142-146, March 1997 (“Baines”)
- Ex. 1015: Esvelt, M.B.P., “A multicarrier modem architecture for VDSL,” 1997 (“Esvelt”)

- Ex. 1016: U.S. Pat. No. 6,091,932 (“Langlais”)
- Ex. 1017: Sari, Hikmet, et al., “Extending the Capacity of Multiple Access Channels,” *IEEE communications Magazine*, vol. 38, no. 1, pp. 74-82, January 2000 (“Sari”)
- Ex. 1018: Jacobsen, Krista et al., “An Efficient Digital Modulation Scheme for Multimedia Transmission on the Cable Television Network,” *43rd Annual National Cable Television Association (NTCA) Convention and Exposition*, New Orleans, LA. 1994 (“Jacobsen 94”)
- Ex. 1019: Haykin, Simon, *Communication Systems*, 3rd ed., Wiley & Sons, 1994 (“Haykin”)
- Ex. 1020: Lathi, B.P., *Linear Systems and Signals*, Cambridge Press, 1992 (“Lathi”)
- Ex. 1021: Oppenheim, Alan V. et al., *Discrete-Time Signal Processing*, Prentice Hall PTR, 1989 (“Oppenheim”)
- Ex. 1022: U.S. Patent No. 6,737,984 to Welles, II et al. (“Welles”)
- Ex. 1023: Couch II, Leon W., *Digital and Analog Communication Systems*, 4th ed., Macmillan Publishing Company, 1993 (“Couch”)
- Ex. 1024: Ciciora, Walter S. *Modern Cable Television Technology: Video, Voice, and Data Communications*. San Francisco, Calif: Morgan Kaufmann Publishers, 1999, Sections 4.1-4.3.3 (Chapter 4, pp. 161-192) (“Ciciora”)

MANDATORY NOTICES

Real Parties in Interest (37 C.F.R. § 42.8(b)(1))

The real parties-in-interest for this petition are (i) Comcast Corporation, (ii) Comcast Cable Communications, LLC, and (iii) Comcast Cable Communications Management, LLC. These entities are referenced below as “Comcast entity _” or as “Comcast entities __,” where “__” is one of or more of (i)-(iii).

No unnamed entity is funding, controlling, or directing this Petition for *inter partes* review (IPR) of U.S. Patent No. 7,295,518 (“the ’518 patent”), or otherwise has an opportunity to control or direct this Petition or Petitioner’s participation in any resulting IPR.

Related Matters (37 C.F.R. § 42.8(b)(2))

The ’518 patent is asserted against Comcast Corporation, Comcast Cable Communications, LLC, and Comcast Cable Communications Management, LLC, in the Central District of California in *Entropic Communications, LLC v. Comcast Corporation et al.*, 2-23-cv-01048 (C.D. Cal.) (“1048 CDCA Litigation”). The earliest date of service on any Comcast entity named in the 1048 CDCA Litigation was February 16, 2023. Petitioner is aware of the following additional litigation matters involving the ’518 patent:

Case	Filing Date
<i>Entropic Communications, LLC v. DirecTV, LLC f/k/a DirecTV, Inc. et al.</i> , 2-23-cv-05253 (CDCA)	July 1, 2023

Case	Filing Date
<i>Entropic Communications, LLC v. Cox Communications, Inc. et al.</i> , 2-23-cv-01047 (CDCA)	February 10, 2023
<i>Entropic Communications, LLC v. DISH Network Corporation et al.</i> , 2-23-cv-01043 (CDCA)	February 10, 2023
<i>Entropic Communications, LLC v. Charter Communications, Inc.</i> , 2-23-cv-00050 (EDTX) – terminated pursuant to a settlement on December 13, 2023	February 10, 2023
<i>Entropic Communications, Inc. v. ViXS Systems, Inc. et al.</i> , 3-13-cv-01102 (SDCA) – terminated pursuant to a settlement on September 15, 2014	May 8, 2013

A petition for *inter partes* review was filed against the '518 patent by Dish Network L.L.C. on January 16, 2024, as IPR2024-00393.

Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3))

Petitioner designates counsel listed below. A power of attorney for counsel is being concurrently filed.

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Petitioner consents to electronic service by email at the following address and the above emails: ComcastIPRService@bannerwitcoff.com.

I. INTRODUCTION

Comcast Cable Communications, LLC (“Petitioner”) petitions for *inter partes* review and cancellation of claims 1-4 of U.S. Patent No. 7,295,518 (“the ’518 patent”) (Ex. 1001). This petition demonstrates the unpatentability for obviousness of the claims under 35 U.S.C. §103(a) (pre-AIA), and merits institution of trial under 35 U.S.C. §314(a).

II. SUMMARY OF ARGUMENT

The ’518 patent is directed to a coaxial cable local area network (LAN). The ’518 patent purports to overcome impairments of the coaxial cable medium by using a multi-carrier modulation protocol, such as orthogonal frequency division multiplexing (OFDM) or discrete multi-tone (DMT). These multi-carrier modulation protocols use a set of modulated sub-carriers to transmit data, with each sub-carrier corresponding to a frequency channel. The ’518 patent also describes the use of channel probe messages to estimate the signal to noise ratio (SNR) of each frequency channel. The ’518 patent explains that bit-loading is used to vary the number of bits transmitted by a sub-carrier based on the SNR estimated for a corresponding frequency channel. Frequency channels with higher SNRs are assigned more bits for transmission using a higher order modulation scheme, while frequency channels with lower SNRs are assigned fewer bits for transmission using a lower order modulation scheme.

As set forth below, these features were known in the prior art, and claims 1-4 of the '518 Patent are unpatentable and should be canceled.

III. OVERVIEW OF THE '518 PATENT

A. Brief Description

The '518 patent is directed to “communications using coaxial cable building wiring.” Ex. 1001, 1:28-29. Figure 2 (below) illustrates a cable LAN. Ex. 1001, 5:36-6:3. As shown, LAN modems (orange) are connected via coaxial cable (blue) and splitters (pink) to enable LAN devices (e.g., PCs) (green) to communicate with one another. Ex. 1001, 5:36-6:3; Ex. 1002, ¶¶ 57-65.

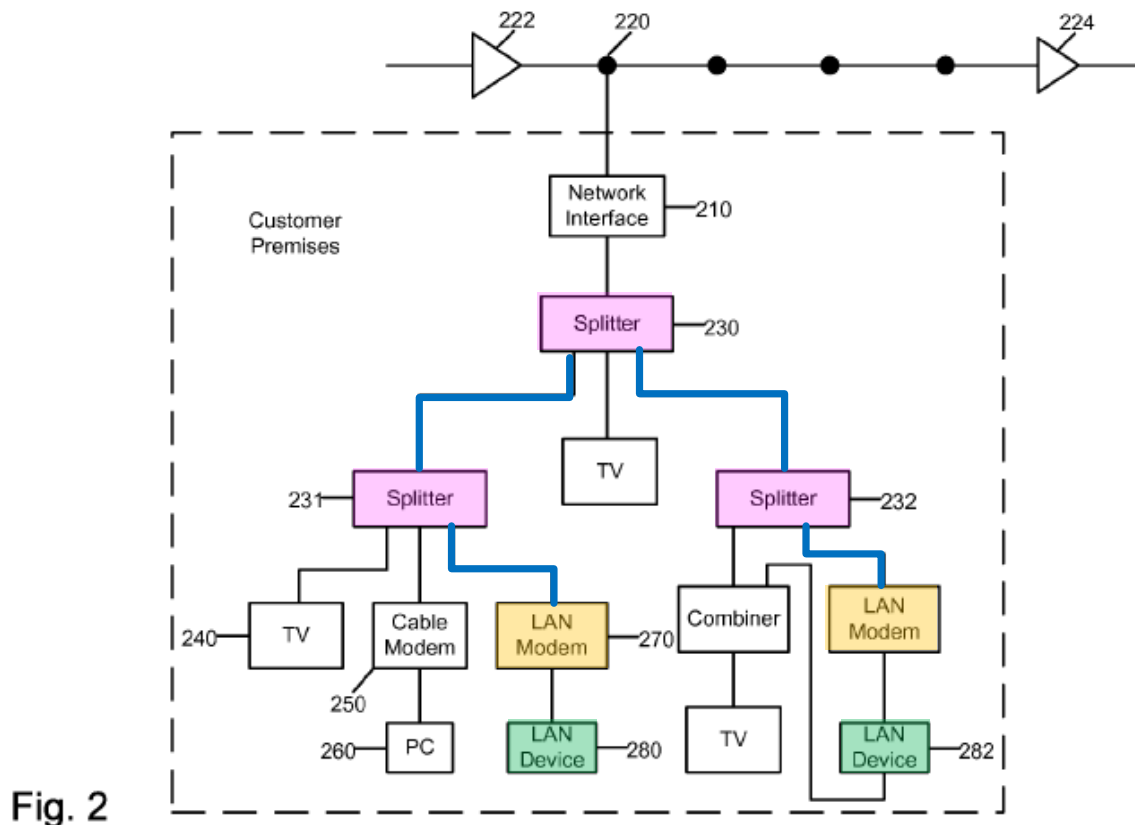


Fig. 2

Ex. 1001, Fig. 2 (annotated)

The '518 patent explains that the frequency spectrum of the coaxial cable may be shared by more than one network. Ex. 1001, Abstract, 1:33-40, 5:57-6:10, Figs. 1-2. Figure 4 (below) shows a first portion of the frequency spectrum used by existing cable services (*e.g.*, including a conventional cable TV (CATV) network) (**green**) and a second portion of the frequency spectrum used by the cable LAN (**red**). Ex. 1001, 6:4-10; Ex. 1002, ¶¶ 66-67.

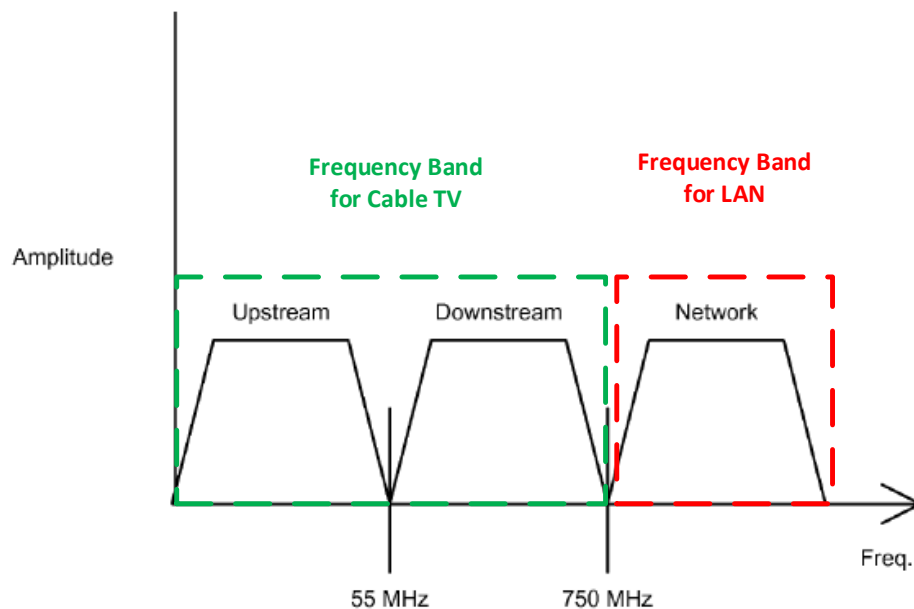


Fig. 4

Ex. 1001, Fig. 4 (annotated)

The '518 patent describes the use of multi-carrier modulation (or multi-tone modulation) techniques to address channel impairments present in coaxial building wiring. Ex. 1001, Abstract, 4:37-46, 7:22-8:50. The '518 patent describes orthogonal frequency division multiplexing (OFDM) and discrete multi-tone (DMT)

as multi-carrier modulation techniques that employ a set of modulated carriers (or sub-carriers). Ex. 1001, 7:22-43, 8:27-28.¹ With OFDM and DMT, each carrier corresponds to a frequency channel (or frequency bin). Ex. 1001, 7:22-43. Each carrier is separately modulated based on a set of bits assigned to the carrier, using a modulation scheme such as Quadrature Phase Shift Keying (QPSK) or Quadrature Amplitude modulation (QAM). Ex. 1001, 7:22-43. The modulated carriers are then summed for transmission over the coaxial cable channel. Ex. 1001, 7:38-40; Ex. 1002, ¶ 68.

The '518 patent also describes the use of bit-loading. Ex. 1001, 8:9-26, 10:11:6, Fig. 10. With bit-loading, carriers corresponding to frequency channels having lower signal to noise ratios (SNRs) modulate data using lower order signal constellations (*e.g.*, 16-QAM) while carriers corresponding to frequency channels having higher SNRs modulate data using higher order signal constellations (*e.g.*, 64-QAM). Ex. 1001, 8:9-26, 10:61-11:6, Fig. 10. Higher order signal constellations correspond to more bits per transmission than lower order constellations, so carriers with higher SNRs are allocated more bits for modulation and transmission while

¹ Petitioner's expert James Bertoni explains relevant background technologies in his declaration. Ex. 1002, ¶¶ 29-56.

carriers with lower SNRs are allocated fewer bits for modulation and transmission. Ex. 1001, 8:9-26, 10:61-11:6, Fig. 10; Ex. 1002, ¶¶ 68-69.

The '518 patent further describes determining the SNR for each carrier (or frequency channel/bin), collectively referred to as an SNR profile. Ex. 1001, 9:35-10:20. The '518 patent describes the use of channel probe messages to build SNR profiles. Ex. 1001, 4:48-62, 9:35-10:20. To generate an SNR profile, a first LAN device transmits a channel probe message to a second LAN device. Ex. 1001, 9:35-49. The '518 patent states that a probe message is “a predetermined bit sequence which [is] known by the receiving device.” Ex. 1001, 9:38-39, 10:6-20, Fig. 7. The receiving LAN device determines the SNR profile based on the received predetermined bit sequence, and then determines the bit-loading for each carrier based on the SNR profile. Ex. 1001, 4:48-62, 9:35-10:20. The receiving LAN device provides the determined bit-loadings back to the transmitting LAN device for use in subsequent communications with the receiving LAN device. Ex. 1001, 4:48-62, 9:35-10:20. The '518 patent admits that determining an SNR profile “from a known signal is well known in the art.” Ex. 1001, 10:13-14; Ex. 1002, ¶¶ 67-74.

B. Prosecution History

The '518 patent was filed as application no. 10/322,834 (“the '834 application”) on December 18, 2002. Ex. 1001; Ex. 1004, 2-41. Prosecution of the '834 application was brief as no substantive Office Action was issued. *See generally*

Ex. 1004. The '834 application was filed with 10 claims, with claims 1, 5, 8, and 10 being independent. Ex. 1004, 2-41. In response to a Restriction Requirement, Applicant elected claims 1-4 and 10 for prosecution and canceled claim 5-9. Ex. 1004, 61-66, 68-73. To gain allowance, Applicant agreed to the Examiner's suggestion to amend claim 1 to include the limitations of claim 2, which correspond to element [1D]. Ex. 1004, 75-86, 82. In the Notice of Allowance, the Examiner stated:

The prior art of record, Dodds et al. (US 6,886,181) and an article "Multicarrier Modulation for Data Transmission; An Idea Whose Time has Come", by John A.C. Bingham, IEEE, alone or in combination, fails to disclose a network device for communicating data to other network devices by utilizing unique method step of determining channel characteristics and a bit loading profile used to transmit data by analyzing received probe message signals (claims 1 and 10).

Ex. 1004, 80; Ex. 1002, ¶¶ 75-78.

C. Earliest Priority Date for the Claims

As noted in Section III.B, the '518 patent was filed as the '834 application on December 18, 2002. Ex. 1001; Ex. 1004, 2-41. The '518 patent indicates that it is a continuation of application no. 10/230,687 ("the '687 application"). Ex. 1001; Ex. 1004, 2-41. The '834 application and the '687 application, however, were not copending at the time the '834 application was filed. Therefore, the '518 patent

cannot claim priority to the '687 application. 35 U.S.C § 120; 37 C.F.R § 1.78; MPEP § 201.11.²

The '687 application was filed on August 29, 2002. Ex. 1005, 2-36. On October 1, 2002, a Notice to File Missing Parts was issued. Ex. 1005, 37-38. Applicant never responded to the Notice to File Missing Parts. Ex. 1005. Consequently, the '687 application was abandoned as of December 2, 2002. 35 U.S.C. § 133; 37 C.F.R §§ 1.53, 1.135, 1.136; MPEP §§ 711.02, 711.04(a). To claim priority to the '687 application, the '834 application must have been filed prior to abandonment of the '687 application. Because the '834 application was filed after the '687 application was abandoned, the '834 application and the '687 application were never copending. The lack of copendency prevents the '518 patent from claiming priority to the '687 application. 37 CFR § 1.78; MPEP § 201.11.

The '518 patent also indicates that it claims priority to provisional application No. 60/385,361 (“the '361 provisional application”), filed on June 3, 2002, provisional application No. 60/363,420 (“the '420 provisional application”), filed on March 12, 2002, and provisional application No. 60/316,820 (“the '820 provisional application”), filed on August 30, 2001. Ex. 1001. Because the '518 patent cannot claim priority to the '687 application, the '518 patent cannot claim priority to the

² All citations in this sections are to MPEP, 8th ed., published August, 2001.

'820 provisional application as the '518 patent was filed more than a year after the '820 provisional application was filed. 35 U.S.C § 119; MPEP § 201.11.

Accordingly, the earliest possible date to which the '518 patent may claim priority is March 12, 2002, the filing date of the '420 provisional application. Each of the references relied on herein – Afshary, Mirfakhraei, and Welles – qualify as prior art to the '518 patent even if the priority date of the '518 patent is determined to be August 30, 2001, and the analysis provided herein does not depend on whether the priority date of the '518 patent is determined to be March 12, 2002, or August 30, 2001.

IV. OVERVIEW OF PRIOR ART

A. U.S. Patent Publication No. 2006/0218593 (“Afshary”) (Ex. 1006)

Afshary was filed on January 3, 2006, as a continuation of U.S. Pat. App. No. 09/164,427, filed on September 30, 1998, and published on September 28, 2006. Afshary is prior art under pre-AIA 35 U.S.C. § 102(e) whether the priority date of the '518 patent is determined to be March 12, 2002, or August 30, 2001. Ex. 1006.

Afshary relates to “networking and more particularly to data distribution through a coaxial cable.” Ex. 1006, ¶ 2. Afshary describes “a coaxial cable local area network (LAN) for communicating data between clients of the cable LAN.” Ex. 1006, ¶ 12, *see also id.*, Abstract, ¶¶ 2, 7, 12, 14, 19-23, 41, Figs. 1-2. Figure 1 (below) illustrates “an in-home coaxial cable LAN.” Ex. 1006, ¶ 14. Afshary

explains that the cable LAN includes cable LAN adapters 32 (**orange**) that enable client devices (**green**) – such as PCs 36 and 48 – to communicate with each other via coaxial cable wire 24 (**blue**) and splitters 22 and 38 (**purple**). Ex. 1006, ¶¶ 18-19, 21, 23, 41, Figs. 1-2; Ex. 1002, ¶¶ 79-83.

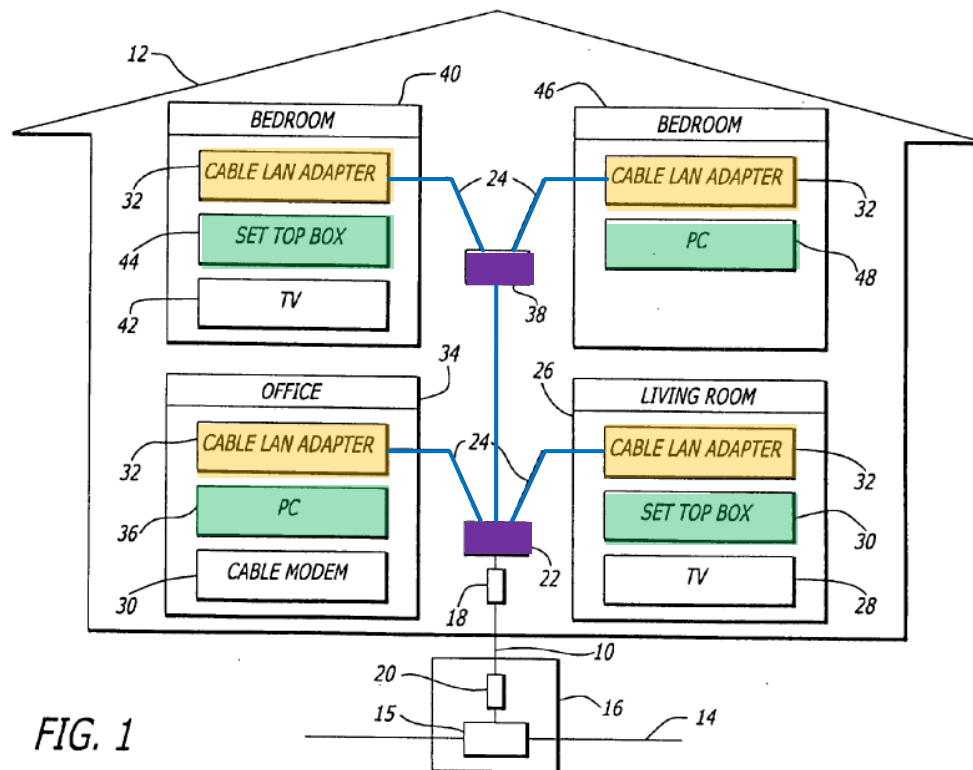


FIG. 1

Ex. 1006, Fig. 1 (annotated)

Afshary explains that the cable LAN operates over a frequency range so as not to interfere with a frequency range used by conventional services, such as cable TV, provided over the same coaxial cable. Ex. 1006, ¶¶ 4, 5, 7, 24, 25-28, Fig. 3. As shown in Figure 3 (below), existing cable services are provided over an operating frequency range of 0-950 MHz (**green**) while the cable LAN is provided over a non-overlapping operating frequency range of 1000-2000 MHz (**red**). Ex. 1006, ¶¶ 24-

28. As an example, data is transmitted over the cable LAN with a center frequency of 1300 MHz and occupies a bandwidth of 5 MHz (**blue**). Ex. 1006, ¶ 25; Ex. 1002, ¶ 84.

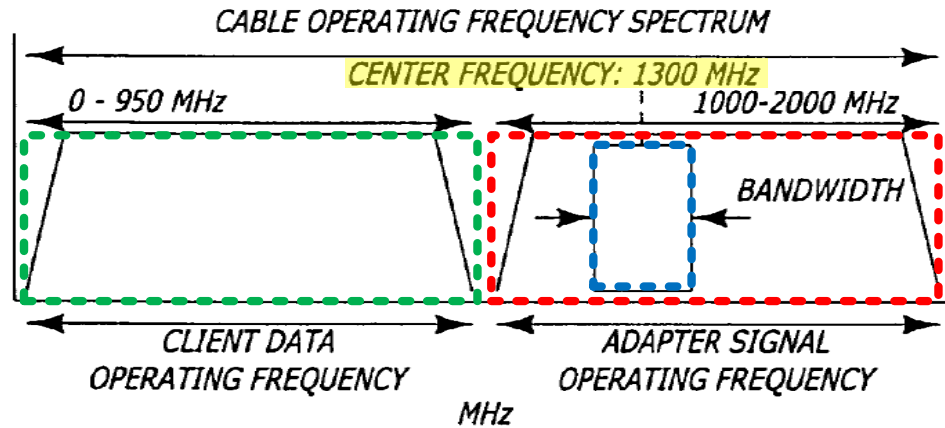
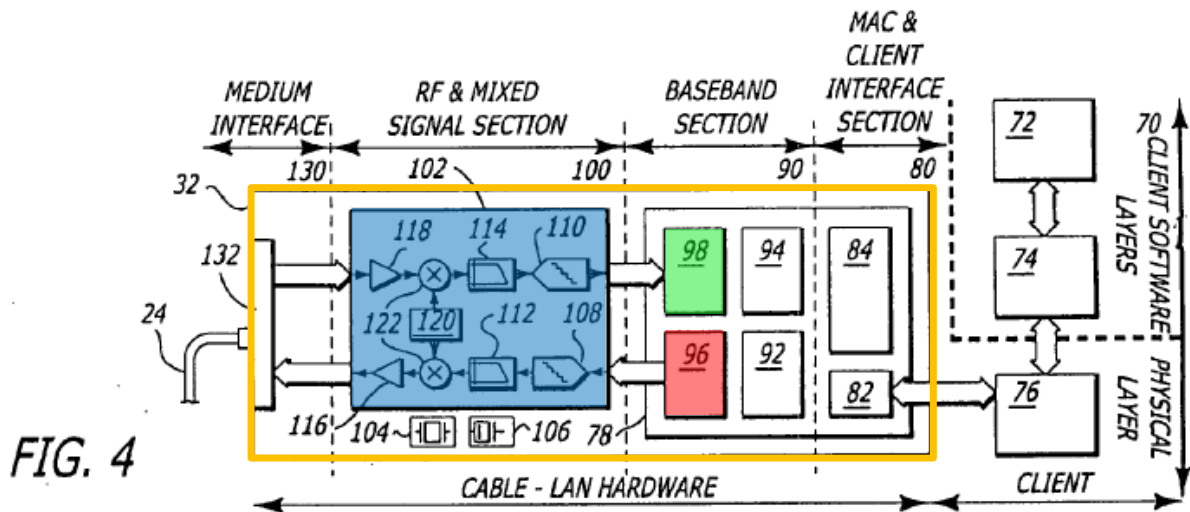


FIG. 3

Ex. 1006, Fig. 3 (annotated)

Figure 4 of Afshary illustrates the architecture of a cable LAN adapter (**orange**). Ex. 1006, ¶ 29. Data from a client device is modulated by modulator 96 (**red**) using a modulation scheme such as Quadrature Phase Shift Keying (QPSK) digital modulation. Ex. 1006, ¶¶ 26, 35-41. Radio Frequency (RF) and Mixed Signal section 100 (**blue**) up-converts the modulated data to an RF frequency (e.g., to an RF center frequency of 1300 MHz as shown in Figure 3). Ex. 1006, ¶¶ 38-39. RF data signals received by the cable LAN adapter are down-converted by the RF and Mixed Signal section 100 and then demodulated by demodulator 98 (**green**) to recover the original data. Ex. 1006, ¶¶ 38-42; Ex. 1002, ¶¶ 85-87.



Ex. 1006, Fig. 4 (annotated)

B. European Patent Publication No. 1087586A2 (“Mirfakhraei”) (Ex. 1007)

Mirfakhraei was published on March 28, 2001, and is prior art under pre-AIA 35 U.S.C. § 102(a) whether the priority date of the ’518 patent is determined to be March 12, 2002, or August 30, 2001. Ex. 1007.

Mirfakhraei “relates to communications and communications systems such as modems and transceivers that use multiple carrier frequencies for information transmissions.” Ex. 1007, ¶ 1. Mirfakhraei describes modems that use discrete multi-tone (DMT) and bit-loading to increase data transmission rates. Ex. 1007, Abstract, ¶¶ 2-3, 5-8; Ex. 1002, ¶¶ 88-89.

Mirfakhraei explains that DMT is a multi-carrier modulation technique that “simultaneously uses multiple carrier frequencies where each carrier frequency corresponds to a sub-channel.” Ex. 1007, Abstract, ¶ 3. Mirfakhraei describes that

“[f]or data transmission, a sending modem breaks transmitted data into packets for simultaneous transmission on separate sub-channels and independently modulates communication signals for the sub-channels according to the data carried on each sub-channel.” Ex. 1007, Abstract, ¶ 3. For reception, the “receiving modem separates sub-channel signals according to carrier frequency, demodulates the separate sub-channel signals, and reassembles the data.” Ex. 1007, Abstract, ¶ 3; Ex. 1002, ¶ 90.

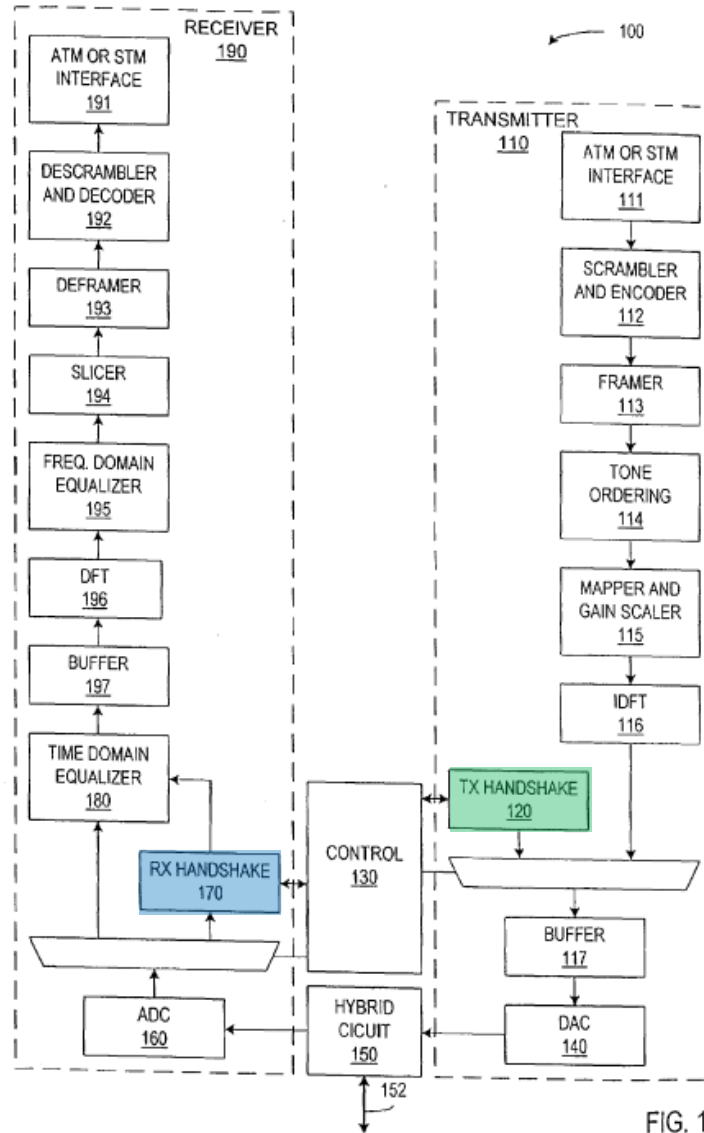
Mirfakhraei’s modems employ “a ‘bit-loading’ process that characterizes the capabilities of sub-channels and determines the number of bits-per-symbol transmitted over the channel.” Ex. 1007, ¶ 14. Mirfakhraei explains that with bit-loading, more bits are assigned to a sub-carrier having a higher SNR, which indicates a more reliable sub-channel. Ex. 1007, ¶¶ 4, 17-18, 23-24. In contrast, fewer bits are assigned to a sub-carrier having lower SNR, indicating a less reliable sub-channel. Ex. 1007, ¶¶ 4, 17-18, 23-24. The number of bits assigned to a sub-channel are modulated using quadrature amplitude modulation (QAM), such that each sub-carrier transmits a QAM symbol. Ex. 1007, ¶¶ 4, 17-18, 23-24. A sub-channel with a higher SNR uses a larger QAM constellation for modulating the number of bits assigned to the sub-channel. Ex. 1007, ¶¶ 4, 17-18, 23-24. A larger QAM constellation allows more bits per QAM symbol to be transmitted by a corresponding sub-carrier, resulting in higher bit-loading. Ex. 1007, ¶¶ 4, 17-18, 23-24. A sub-

channel with a lower SNR uses a smaller QAM constellation that is limited to transmitting fewer bits per QAM symbol on a corresponding sub-carrier, resulting in lower bit-loading. Ex. 1007, ¶¶ 4, 17-18, 23-24; Ex. 1002, ¶¶ 29-55, 91.

Figure 1 (below) illustrates a modem transceiver 100 that includes a transmitter 110 and a receiver 190. Ex. 1007, ¶¶ 14-15. To implement the DMT bit-loading protocol, the transmitter 110 includes TX handshake block 120 (**green**) and the receiver 190 includes RX handshake block 170 (**blue**). Ex. 1007, ¶¶ 2-3, 5-8, 14-25 14. Mirfakhraei explains that the TX handshake block 120 of a first transceiver generates and transmits a handshake signal to a second transceiver, with the handshake signal comprising a predetermined signal known to both the first and second transceivers (*e.g.*, a known signal pattern or a known pseudo-random signal). Ex. 1007, ¶¶ 20-22. The RX handshake block 170 of the second transceiver estimates the signal-to-noise ratio (SNR) for each sub-channel based on the received handshake signals. Ex. 1007, ¶¶ 21-23; Ex. 1002, ¶ 92.

Mirfakhraei explains that by comparing the received handshake signal to the known signal values that were transmitted, SNR values for each sub-channel are determined. Ex. 1007, ¶¶ 5-8, 14, 20, 22-23, 25-32, Figs. 1-2. Bit-loadings for each sub-channel are then determined based on the SNR values determined for each sub-channel. Ex. 1007, ¶¶ 5-8, 14, 17, 20, 22-23, 25-32, Figs. 1-2. The RX handshake block 170 of the second transceiver sends the determined bit-loadings for each sub-

channel to the first transceiver, which then employs the bit-loadings in subsequent communications with the second transceiver. Ex. 1007, ¶¶ 5-8, 14, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶ 93.



Ex. 1007, Fig. 1 (annotated)

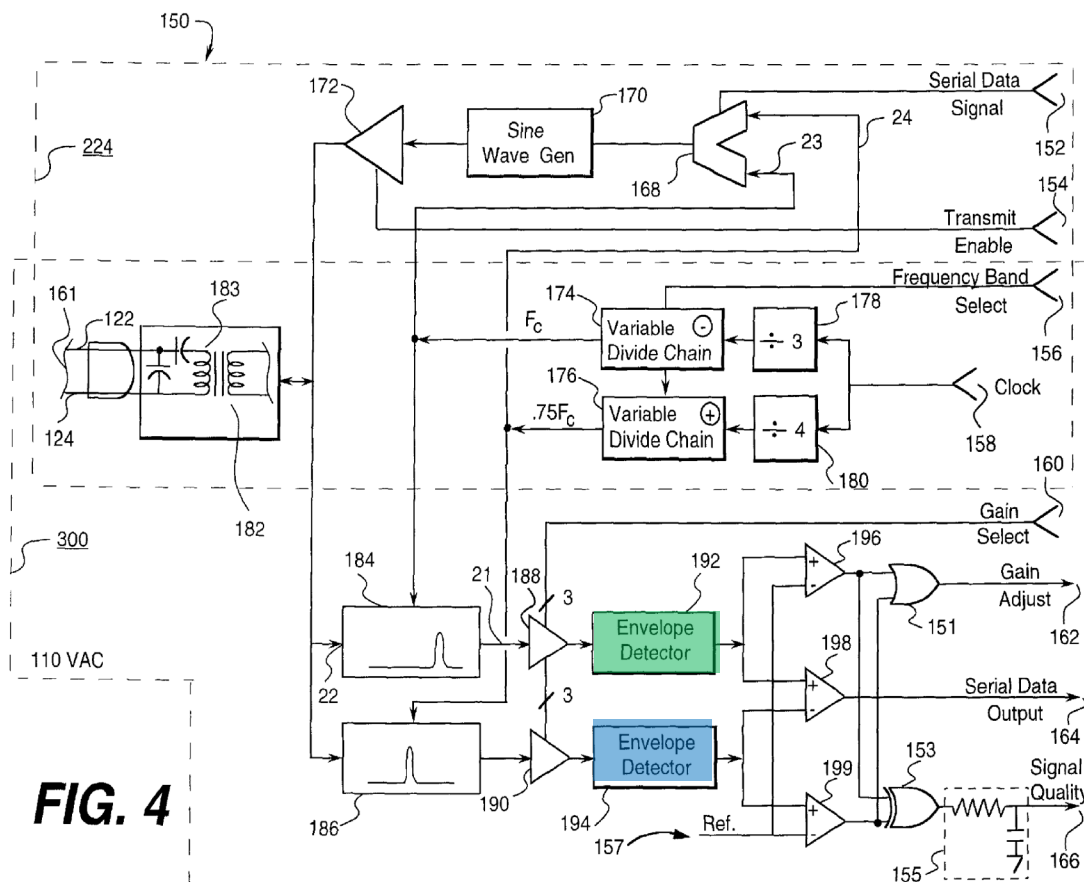
C. U.S. Patent No. 6,737,984 (“Welles”) (Ex. 1022)

Welles was filed on March 10, 2000, and issued on May 18, 2004. Ex. 1022. Welles is prior art under pre-AIA 35 U.S.C. § 102(e) whether the priority date of the ’518 patent is determined to be March 12, 2002, or August 30, 2001. Ex. 1022.

Welles describes a LAN formed over power line cables that allows utility meters to communicate with each other. Ex. 1022, Abstract, 1:14-18, 1:56-2:9, 2:55-7:11, Figs. 1-2, 4. Welles explains that each utility meter includes a frequency shift keying (FSK) transceiver as shown in Figure 4 (below) to communicate data over a pair of frequencies (*e.g.*, a center frequency and a non-center frequency). The FSK transceiver includes a pair of envelope detectors – center frequency envelope detector 192 (**green**) and non-center frequency envelope detector 194 (**blue**). Ex. 1022, 4:5-16, 5:5-7:11; Ex. 1002, ¶¶ 94-98.

Welles explains that the pair of envelope detectors scan a range of frequencies to determine if the frequency range is in use by another FSK transceiver on the LAN or if the frequency range is affected by other interference or noise. Ex. 1022, 5:5-7:11. As an example, center frequency envelope detector 192 (**green**) measures the received signal power of a signal on power line 122 and compares it to a reference signal power level 157 using comparator 196. Ex. 1022, 5:5-7:11. If the received signal power exceeds the reference signal power level 157, an active signal is provided via signal quality output 166, which indicates that the corresponding

frequency is occupied or otherwise not available or suitable for use. Ex. 1022, 5:5-7:11. Welles' envelope detector and its techniques for using the envelope detector enable "the frequency spectrum [to be] scanned to find a clear frequency pair from which [the FSK transceiver] may transmit utility meter data using FSK modulation." Ex. 1022, 7:6-8; Ex. 1002, ¶¶ 99-102.



Ex. 1022, Fig. 4 (annotated)

V. IDENTIFICATION OF CHALLENGE PURSUANT TO 37 C.F.R. § 42.104(b)

A. Claims for Which Review is Requested and Grounds on Which Challenge Is Based

Petitioner requests review of claims 1–4 on the following grounds.

Ground	References	Basis	Claims Challenged
A	Afshary in view of Mirfakhraei	§103	1-4
B	Afshary in view of Mirfakhraei in further view of Welles	§103	2

None of this prior art was before the examiner during prosecution of the '518 patent.

B. 314(a) Discretion Does Not Apply

1. *Fintiv* Discretionary Denial Unwarranted

The *Fintiv* factors as set forth in the Director's June 21, 2022 Guidance Memorandum do not warrant discretionary denial.

Factor one (court stay-related) appears neutral. Petitioner has filed IPR petitions challenging two of the twelve patents asserted in the District Court in case no. 2:23-cv-01048. If trial is instituted in one or more of those IPRs, Petitioner expects to request a stay.

Factor two (proximity of trial date) favors institution. Petitioner has filed a motion to dismiss, Patent Owner has filed an Amended Complaint, and Petitioner

will renew its Motion to Dismiss in order to seek dismissal of the operative complaint. Further, no trial date has been set.

Factor three (investment in parallel proceedings) favors institution. The investment by the District Court has been limited to considering motions to dismiss.

Factor four (issues overlap) strongly favors institution. The petition challenges all 4 claims in the '518 patent while only claims 1 and 3 are asserted in the District Court.

Factor five (parties-related) does not warrant denial as Petitioner is a defendant in the District Court case.

Factor six (other circumstances including merits) favors institution. Petitioner presents compelling unpatentability challenges that merit institution.

2. *General Plastic* Discretionary Denial Unwarranted

An unrelated party, Dish Network L.L.C., (“Dish”), filed a petition challenging claims 1 and 3 of the '518 patent on January 16, 2024. Dish’s filing does not warrant a discretionary denial of this petition—filed less than a month later. The *General Plastic*³ factors are addressed below.

³*General Plastic Industrial Co. Ltd. v. Cannon Kabushiki Kaisha*, No. IPR2016-01357, Paper 19 at 16 (PTAB Sept. 6, 2017) (precedential as to section II.B.4.i).

a. Factor One (whether the same petitioner previously filed a petition directed to the same claims of the same patent) favors institution

Dish is not the present petitioner. Nor does Dish's prior petition challenge the same claims as the instant petition. Moreover, petitioner Comcast and the prior petitioner Dish have no significant relationship to each other. They are unrelated competitor companies sued separately for alleged patent infringement based on their respective products/services. Further, counsel can (and does) represent that Comcast and Dish have not cooperated in any way in preparing their petitions. Thus, these parties have no relationship in their requested IPRs.

In these (and other) respects, the facts align with *Google LLC v. Uniloc 2017 LLC*, No. IPR2020-00396, 2020 WL 4463086, *4 (PTAB Aug, 3, 2020; Paper 11) (petitioners "have no relationship and offer competing products"; no cooperation in preparing the petitions). "[T]here is not a significant relationship between Petitioner and [Dish], and accordingly, the first *General Plastic* factor does not weigh in favor of denying institution." *Id.*, *5.

Valve Corp. v. Elec. Scripting Prods., Inc., No. IPR2019-00062, Paper 11 at 9–10 (PTAB April 2, 2019) (precedential) is clearly distinguishable. There, the Board discretionarily denied a second petition filed by another petitioner largely because of the significant relationship found to exist between the petitioners (HTC and Valve). The petitioners were co-defendants accused of infringing the same

patent based on “HTC’s ... devices that incorporate technology licensed from Valve.” *Id.*

b. Factor Two (knowledge of prior art asserted in second petition at the time first position was filed)

That Comcast knew of the references it relies on here, at the time Dish filed its petition, at most “weighs slightly in favor of denying institution.” This is even further reduced by the short time (less than a month) between the filing of the two petitions. *Google*, 2020 WL 4463086 at *6.

c. Factor Three (timing in relation to preliminary response and institution decision in first IPR) favors institution

As in *Google*, there can be “no dispute that the Petition was filed before the preliminary response was filed or the institution decision was issued” in the earlier proceeding. *Id.*

d. Factor Four (elapsed time between when the petitioner learned of the prior art asserted in the second petition and the time of its filing) does not favor denial of institution

Upon Entropic filing suit, Comcast undertook to diligently investigate the allegations, including the invalidity of the patents asserted. Patent invalidity searches and studies were undertaken, with the references relied upon herein ultimately being identified as material prior art.

Petitioner submits that the time taken to investigate invalidity, identify IPR challenge grounds and prepare the instant petition for filing was reasonable under

the circumstances, including the large number of patents asserted against Petitioner by Entropic (twelve). The situation here is a direct result of Patent Owner's litigation activity. *Cf., id.* at *7.

e. Factor Five (explanation of the time elapsed between the filing of the multiple petitions directed to the same claims of the same patent) favors institution

Dish's earlier petition challenges only claims 1 and 3 of the '518 patent. On the other hand, the instant petition challenges all 4 claims. Further, the time elapsed between the two petition filings (less than a month) is minimal. *Cf., Google*, 2020 WL 4463086 at *6 (a "nearly three month lapse in time" is not unreasonable).

f. Factor Six (Board's finite resources) and Seven (statutory time frame for Board to issue a final determination) do not favor denial of institution

As in *Google*, the filing of two petitions by different petitioners here is the direct result of Patent Owner's litigation activity. The Board should be "mindful of potential prejudice to a second or subsequent petitioner if institution of review based on the second petition is denied and the proceeding involving the first petitioner is terminated." *Id.* at *7. The potential prejudice to Comcast is even greater here, where Dish's petition challenges only claims 1 and 3, while the instant petition challenges all claims 1-4.

Further, the grounds asserted in the respective petitions are distinct, and merit the Board's separate reviews. Each relies on different references.

Still further, the minimal amount of elapsed time between the two petition filings lends itself to the efficient conduct of proceedings on both, *e.g.*, potentially consolidation and concurrent issuance of final written decisions within the statutory time frame.

C. § 325(d) Discretion Does Not Apply

Considering the two-part framework discussed in *Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GMBH*, No. IPR2019-01469, Paper 6 at 8-9 (PTAB Feb. 13, 2020), the Board should not exercise its §325(d) discretion to deny institution. The grounds raised by this Petition do not present the same or substantially the same art or arguments as raised during prosecution. None of the references relied upon herein were considered during prosecution. No substantive office action was issued during prosecution. *See* Section III.B. The Examiner mentioned the Bingham article in the Notice of Allowance but did not apply this reference. Regardless, Afshary, Mirfakhraei, and Welles relied on herein differ substantially and materially from the Bingham article and were not before the Examiner.

Claim 1 was allowed after limitation [1D] – relating to transmitting and analyzing probe messages to determine channel characteristics and bit loading from the determined channel characteristics – was added to the claim. Claim 4 already recited limitations similar to limitation [1D] (*see* limitations [4C]-4[D]) but in means

plus function form. *See* Ex. 1004, 75-86, 82. The Examiner erred in allowing these claims at least because the Examiner was not made aware of Mirfakhraei, which teaches precisely this, as well as other claimed features (*see, e.g.,* § IV.B, *supra* and §§ VI.A.1.e, VI.A.4.d-e, *infra*).

D. Level of Ordinary Skill

In relation to the '518 patent, a person of ordinary skill in the art (“POSITA”) would have had a bachelor’s degree in electrical engineering, computer engineering, or a similar discipline, and three to four years of experience working in signal processing and/or communication systems/networks. Additional education may substitute for experience, and significant work experience may substitute for formal education. Ex. 1002, ¶¶ 103-105. As set forth in his attached declaration, James G. Bertonis at least meets the level of skill of a POSITA. Ex. 1002, ¶¶ 1-28.

E. Claim Construction

The below three claim terms presumptively invoke pre-AIA §112 ¶ 6 through use of the words “means for,” and constructions are provided below in the event these are determined to be subject to §112 ¶ 6.⁴ All other claim terms herein should

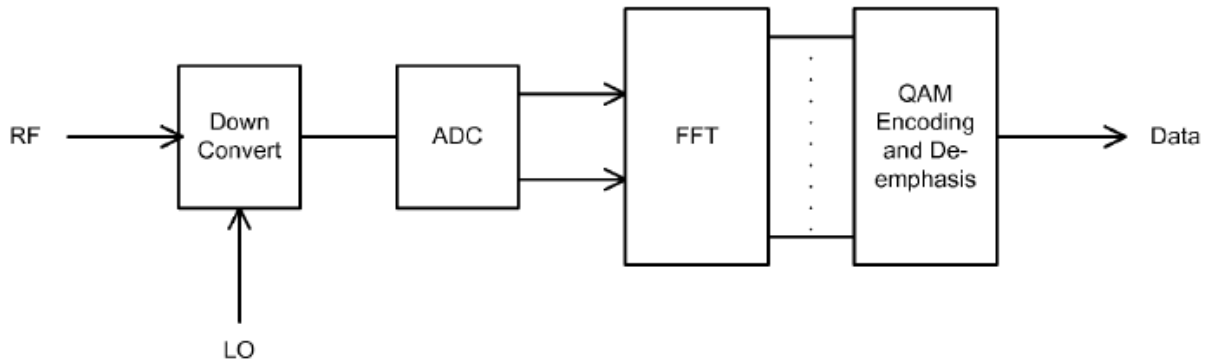
⁴ No admission is made with respect to the sufficiency of the disclosures of corresponding structure/algorithm for satisfying 35 U.S.C. § 112, ¶ 2, or for compliance with 35 U.S.C. § 101.

be given their ordinary and customary meaning to a POSITA, consistent with the specification and prosecution history, as they would be given in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b). While Petitioners propose the below constructions, the challenged claims are invalid under any reasonable construction of all claim terms. Ex. 1002, ¶¶ 105-107.

1. “means for determining signal activity”

The claimed function for this term is “determining signal activity,” which does not require further construction for purposes of this IPR. Ex. 1001, claim 2; Ex. 1002, ¶¶ 108-109. The ’518 patent describes at least four different approaches for determining signal activity. Ex. 1001, 11:7-43; Ex. 1002, ¶ 109. One approach is to perform an Fast Fourier Transform (FFT) on data samples from an A/D converter using the same receiver signal path that is used for data communication. Ex. 1001, 11:7-23; Ex. 1002, ¶ 109.

The ’518 patent describes Figure 6 (below) as a receiver signal path used for data communication. Ex. 1001, 8:51-9:27; Ex. 1002, ¶ 109. As shown, the receiver signal path performs an FFT on data samples from an ADC. *Id.*; Ex. 1002, ¶ 109.



Ex. 1001, Fig. 6

Accordingly, one corresponding structure for “determining signal activity” is a receiver that performs an FFT on data samples from an A/D converter. Ex. 1002, ¶ 109.

Another approach is to measure received signal power with an envelope detector. Ex. 1001, 11:23-29; Ex. 1002, ¶ 110. Accordingly, another corresponding structure for “determining signal activity” is an envelope detector. Ex. 1002, ¶ 110.

2. “means for producing and transmitting a probe message”

The claimed function for this term is “producing and transmitting a probe message,” which does not require further construction for purposes of this IPR. Ex. 1001, claim 4; Ex. 1002, ¶¶ 111-112. A probe message is a signal “known by the receiving device” that is used “to estimate the channel characteristics” such as SNR. Ex. 1001, 9:36-39; *see also id.*, 4:48-62, 7:22-42, 8:9-35, 9:40-10:20; Ex. 1002, ¶¶ 111-112. The ’518 patent describes the structures that generate and transmit these signals as follows:

The signal processing and computations performed on signal samples needed for modulating, demodulating, channel estimation, and other operations can be performed by dedicated hardware resources or by a programmed signal processor. A typical system will utilize both hardware and software techniques to perform the needed signal processing. Signal processing circuitry can be integrated into a single system on a chip (SOC), partitioned into several chips, or programmed into a field programmable gate array (FPGA).

Ex. 1001, 10:29-38; Ex. 1002, ¶¶ 111-112.

Accordingly, one corresponding structure for “producing and transmitting a probe message” is a processor. Ex. 1002, ¶¶ 111-112. To the extent the identified structure of a processor requires an algorithm for performing the recited function, the algorithm is: (a) generating a signal known to a receiving device; and (b) transmitting the known signal. Ex. 1001, Abstract, 4:48-62, 9:35-10:38, Fig. 7; Ex. 1002, ¶¶ 111-112.

3. “means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data”

As discussed above, the '518 patent describes transmitting probe messages to estimate SNR. Ex. 1001, 7:22-42, 8:9-35, 9:34-10:20; Ex. 1002, ¶¶ 113-114. The '518 patent further describes determining a bit loading profile for transmitting data by calculating the SNR for each subchannel based on a received probe message. Ex. 1001, 8:9-26, 9:17-18, 9:34-10:20, 10:61-11:6, Fig. 10; Ex. 1002, ¶¶ 113-114. The

'518 patent admits that “[d]etermination of . . . [an] SNR profile from a known signal is well known in the art.” Ex. 1001, 10:12-14. The claimed function for this term is “receiving and analyzing a probe message to determine a bit loading profile used to transmit data,” which requires no further construction for purposes of this IPR. Ex. 1001, claim 4; Ex. 1002, ¶¶ 113-114. Based on the specification of the '518 patent, as described above, one corresponding structure for this function is a processor. Ex. 1001, 10:29-38; Ex. 1002, ¶¶ 113-114. To the extent the identified structure of a processor requires an algorithm for performing the recited function, the algorithm is: (a) receiving a known signal; (b) determining a SNR for each subchannel based on the received known signal; and (c) determining a bit loading for each subchannel based on the determined SNR for the subchannel. Ex. 1001, Abstract, 4:48-62, 8:9-26, 9:17-19, 9:35-10:38, 10:61-11:6, Fig. 7; Ex. 1002, ¶¶ 113-114.

VI. SPECIFIC GROUNDS FOR UNPATENTABILITY

Claims 1-4 are unpatentable under §103(a), because the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a POSITA. *See, KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Consideration of the *Graham* factors underlying the question of obviousness leads inexorably to a conclusion of obviousness for all claims. *See, Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966).

A. Ground A: Claims 1-4 are Rendered Obvious by Afshary in View of Mirfakhraei

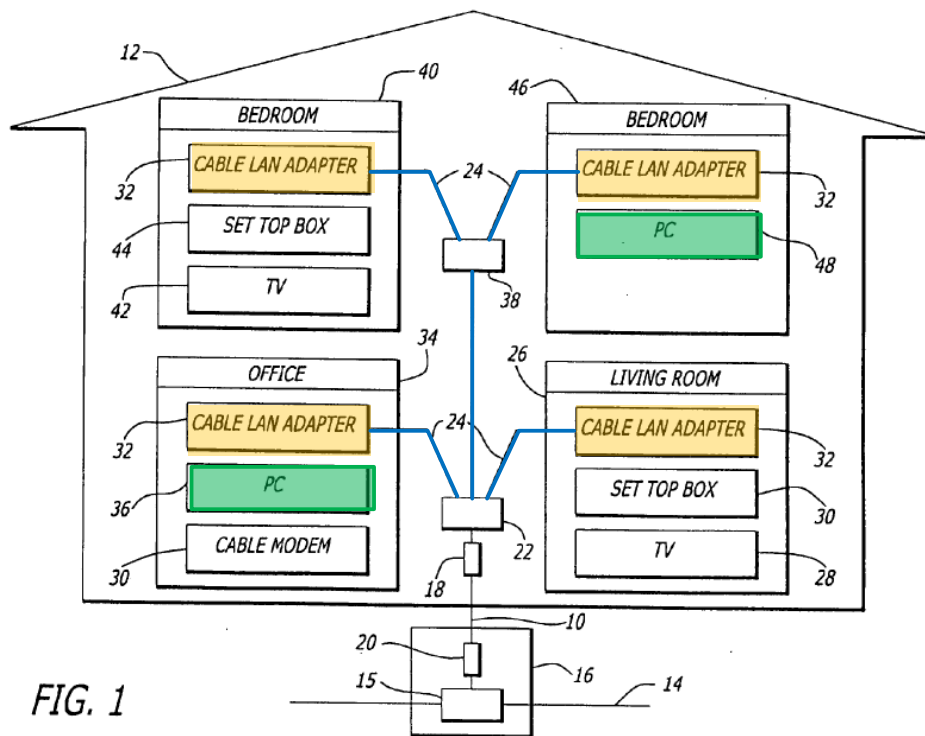
As set forth below, Afshary in view of Mirfakhraei renders obvious claims 1-4. Ex. 1002, ¶¶ 115-175.

1. Independent Claim 1

a. [1pre]: “A data communication network comprising:”

To the extent the preamble [1pre]⁵ is limiting, Afshary teaches it. Ex. 1002, ¶¶ 118-120. As discussed above in Section IV.A, Afshary discloses a coaxial cable local area network (LAN) (claimed “data communication network”) and states that “[t]he invention relates to a coaxial cable local area network (LAN) for digitally communicating client generated data between clients of the cable LAN.” Ex. 1006, ¶ 7; *see id.*, Abstract, ¶¶ 2, 12, 14, 19-23, 41, Figs. 1-2; Ex. 1002, ¶ 119. Figure 1 (below) shows the “in-home coaxial cable LAN” disclosed by Afshary. Ex. 1006, ¶ 14; Ex. 1002, ¶ 119. Afshary teaches that the cable LAN includes cable LAN adapters 32 (**orange**) that enable client devices – such as PCs 36 and 48 (**green**) – to communicate with each other via coaxial cable wire 24 (**blue**). Ex. 1006, ¶¶ 18-19, 21, 23, 41, Figs. 1-2; Ex. 1002, ¶ 119.

⁵ The claims appear and are labelled in the Claims Listing Appendix.



Ex. 1006, Fig. 1 (annotated)

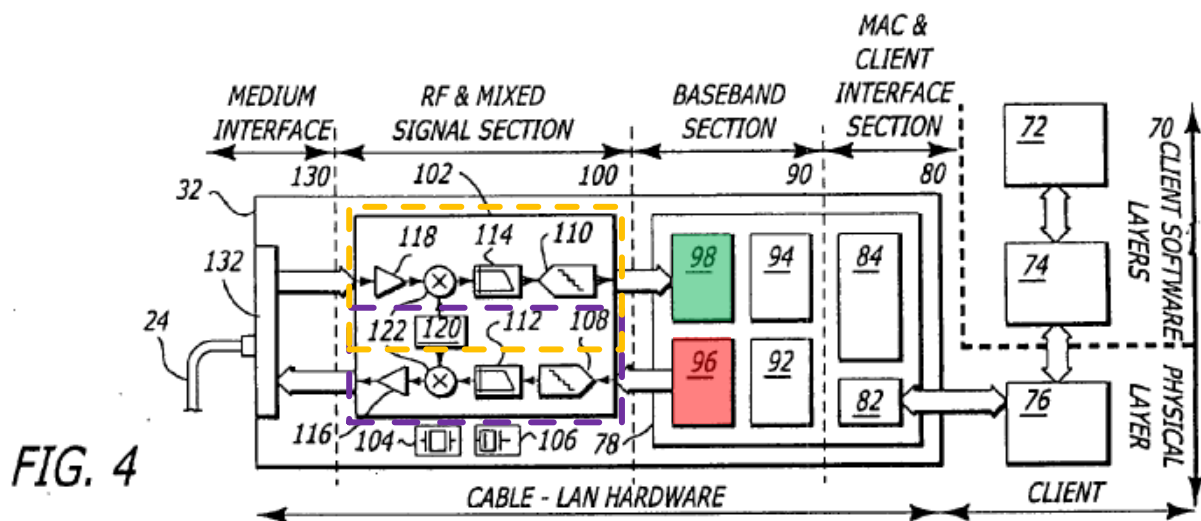
Therefore, Afshary teaches [1pre]. Ex. 1002, ¶¶ 118-120.

- b. [1A] “at least two network devices, each network device comprising a multi-carrier modulator for modulating data, an up converter for translating the modulated data to an RF carrier frequency, a down converter for translating an RF signal, and a multi-carrier demodulator for demodulating the translated RF signal to produce data; and”

Afshary discloses each feature of [1A] other than a modulator that is multi-carrier and a demodulator that is multi-carrier, which are disclosed by Mirfakhraei. As explained below, a POSITA would have found it obvious to incorporate Mirfakhraei’s multi-carrier modulation and bit-loading techniques into Afshary’s

Afshary's Modulator and Up-Converter

Figure 4 (below) of Afshary shows the architecture of a cable LAN adapter 32. Ex. 1006, ¶ 29; Ex. 1002, ¶ 122. Afshary explains that digital data originating from the Media Access Control (MAC) & Client Interface section 80 is encoded and modulated by Baseband section 90. Ex. 1006, ¶¶ 30, 35; Ex. 1002, ¶ 122. Specifically, Afshary teaches that the digital data is encoded by Forward Error Correction (FEC) encoder 92 and then modulated by modulator 96 (red) using a modulation scheme such as Quadrature Phase Shift Keying (QPSK) digital modulation. Ex. 1006, ¶¶ 26, 35-41; Ex. 1002, ¶ 122.



Ex. 1006, Fig. 4 (annotated)

The modulated data from modulator 96 is provided to the RF & Mixed Signal section 100. Ex. 1006, ¶¶ 38-39; Ex. 1002, ¶ 123. To transmit the modulated data over RF frequencies, the RF & Mixed Signal section 100 includes digital to analog

converter (DAC) 108, up converter 112, local oscillator (LO) frequency synthesizer timing circuit 120, mixer 122, and power amplifier (PA) 116 (**dashed purple**) (collectively, claimed “up converter for translating the modulated data to an RF carrier frequency”). Ex. 1006, ¶¶ 38-39; Ex. 1002, ¶¶ 123-124. Afshary teaches that these components operate to translate the modulated data from the Baseband section 90 to a 1300 MHz center frequency (**red**) (claimed “RF carrier frequency”) and that the modulated data occupies a bandwidth of 5 MHz (**dark blue**) as shown in Figure 3 (below). Ex. 1006, ¶¶ 25, 38-39; Ex. 1002, ¶¶ 123-124. The up-converted modulated data is transmitted as an RF signal to another cable LAN adapter 32 to facilitate communication between client devices. Ex. 1006, ¶¶ 23, 26, 39, 41; Ex. 1002, ¶¶ 123-124.

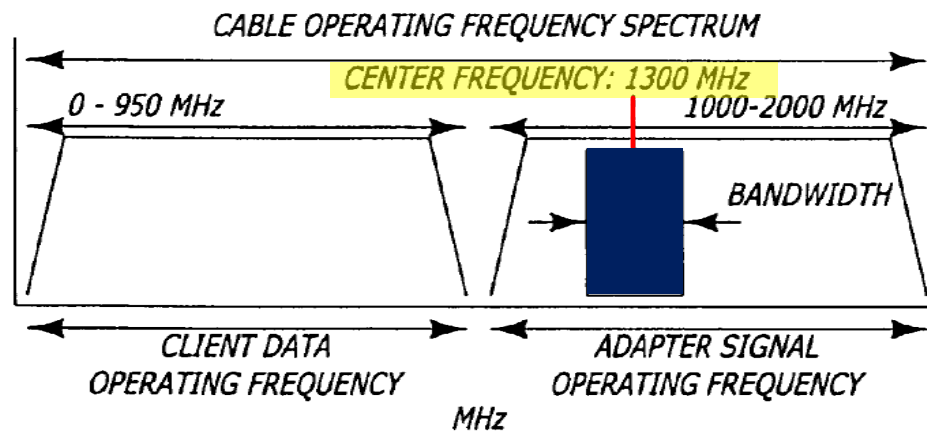


FIG. 3

Ex. 1006, Fig. 3 (annotated)

Afshary's Demodulator and Down-Converter

Referring back to Figure 4, for receiving RF modulated data, the RF & Mixed Signal section 100 includes low noise amplifier (LNA) 118, LO 120, mixer 122, down converter 114, and analog to digital converter (ADC) 110 (**dashed orange**) (collectively, claimed “down converter for translating an RF signal”). Ex. 1006, ¶¶ 38-39, 41; Ex. 1002, ¶¶ 125-126. Afshary teaches that these components operate to translate a received RF signal to a lower frequency signal. Ex. 1006, ¶¶ 38-39, 41; Ex. 1002, ¶¶ 125-126. Afshary teaches that the down-converted signal from the RF & Mixed Signal section 100 is demodulated by demodulator 98 (**green**). Ex. 1006, ¶¶ 41-42; Ex. 1002, ¶¶ 125-126. The demodulated data from demodulator 98 is decoded and corrected by FEC decoder 94 to recover digital data that is provided to MAC & Client Interface section 80. Ex. 1006, ¶¶ 41-42; Ex. 1002, ¶¶ 125-126.

Mirfakhraei’s Multi-Carrier Modulation and Bit-Loading Techniques

While Afshary describes the cable LAN adapter 32 as using a single carrier modulation technique (*e.g.*, modulating data using QPSK and then up-converting the modulated data to a single RF carrier frequency), multiple carrier modulation techniques and their benefits were well known, as evident from Mirfakhraei. Ex. 1006, ¶¶ 26, 35-41; Ex. 1007, Abstract ¶¶ 1-3, 5; Ex. 1008, ¶ 5; Ex. 1009, p. 5; Ex. 1010, pp. 374-376; Ex. 1011, pp. 392-395; Ex. 1018, pp. 305-307, 312; Ex. 1002, ¶ 127.

Mirfakhraei describes modem transceivers that communicate using a Discrete Multi-Tone (DMT) protocol that provides increased data rates over single carrier communication protocols. Ex. 1007, Abstract, ¶¶ 1-3, 5-8, 14-25, Figs. 1-2; Ex. 1002, ¶ 128. Mirfakhraei explains that DMT, like OFDM, is a multi-carrier communication protocol that uses multiple carriers to transmit and receive modulated data. Ex. 1007, Abstract, ¶¶ 2-5; Ex. 1008, ¶ 5; Ex. 1009, p. 5; Ex. 1010, pp. 374-376; Ex. 1011, pp. 392-294; Ex. 1012, Abstract, 1:10-59, Figs. 1-2; Ex. 1013, Abstract, 2:30-5:39, Figs. 1-2; Ex. 1014, p. 142; Ex. 1015, pp. 5-8, Figs. 4, 9; Ex. 1002, ¶ 128. Mirfakhraei provides an overview of DMT and explains the relationship between multiple carriers and subchannels as follows:

A DMT protocol simultaneously uses multiple carrier frequencies where each carrier frequency corresponds to a subchannel. Each signal for a sub-channel has relatively narrow bandwidths (e.g., 4 kHz) to reduce distortion within the sub-channel signal. For data transmission, a sending modem breaks transmitted data into packets for simultaneous transmission on separate sub-channels and independently modulates communication signals for the sub-channels according to the data carried on each sub-channel. The receiving modem separates sub-channel signals according to carrier frequency, demodulates the separate sub-channel signals, and reassembles the data.

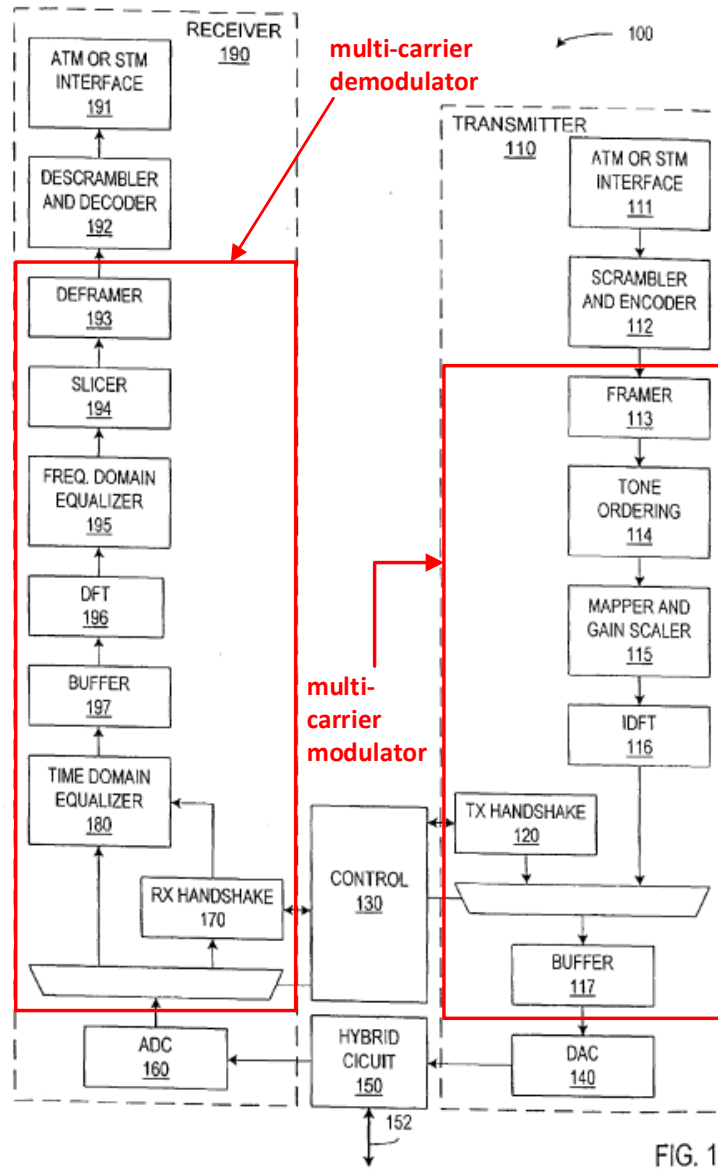
Ex. 1007, ¶ 3; Ex. 1002, ¶ 128.

Mirfakhraei further explains that its modem transceivers employ “a ‘bit-loading’ process that characterizes the capabilities of sub-channels and determines the number of bits-per-symbol transmitted over the channel.” Ex. 1007, ¶ 14; Ex. 1002, ¶ 129. In contrast to having each subcarrier transmit QAM symbols representing the same number of bits, Mirfakhraei’s bit-loading process enables each subcarrier to transmit QAM symbols that represent different numbers of bits based on the signal to noise ratio (SNR) determined for each subcarrier, thereby increasing data transmission rate. Ex. 1007, ¶¶ 4, 6, 14, 17-19, 22-25; Ex. 1002, ¶ 54-55, 129. A subcarrier with a higher SNR is assigned a larger symbol set (or constellation map, e.g., based on 256-QAM), while a subcarrier with a lower SNR is assigned a smaller symbol set (e.g., based on 16-QAM). Ex. 1007, ¶¶ 4, 6, 17-19; Ex. 1002, ¶¶ 29-55, 129; Ex. 1024, pp. 175-182. Each symbol in a larger symbol set that is transmitted by a carrier represents more bits compared to each symbol in a smaller symbol set. *Id.*

Mirfakhraei’s Multi-Carrier Modulator

Figure 1 of Mirfakhraei (below) shows a transmitter 110 and a receiver 190 of a transceiver 100 that communicates using Mirfakhraei’s DMT and a bit-loading scheme. Ex. 1007, ¶¶ 5-8, 14-15; Ex. 1002, ¶ 130. Mirfakhraei teaches that the transmitter 110 includes framer 113, tone ordering block 114, constellation mapper 115, Inverse Discrete Fourier Transform (IDFT) block 116, buffer 117, and TX

handshake block 120 (collectively, claimed “multi-carrier modulator for modulating data”). Ex. 1007, ¶¶ 15-19; Ex. 1002, ¶ 130.



Ex. 1007, Fig. 1 (annotated)

Mirfakhraei explains that after an initial encoding of data by encoder 112, “framer 113 breaks the encoded data stream from encoder 112 into bit sets” and that “[e]ach bit set is assigned to a sub-channel for transmission and corresponds to a

symbol to be transmitted on the assigned sub-channel.” Ex. 1007, ¶ 17; Ex. 1002, ¶ 131. The number of bits in each bit set is dictated by the bit loading determined for a corresponding sub-channel. Ex. 1007, ¶ 17; Ex. 1002, ¶ 131. Tone ordering block 114 then “orders the bit sets by sub-channel for a constellation mapper 115.” Ex. 1007, ¶ 17; Ex. 1002, ¶ 131.

Next, “[f]or each bit set, constellation mapper 115 determines a QAM symbol associated with the bit set for the quadrature amplitude modulation (QAM) of the assigned sub-channel.” Ex. 1007, ¶ 18; Ex. 1002, ¶ 132. The set of possible QAM symbols that can be transmitted on a particular sub-channel is determined by the bit-loading determined for the sub-channel. Ex. 1007, ¶ 17; Ex. 1002, ¶ 132. A sub-channel with a higher SNR uses a larger QAM constellation that allows more bits per QAM symbol to be transmitted by a corresponding sub-carrier (higher bit-loading), while a sub-channel with a lower SNR uses a smaller QAM constellation that is limited to transmitting fewer bits per QAM symbol on a corresponding sub-carrier (lower bit-loading). Ex. 1007, ¶¶ 4, 17-18, 23-24; Ex. 1002, ¶¶ 29-55, 132. For example, a sub-channel with a higher SNR may modulate data using a larger QAM constellation such as 256-QAM, which enables each transmitted QAM symbol to represent 8 bits. Ex. 1007, ¶¶ 4, 17-18, 23-24; Ex. 1002, ¶¶ 29-55, 132. A sub-channel with a lower SNR, on the other hand, may modulate data using a

smaller QAM constellation such as 16-QAM, which enables each transmitted QAM symbol to represent 4 bits. Ex. 1007, ¶¶ 4, 17-18, 23-24; Ex. 1002, ¶¶ 29-55, 132.

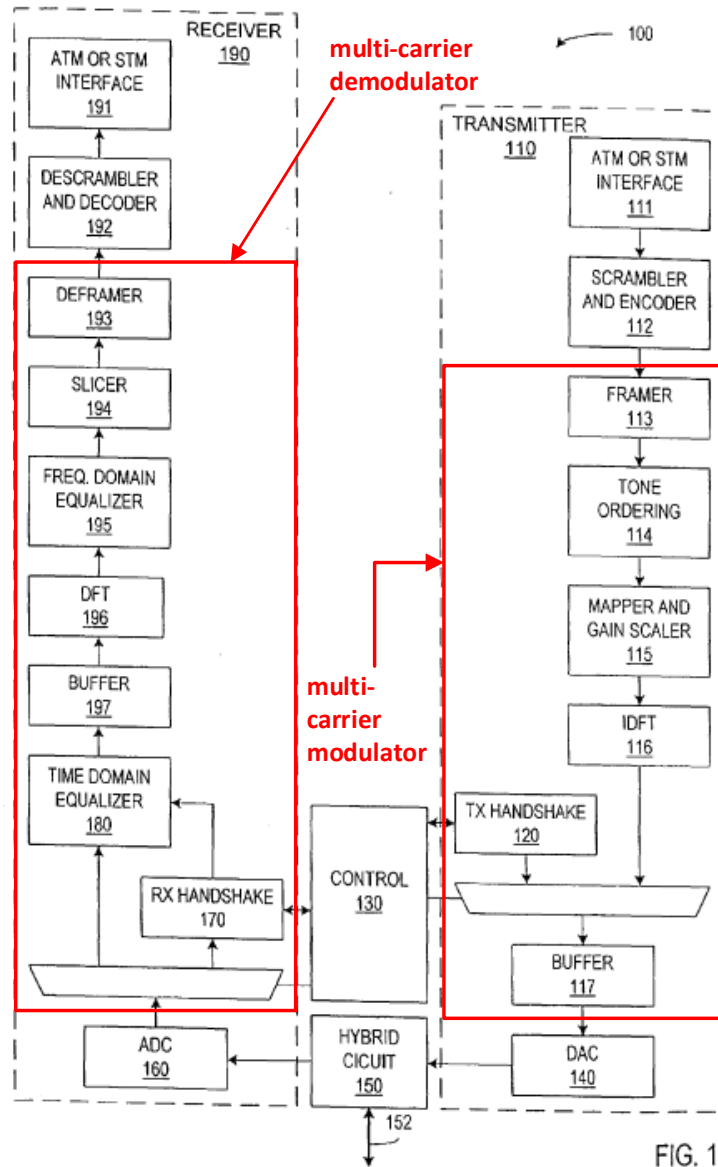
Mirfakhraei explains that a “DMT symbol includes one QAM symbol per sub-channel” and teaches that each DMT symbol is converted by IDFT block 116 to a sequence of time-domain samples that define the transmitted signal for a symbol period. Ex. 1007, ¶¶ 18-19; Ex. 1002, ¶ 133. The buffer 117 receives the time-domain samples and provides them to DAC 140 which converts the samples to an analog signal for transmission. Ex. 1007, ¶ 19; Ex. 1002, ¶ 133.

TX handshake block 120 transmits a handshake signal used to calculate the SNR for each subchannel which is then used to determine the bit-loading for each subchannel. Ex. 1007, ¶¶ 14, 18, 20; Ex. 1002, ¶ 134. Accordingly, Mirfakhraei teaches that these components of the transmitter 110 operate to implement its DMT bit-loading protocol by generating different QAM symbols representing different numbers of bits for each subcarrier based on the SNR determined for each subcarrier. Ex. 1007, ¶¶ 3, 5-8, 17-26; Ex. 1002, ¶ 134.

Mirfakhraei’s Multi-Carrier Demodulator

Mirfakhraei teaches that the receiver 190 includes time domain equalizer (TEQ) 180, buffer 197, Discrete Fourier Transform (DFT) block 196, frequency domain equalizer 195, slicer 194, deframer 193, and RX handshake block 170

(collectively, claimed “multi-carrier demodulator for demodulating the translated RF signal to produce data”). Ex. 1007, ¶¶ 21-24; Ex. 1002, ¶ 135.



Ex. 1007, Fig. 1 (annotated)

TEQ 180 filters samples of a received signal from ADC 160 and stores the filtered samples in buffer 197. Ex. 1007, ¶¶ 21-24; Ex. 1002, ¶¶ 136-137. The DFT block 196 performs a discrete Fourier transform on the filtered time-domain samples

stored in buffer 197 that correspond to a received DMT symbol. Ex. 1007, ¶¶ 21-24; Ex. 1002, ¶ 137. Mirfakhraei explains that performing the discrete Fourier transform on the filtered time-domain samples enables the receiver 190 to “determine frequency components associated with the sub-channels.” Ex. 1007, ¶ 24; Ex. 1002, ¶ 137. Mirfakhraei teaches that the slicer 194 determines the QAM symbols for each sub-channel based on the filtered frequency components of each sub-channel provided by the frequency domain equalizer 195. Ex. 1007, ¶ 24; Ex. 1002, ¶ 137. The deframer 193 then “converts the QAM symbols into a bit stream” which is then decoded to provide the final recovered data. Ex. 1007, ¶ 24; Ex. 1002, ¶ 137.

The RX handshake block 170 calculates the SNR for all subchannels, based on a received handshake signal, which are then used to determine the bit-loadings for each subchannel. Ex. 1007, ¶¶ 14, 18, 20-23; Ex. 1002, ¶ 138. Accordingly, Mirfakhraei teaches that these components of the receiver 190 operate to implement its DMT bit-loading protocol by recovering an original bit stream from the different QAM symbols representing different numbers of bits transmitted on each subcarrier. Ex. 1007, ¶¶ 3, 5-8, 17-26; Ex. 1002, ¶ 138.

Combining Afshary and Mirfakhraei

Afshary’s network operates over a coaxial cable which a POSITA would understand is a harsh medium for communication. Ex. 1006, Abstract, ¶¶ 7, 12-20,

Fig. 1; Ex. 1002, ¶¶ 49-55. A POSITA would understand that Mirfakhraei's DMT bit loading scheme is well suited to address typical impairments of coaxial cables, notably the variable frequency response of the cable medium. Ex. 1002, ¶¶ 49-55, 128-138; Ex. 1018, pages 305-307. By using multiple narrowband subcarriers, as opposed to a single wideband carrier used by Afshary, a POSITA would understand that Mirfakhraei's DMT bit loading scheme is less susceptible to the variable frequency response of the cable medium, including the variable frequency response caused by interference and signal reflections. Ex. 1007, ¶ 3; Ex. 1002, ¶¶ 49-55, 128-138. Further, by separately modulating the narrowband subcarriers, such that subcarriers with higher SNRs use higher order signal constellations (*e.g.*, 256-QAM) and subcarriers with lower SNRs use lower order signal constellations (*e.g.*, 16-QAM), a POSITA would understand that the collective data rate across all subcarriers would be increased, as opposed to requiring each subcarrier to use the same signal constellation. Ex. 1007, Abstract, ¶¶ 2-5, 14; Ex. 1002, ¶¶ 29-55, 128-138.

Accordingly, a POSITA would have been motivated to modify Afshary's cable LAN adapter, which operates over a harsh coaxial cable medium, to implement the DMT bit-loading protocol of Mirfakhraei, which is well-suited to mitigate the impairments of a coaxial cable medium, because the result would be a coaxial cable network that is less susceptible the variable frequency response of the coaxial cable

environment, thereby enabling the data transmission rate of Afshary's coaxial cable network to be increased, as taught by Mirfakhraei. Ex. 1007, ¶ 3; Ex. 1002, ¶¶ 29-55, 139. Further, implementing Mirfakhraei's DMT bit-loading protocol would improve the reliability and robustness of the communications within Afshary's coaxial cable network. Ex. 1002, ¶ 139. While Mirfakhraei describes its DMT bit-loading scheme in relation to communication over a conventional telephone line, a POSITA would have understood that Mirfakhraei's DMT bit-loading scheme could be implemented over a variety of mediums, including coaxial cable. Ex. 1010, p. 374; Ex. 1013, Abstract, 2:30-5:39, Figs. 1-2; Ex. 1016, Abstract, 1:9-16, 3:34-59, 6:66-7:46, Fig. 1; Ex. 1017, pp. 74; Ex. 1018, pp. 305-307, 312; Ex. 1002, ¶ 140.

A POSITA would have understood that modifying Afshary's cable LAN adapter 32 to implement the DMT bit-loading protocol of Mirfakhraei would entail incorporating the functionality of the above-identified components of Mirfakhraei's transmitter 110 and receiver 190. Ex. 1002, ¶¶ 141-144. As an example, Afshary describes the Baseband section 90 of its cable LAN adapter 32 as being implemented on an application specific integrated circuit (ASIC) 78. Ex. 1006, ¶¶ 30, 32, 35, Fig. 4; Ex. 1002, ¶¶ 141-144. Mirfakhraei describes the components of its transmitter 110 and receiver 190 as being implemented in hardware, software, or a combination of hardware and software. Ex. 1007, ¶ 15, Fig. 1; Ex. 1002, ¶¶ 141-144. Accordingly, a POSITA would have understood that modifying Afshary's cable

LAN adapter 32 to implement the DMT bit-loading protocol of Mirfakhraei, for example, would entail incorporating the functionality of Mirfakhraei's multi-carrier modulator and multi-carrier demodulator into an ASIC (*e.g.*, ASIC 78). As a result, Afshary's cable LAN adapter would be able to transmit data at higher data rates. Ex. 1002, ¶¶ 141-144. Additionally, data transmissions between the cable LAN adapters would be more robust and reliable because they would be less affected by the harsh environment of a coaxial cable infrastructure, including outside interference and signal reflections. Ex. 1007, ¶ 2; Ex. 1018, pp. 305-307, 312; Ex. 1002, ¶¶ 141-144. Further, the power efficiency of the resulting Afshary-Mirfakhraei system would also be improved by using more available bandwidth for communicating, and using higher order modulation schemes to transmit more bits onto frequency channels that experience less noise and/or interference. Ex. 1002, ¶¶ 141-144.

A POSITA would have understood that combining the teachings of Afshary and Mirfakhraei is nothing more than an obvious combination of known elements (Afshary's cable LAN adapter and Mirfakhraei's multi-carrier DMT modulator and multi-carrier DMT demodulator) according to known methods (incorporating the functionality of Mirfakhraei's multi-carrier DMT modulator and multi-carrier DMT demodulator into Afshary's cable LAN adapter – for example, by incorporating this functionality into an ASIC such as Afshary's ASIC 78) to yield predictable results (Afshary's cable LAN adapter transmits and receives data using Mirfakhraei's DMT

protocol and bit loading to provide increased data rates and robust communications within Afshary's coaxial cable LAN). Ex. 1002, ¶ 145. Moreover, in doing so, a POSITA would have had a reasonable expectation of success because the proposed implementation of Afshary and Mirfakhraei would be well within the standard skill set of a POSITA and the resulting benefits of communicating over coaxial cable wiring using bit-loading and multi-carrier modulation were well known. Ex. 1002, ¶ 145.

A POSITA would have also understood that combining the teachings of Afshary and Mirfakhraei is nothing more than applying a known technique (the DMT bit-loading protocol of Mirfakhraei) to a known device (Afshary's cable LAN adapter) ready for improvement to yield a predictable result (Afshary's cable LAN adapter enables communication over a coaxial cable LAN using the DMT bit-loading protocol of Mirfakhraei, thereby improving data rates and susceptibility to coaxial cable channel impairments). Ex. 1002, ¶ 146. Afshary's cable LAN adapter enables communication between devices over a coaxial cable LAN but does not include a multi-carrier modulator or multi-carrier demodulator. Ex. 1002, ¶ 146. Mirfakhraei discloses a multi-carrier communication protocol that uses bit-loading to improve data throughput and communication robustness. Ex. 1002, ¶ 146. A POSITA would have recognized that modifying Afshary's cable LAN adapter 32 (e.g., the ASIC 78 providing baseband single-carrier modulation and demodulation)

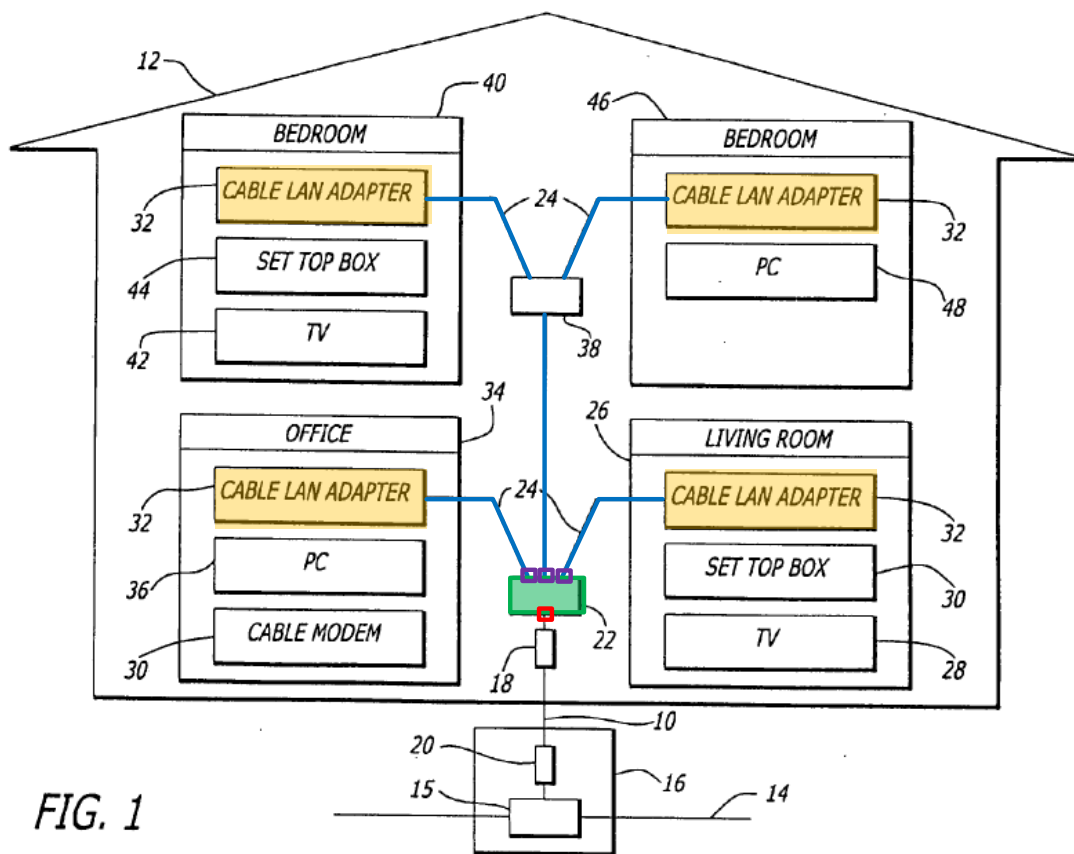
to incorporate the functionality of Mirfakhraei's multi-carrier modulator and multi-carrier demodulator that implement Mirfakhraei's DMT bit-loading protocol (*e.g.*, by incorporating the DMT bit-loading protocol of Mirfakhraei's transceiver into the ASIC 78) would provide the predictable result of Afshary's cable LAN adapter communicating using multi-carrier DMT modulation with bit-loading as taught by Mirfakhraei. Ex. 1002, ¶ 146. Further, a POSITA would have recognized that modifying Afshary's cable LAN adapter in this manner would have resulted in increased data throughput and more reliable communications within the harsh coaxial cable environment. Ex. 1002, ¶ 146.

Therefore, Afshary in view of Mirfakhraei teaches [1A]. Ex. 1002, ¶¶ 121-147.

- c. **[1B]: “cable wiring comprising a splitter with a common port and a plurality of tap ports, and a plurality of segments of coaxial cable connecting between the splitter tap ports and the network devices;”**

As discussed for [1A] (Section VI.A.1.b), Figure 1 (below) of Afshary shows cable LAN adapters 32 (**orange**) within the coaxial cable LAN. Ex. 1006, ¶¶ 18-19, 21-23, Figs. 1-2; Ex. 1002, ¶¶ 148-149. Afshary explains that drop cable 10 is provided to splitter 22 within home 12. Ex. 1006, ¶¶ 16, 18-19; Ex. 1002, ¶¶ 148-149. Afshary teaches that “drop cable 10 is split by splitter 22 into different cable wires 24, [with] each cable wire 24 being routed to different rooms in home 12.”

Ex. 1006, ¶ 18; Ex. 1002, ¶¶ 148-149. As shown in Figure 1, the splitter 22 (**green**) (claimed “splitter”) includes an input port (**red**) (claimed “common port”) and multiple output ports (**purple**) (claimed “plurality of tap ports”). Ex. 1006, ¶¶ 16, 18-19; Ex. 1001, 1:53-57, Fig. 1; Ex. 1002, ¶¶ 148-149. From the output ports, multiple cable wires 24 (**blue**) (claimed “cable wiring” and claimed “plurality of segments of coaxial cable connecting between the splitter tap ports and the network devices”) are connected to the cable LAN adapters 32 (*e.g.*, the cable LAN adapter 32 within office 34 and the cable LAN adapter 32 within living room 26). Ex. 1006, ¶¶ 16, 18-19; Ex. 1001, 1:53-57, Fig. 1; Ex. 1002, ¶¶ 148-149.



Ex. 1006, Fig. 1 (annotated)

Therefore, Afshary in view of Mirfakhraei teaches [1B]. Ex. 1002, ¶¶ 148-150.

- d. [1C]: “whereby network devices communicate with each other through the cable wiring using multi-carrier signaling;”

As discussed for [1pre]-[1B] (Sections VI.A.1.a-c), Afshary teaches that cable LAN adapters 32 (claimed “network devices”) communicate with each other via cable wire 24 (claimed “cable wiring”). Ex. 1006, ¶¶ 16, 18-19, 21-23, Figs. 1-2; Ex. 1002, ¶ 151. Further, as explained for [1A], the cable LAN adapters 32 in the

Afshary-Mirfakhraei system communicate with each other using the DMT bit-loading protocol taught by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-15, Fig. 1; Ex. 1002, ¶ 151. As noted for [1A], Mirfakhraei explains that DMT is a multi-carrier communication technique (claimed “communicat[ing] ... using multi-carrier signaling”). Ex. 1007, Abstract, ¶¶ 2-3, 5-6, Fig. 1; Ex. 1002, ¶ 151.

Therefore, Afshary in view of Mirfakhraei teaches [1C]. Ex. 1002, ¶¶ 151-152.

- e. **[1D]: “wherein network devices transmit probe messages through the cable wiring and analyze received probe message signals to determine channel characteristics and bit loading is selected based on the determined channel characteristics.”**

As discussed for [1A] (Section VI.A.1.b), the Afshary-Mirfakhraei system implements the DMT bit loading scheme taught by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 153. To facilitate the DMT bit loading scheme, the cable LAN adapters (claimed “network devices”) of the Afshary-Mirfakhraei system include the TX handshake block 120 (**green**) and the RX handshake block 170 (**blue**) to implement the “‘bit-loading’ process that characterizes the capabilities of sub-channels and determines the number of bits-per-symbol transmitted over the channel” as taught by Mirfakhraei. Ex. 1007, ¶ 14, *see also id.*, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 153.

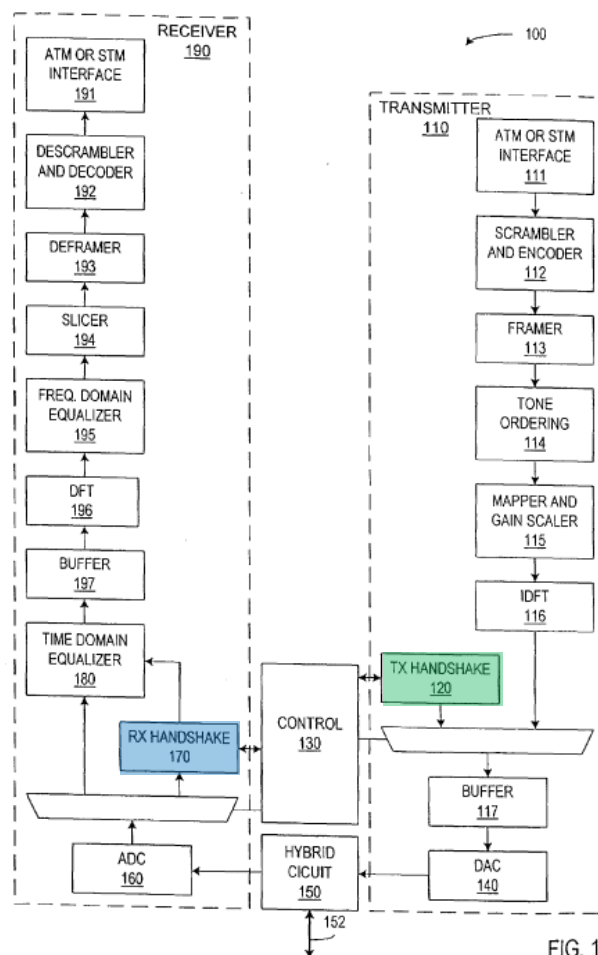


FIG. 1

Ex. 1007, Fig. 1 (annotated)

Mirfakhraei's Handshake Signals

The '518 patent describes a probe message as a known signal transmitted from a first device to a second device that is used to estimate SNRs for different frequency channels. Ex. 1001, 9:35-10:37. Mirfakhraei describes and uses its handshake signals in the exact same manner. Ex. 1007, ¶¶ 20-23; Ex. 1002, ¶ 154. As explained by Mirfakhraei, the TX handshake block 120 of a first transceiver generates and transmits handshake signals to a second transceiver (claimed “transmit probe

messages through the cable wiring”), with each handshake signal comprising a known signal (*e.g.*, a known signal pattern or a known pseudo-random signal). Ex. 1007, ¶ 20, *see also* ¶ 22; Ex. 1002, ¶ 154. Mirfakhraei further teaches that RX handshake block 170 of the second transceiver estimates the SNR (claimed “channel characteristics”) for each sub-channel based on received handshake signals (claimed “analyze received probe message signals”). Ex. 1007, ¶¶ 21-23; Ex. 1002, ¶ 154.

Mirfakhraei’s Bit-Loading

The ’518 patent describes bit-loading as selecting a modulation order or constellation size for a subchannel (or subcarrier) based on the SNR for the subchannel. Ex. 1001, 4:37-62, 8:9-39, 9:17-19, 9:35-10:20, 10:61-11:6, Fig. 10; Ex. 1002, ¶ 155. Mirfakhraei teaches the same—in particular, that the size of a constellation map for a subchannel, and hence the number of bits represented by each transmitted signal, is based on the SNR of the subchannel. Ex. 1007, ¶¶ 4-8, 14, 17-18, Figs. 1-2; Ex. 1002, ¶¶ 29-55, 155.

Mirfakhraei teaches that the RX handshake block 170 facilitates implementation of the bit loading process by comparing the received handshake signal to the known signal values that were transmitted. Ex. 1007, ¶¶ 5-8, 14, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶ 155. Based on the comparison, SNR values for each sub-channel are determined. Ex. 1007, ¶¶ 5-8, 14, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶ 155. The appropriate bit-loadings for each sub-channel are then

determined based on the SNR values determined for each sub-channel (claimed “bit loading is selected based on the determined channel characteristics”). Ex. 1007, ¶¶ 5-8, 14, 17, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶ 155.

Sub-channels having higher SNRs are assigned higher order modulation constellations. Ex. 1007, ¶¶ 5-8, 14, 17, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶ 155. Sub-channels having lower SNRs are assigned lower order modulation constellations. *Id.* For example, a sub-channel with a higher SNR modulates data using a larger QAM constellation such as 256-QAM, which enables each transmitted QAM symbol to represent 8 bits, while a sub-channel with a lower SNR modulates data using a smaller QAM constellation such as 16-QAM, which enables each transmitted QAM symbol to represent 4 bits. Ex. 1007, ¶¶ 4, 17-18, 23-24; Ex. 1002, ¶¶ 29-55, 155. The RX handshake block 170 of the second transceiver sends the determined bit-loadings for each sub-channel to the first transceiver, which then employs the bit-loadings in subsequent communications with the second transceiver. Ex. 1007, ¶¶ 5-8, 14, 20, 22-23, 25-32, Figs. 1-2; Ex. 1002, ¶¶ 29-55, 155.

Therefore, Afshary in view of Mirfakhraei teaches [1D], and Afshary in view of Mirfakhraei teaches claim 1. Ex. 1002, ¶¶ 153-156.

2. Dependent Claim 2

- a. **“The data communication network of claim 1 wherein a network device comprises a means for determining signal activity and selects a frequency band for operation that is not used by other services.”**

As discussed for [1A] (Section VI.A.1.b), Mirfakhraei’s receiver includes DFT block 196 (**red**) that receives data samples from ADC 160 (**green**). Ex. 1007, Abstract, ¶¶ 15, 19, 24, Fig. 1; Ex. 1002, ¶¶ 157-158. Mirfakhraei explains that “discrete Fourier transform (DFT) block 196 performs a discrete Fourier transform on the filtered time-domain samples ... to determine frequency components associated with the sub-channels” (corresponding to the function of “determining signal activity” for the term “means for determining signal activity”). Ex. 1007, ¶ 24; Ex. 1002, ¶¶ 157-158. As acknowledged by the ’518 patent, performing a Fourier transform on samples from an A/D converter performs the function of determining signal activity because, as also taught by Mirfakhraei, the result determines the frequency components within each subchannel which directly indicate signal activity within each subchannel. Ex. 1001, 8:4-8, 8:27-39, 11:14-18, Fig. 6; Ex. 1007, ¶ 24; Ex. 1002, ¶¶ 157-158.

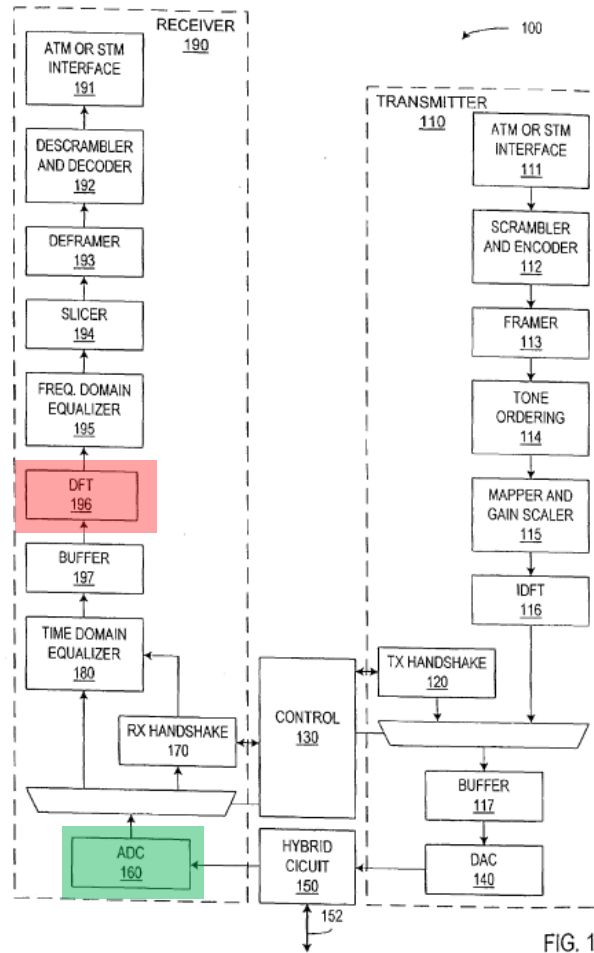


FIG. 1

Ex. 1007, Fig. 1 (annotated)

As further discussed for [1A], in the Afshary-Mirfakhraei data communications network, the receiver of Afshary's cable LAN adapter 32 would incorporate the portion of Mirfakhraei's receiver that includes DFT block 196 and the DFT block 196 would perform a DFT on samples received from an ADC converter (corresponding to the structure of "a receiver that performs an FFT on data samples from an A/D converter" for the term "means for determining signal activity"), as both Afshary and Mirfakhraei teach demodulators within receiver

signal paths that operate on data samples provided by an ADC. Ex. 1006, ¶¶ 38-42, Fig. 4; Ex. 1007, ¶¶ 15, 21, 24, Fig. 1; Ex. 1002, ¶¶ 157-158.

A POSITA would understand that a Fast Fourier Transform (FFT) is a manner of efficiently performing a Discrete Fourier Transform (DFT) and that a DFT is substantially equivalent to an FFT. Ex. 1001, 8:4-8, 8:27-39, 8:65-9:4 (recognizing the equivalency between the FFT and DFT in performing a Fourier transform); Ex. 1019, pp. 100-109; Ex. 1020, pp. 554-561; Ex. 1021, pp. 581-585; Ex. 1002, ¶ 159. Accordingly, a POSITA would understand that to the extent a receiver that performs a DFT on data samples from an A/D converter is not identical to a receiver that performs an FFT on data samples from an A/D converter, it is substantially equivalent, because each performs the same function of determining signal activity (*e.g.*, by determining frequency components over a frequency range based on the Fourier transform). Ex. 1002, ¶ 159. Therefore, Afshary in view of Mirfakhraei teaches the “means for determining signal activity” as required for claim 2. Ex. 1002, ¶¶ 159-160.

Further, as discussed above in Section IV.A, Afshary teaches a coaxial cable LAN that shares the coaxial cable wire 24 with a conventional cable TV service. Ex. 1006, Abstract, ¶¶ 2, 7, 12, 24-25, 39, Figs. 1, 3; Ex. 1002, ¶ 161. As shown in Figure 3 (below), Afshary explains that existing cable services, including a conventional cable TV service, are provided over an operating frequency range of

0-950 MHz (**green**) and that the coaxial cable LAN is provided over a non-overlapping operating frequency range of 1000-2000 MHz (**red**). Ex. 1006, ¶ 25; Ex. 1002, ¶ 161. Afshary teaches that its RF & Mixed Signal section 100 translates modulated data of the coaxial cable LAN to an RF carrier frequency of 1300 MHz to ensure that the operating frequency range of the coaxial cable LAN is above and does not overlap the operating frequency range of the conventional cable TV service. Ex. 1006, ¶¶ 24-25, 39; Ex. 1002, ¶ 161. As shown below, upconverted modulated data of the cable LAN occupies a bandwidth of 5 MHz (**blue**) within the operating frequency range of 1000-2000 MHz. Ex. 1006, ¶¶ 24-25, 39; Ex. 1002, ¶ 161. Accordingly, in the Afshary-Mirfakhraei system, each cable LAN adapter selects a frequency band for operation so as to not interfere with conventional cable TV service (claimed “selects a frequency band for operation that is not used by other services”). Ex. 1002, ¶ 161.

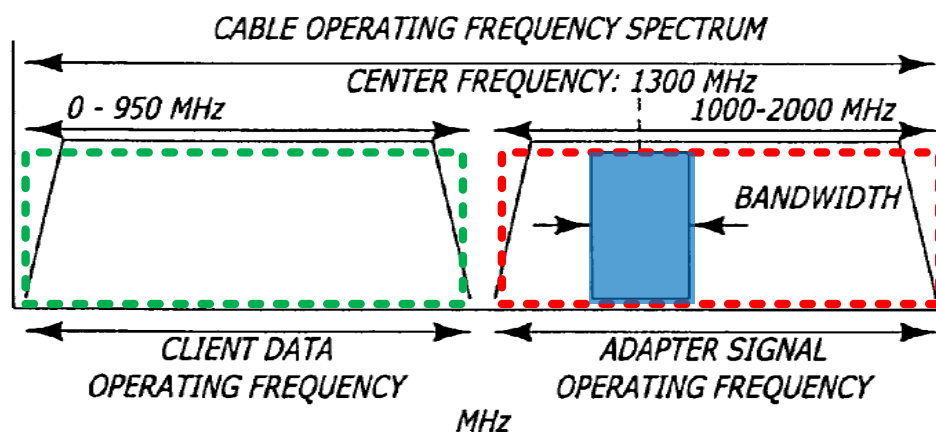


FIG. 3

Ex. 1006, Fig. 3 (annotated)

Therefore, Afshary in view of Mirfakhraei teaches claim 2. Ex. 1002, ¶¶ 157-162.

3. Dependent Claim 3

- a. **“The data communication network of claim 1 wherein the network shares the cable wiring with a cable television service and the network device up converter translates the modulated data to an RF carrier frequency above the frequency used by the cable television service.”**

As discussed above in Section IV.A, and as discussed for [1B] and claim 2 (Sections VI.A.1.b, VI.A.2), Afshary discloses a coaxial cable LAN that shares the coaxial cable wire 24 with existing cable services, including a conventional cable TV service. Ex. 1006, Abstract, ¶¶ 2, 7, 12, 24-25, 39, Figs. 1, 3; Ex. 1002, ¶ 163. As shown in Figure 3 (below), Afshary explains that the conventional cable TV service, along with perhaps other conventional cable services such as digital TV and cable modem services, is provided over an operating frequency range of 0-950 MHz and that the coaxial cable LAN is provided over a non-overlapping operating frequency range of 1000-2000 MHz. Ex. 1006, ¶ 25; Ex. 1002, ¶ 163.

Afshary teaches that the RF & Mixed Signal section 100 translates modulated data of the coaxial cable LAN to an RF carrier frequency that ensures that the operating frequency range of the coaxial cable LAN is above and does not overlap the operating frequency range of the conventional cable TV service. Ex. 1006, ¶¶ 2, 17, 24-25, 37-39; Ex. 1002, ¶ 163. As an example, Afshary teaches that the RF &

Mixed Signal section 100 translates modulated data to a 1300 MHz center frequency (**red**) and that the modulated data occupies a bandwidth of 5 MHz (**dark blue**), which does not overlap the operating frequency of the conventional cable services (**dashed green**) that include the cable TV service, as shown in Figure 3 (below). Ex. 1006, ¶¶ 25, 38-39; Ex. 1002, ¶ 163.

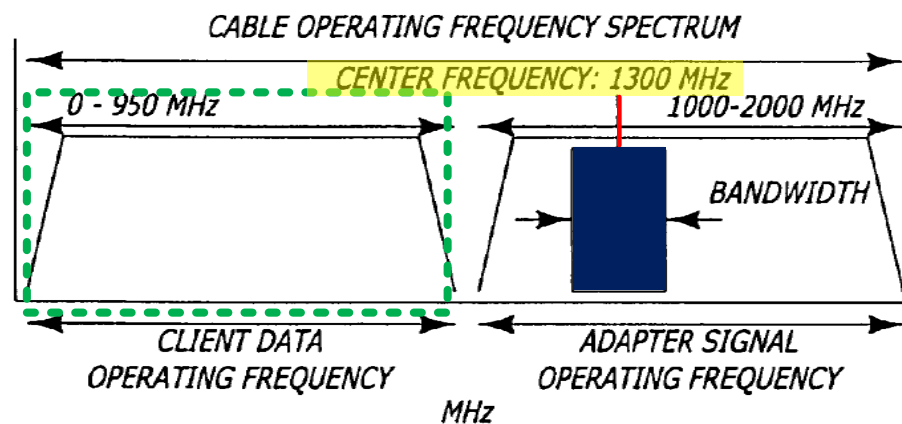


FIG. 3

Ex. 1006, Fig. 3 (annotated)

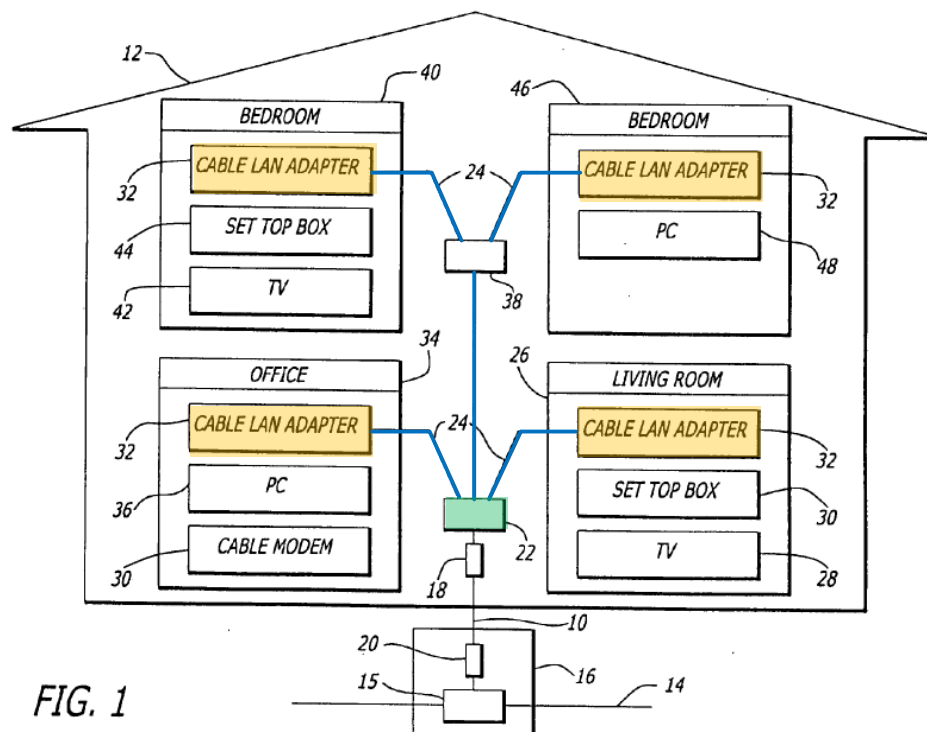
Therefore, Afshary in view of Mirfakhraei teaches claim 3. Ex. 1002, ¶¶ 163-164.

4. Independent Claim 4

- a. [4pre]: “A network device for communicating data to other network devices over a coaxial wiring system comprising a splitter and a plurality of cable segments connected between the splitter and the network devices, the network device comprising:”

As discussed for [1pre]-[1A] (Sections VI.A.1.a-b), Afshary discloses a LAN over coaxial cable (**blue**) (claimed “coaxial wiring system”) that includes cable LAN

adapters (**orange**) (claimed “network device for communicating data to other network devices”). Ex. 1006, Abstract, ¶¶ 2, 7, 12, 14, 18-23, Figs. 1-2; Ex. 1002, ¶ 165. As discussed for [1B] (Section VI.A.1.c), Afshary explains that the coaxial cable LAN includes splitter 22 (**green**) and multiple cable wires 24 (**blue**) connected between the splitter 22 and the cable LAN adapters 32 (e.g., the cable LAN adapter 32 within office 34 and the cable LAN adapter 32 within living room 26) (claimed “plurality of cable segments connected between the splitter and the network devices”). Ex. 1006, ¶¶ 16, 18-19, 21-23, Fig. 1; Ex. 1001, 1:53-57, Fig. 1; Ex. 1002, ¶ 165.

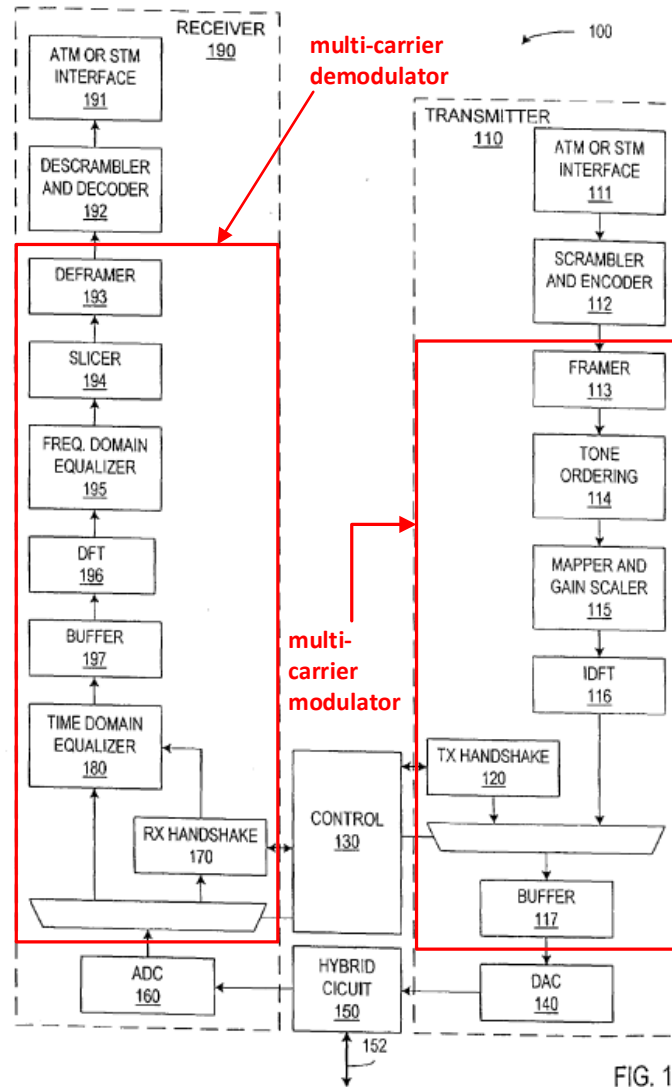


Ex. 1006, Fig. 1 (annotated)

Therefore, Afshary teaches [4pre]. Ex. 1002, ¶¶ 165-166.

b. [4A] “a data modulator to produce a multicarrier modulated signal;”

As discussed for [1A] (Section VI.A.1.b), the cable LAN adapters of the Afshary-Mirfakhraei system would include the functionality of Mirfakhraei’s multi-carrier modulator to implement the DMT bit loading scheme taught by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 167. As further discussed for [1A], Mirfakhraei teaches a transmitter 110 that includes framer 113, tone ordering block 114, constellation mapper 115, IDFT block 116, buffer 117, and TX handshake block 120 (collectively, claimed “data modulator to produce a multicarrier modulated signal”) that generate a multi-carrier modulated signal based on Mirfakhraei’s DMT bit-loading scheme. Ex. 1007, ¶¶ 14-19, Fig. 1; Ex. 1002, ¶ 167. Mirfakhraei teaches that these components of transmitter 110 operate to generate “a discrete multi-tone (DMT) communication signal” (claimed “multicarrier modulated signal”). Ex. 1007, ¶ 5; *see id.*, Abstract, ¶¶ 1-3, 5-8, 14-25, Figs. 1-2; Ex. 1002, ¶ 167.



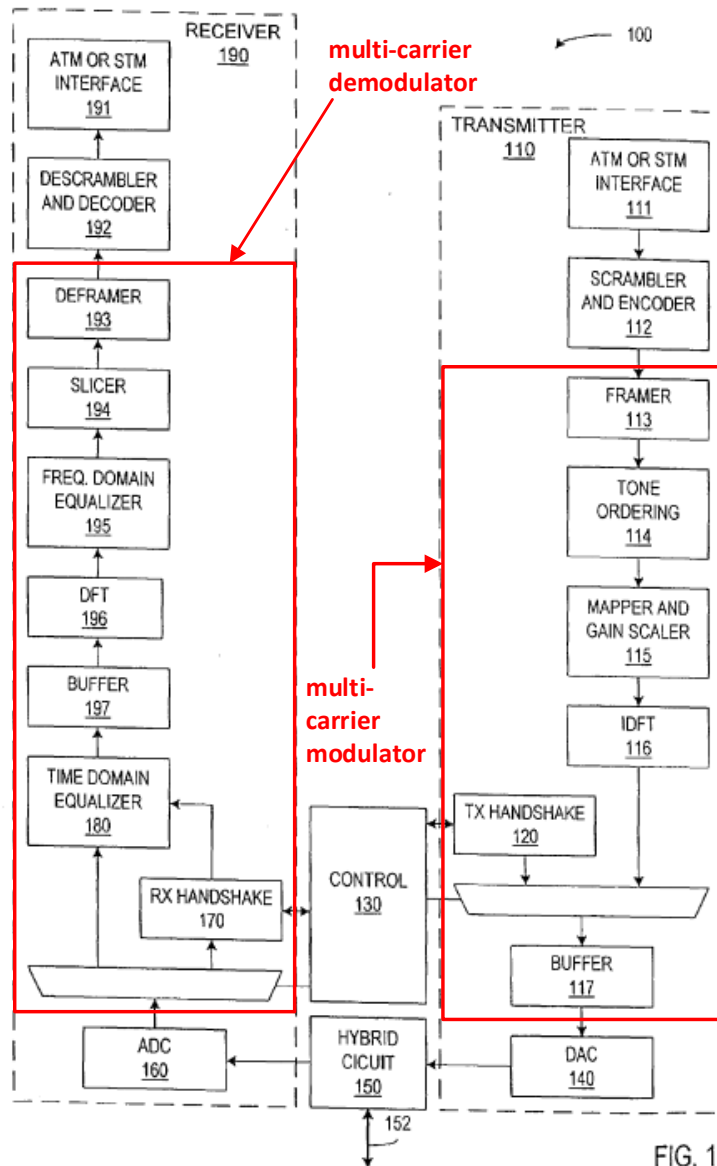
Ex. 1007, Fig. 1 (annotated)

Therefore, Afshary in view of Mirfakhraei teaches [4A]. Ex. 1002, ¶¶ 167-168.

c. [4B] “a demodulator for multicarrier modulated signal to produce data;”

As discussed for [1A] (Section VI.A.1.b), the cable LAN adapters of the Afshary-Mirfakhraei system would include the functionality of Mirfakhraei’s multi-

carrier demodulator to implement the DMT bit loading scheme taught by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 169. As further discussed for [1A], Mirfakhraei teaches that the receiver 190 includes RX handshake block 170, TEQ 180, buffer 197, DFT block 196, frequency domain equalizer 195, slicer 194, and deframer 193 (collectively, claimed “demodulator for multicarrier modulated signal to produce data”). Ex. 1007, ¶¶ 21-24; Ex. 1002, ¶ 169. Mirfakhraei explains that these components operate to recover a data bit stream (claimed “produce[d] data”) from different QAM symbols transmitted on each subcarrier of a multicarrier modulated signal. Ex. 1007, ¶ 24; Ex. 1002, ¶ 169.



Ex. 1007, Fig. 1 (annotated)

Therefore, Afshary in view of Mirfakhraei teaches [4B]. Ex. 1002, ¶¶ 169-170.

d. [4C] “means for producing and transmitting a probe message; and”

As discussed for [1D] (Section VI.A.1.e), each cable LAN adapter 32 in the Afshary-Mirfakhraei system would use Mirfakhraei’s handshake signals to facilitate implementation of the DMT bit loading scheme described by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 171. Accordingly, in the Afshary-Mirfakhraei system, to implement the DMT bit loading scheme, each cable LAN adapter includes the TX handshake block 120 (**green**). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 171. Mirfakhraei explains that “TX handshake block 120 ... generates time domain samples for a handshake signal sent to a remote transceiver” and that the handshake signal is a “known pseudo-random signal” or known signal pattern (corresponding to the function of “producing and transmitting a probe message” of the term “means for producing and transmitting a probe message”). Ex. 1007, ¶¶ 20-22; Ex. 1002, ¶ 171.

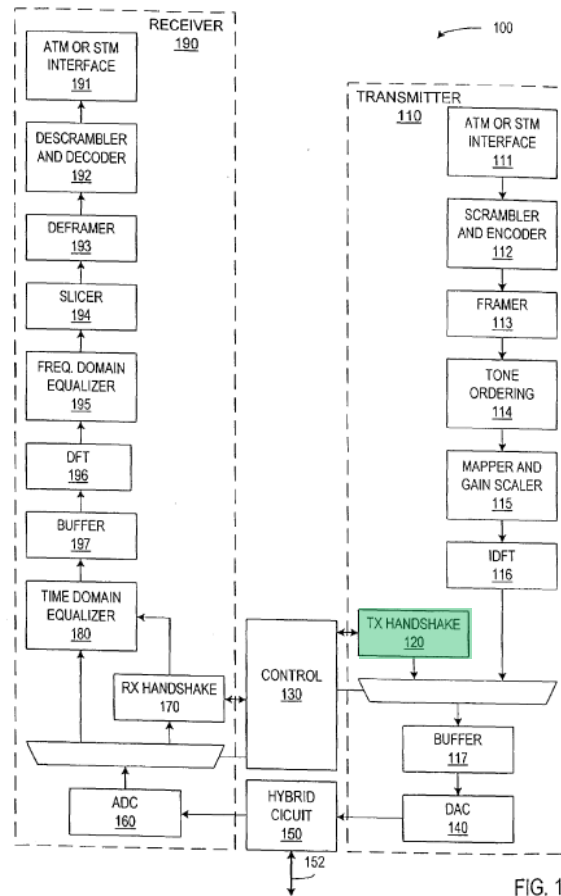


FIG. 1

Ex. 1007, Fig. 1 (annotated)

Mirfakhraei teaches that TX handshake block 120 may be implemented in software by a host computer. Ex. 1007, ¶ 15, Fig. 1; Ex. 1002, ¶ 172. A POSITA would understand that a host computer implementing the TX handshake block 120 in software would entail executing software on a processor (corresponding to the structure of a “processor” for the term “means for producing and transmitting a probe message”). Ex. 1007, ¶ 15, Fig. 1; Ex. 1002, ¶ 172. Further, the TX handshake block 120, when implemented by executing software on a processor, performs an algorithm that includes generating a signal known to a remote transceiver and

transmitting the known signal to the remote transceiver (corresponding to the algorithm of “(a) generating a signal known to a receiving device; and (b) transmitting the known signal,” identified as the algorithm performed by the corresponding structure of a “processor”). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 172. Accordingly, Afshary in view of Mirfakhraei teaches the “means for producing and transmitting a probe message” as required by [4C]. Ex. 1002, ¶ 172.

Therefore, Afshary in view of Mirfakhraei teaches [4C]. Ex. 1002, ¶¶ 171-173.

e. [4D] “means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data.”

As discussed for [1D] and [4C] (Sections VI.A.1.e, VI.A.4.d), each cable LAN adapter 32 in the Afshary-Mirfakhraei system would implement the DMT bit loading scheme described by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 174. Accordingly, in the Afshary-Mirfakhraei system, to implement the DMT bit loading scheme, each cable LAN adapter 32 includes the RX handshake block 170 (blue). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 174. Mirfakhraei teaches that the RX handshake block 170 receives a handshake signal from a TX handshake block 120 from another cable LAN adapter 32. Ex. 1007, ¶ 22; Ex. 1002, ¶ 174. The handshake signal is a known signal. Ex.

1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 174. Mirfakhraei teaches that the RX handshake block 170 compares the received handshake signal to the known values that were transmitted to estimate the SNR for each sub-channel, which are then used to determine the appropriate bit loadings for each sub-channel (corresponding to the function of “receiving and analyzing a probe message to determine a bit loading profile used to transmit data” of the term “means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data”). Ex. 1007, ¶¶ 25-32, Figs. 1-2; Ex. 1002, ¶ 174. The ’518 patent admits that “[d]etermination of... [an] SNR profile from a known signal is well known in the art.” Ex. 1001, 10:12-14; Ex. 1002, ¶ 174.

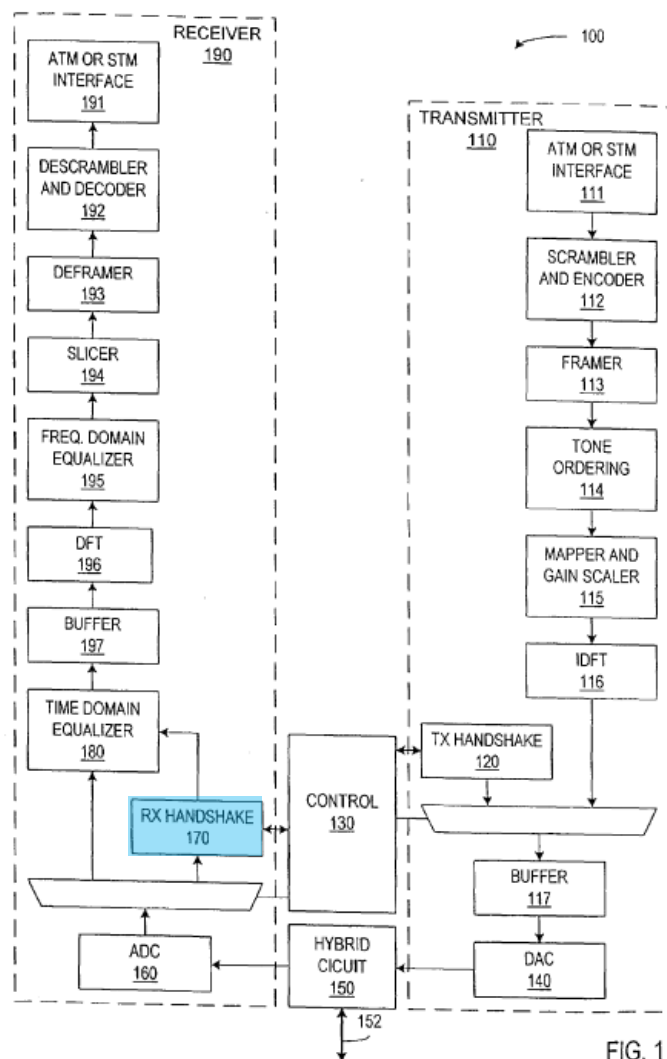


FIG. 1

Ex. 1007, Fig. 1 (annotated)

Mirfakhraei teaches that RX handshake block 170 may be implemented in software by a host computer. Ex. 1007, ¶ 15, Fig. 1; Ex. 1002, Ex. 1002, ¶ 175. A POSITA would understand that a host computer implementing the RX handshake block 170 in software would entail executing software on a processor (corresponding to the structure of a “processor” for the term “means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data”). Ex. 1007,

¶ 15, Fig. 1; Ex. 1002, ¶ 175. Further, the RX handshake block 170, when implemented by executing software on a processor, performs an algorithm that includes receiving a known signal from a remote transceiver, determining SNR levels for each subchannel based on the received known signal, and determining the bit-loading for each subchannel based on the determined SNR level for each subchannel (corresponding to the algorithm of “(a) receiving a known signal; (b) determining a SNR for each subchannel based on the received known signal; and (c) determining a bit loading for each subchannel based on the determined SNR for the subchannel,” identified as the algorithm performed by the corresponding structure of a “processor”). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3; Ex. 1002, ¶ 175. Accordingly, Afshary in view of Mirfakhraei teaches the “means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data” as required by [4D]. Ex. 1002, ¶ 175.

Therefore, Afshary in view of Mirfakhraei teaches [4D], and Afshary in view of Mirfakhraei teaches claim 4. Ex. 1002, ¶¶ 174-175.

B. Ground B: Claim 2 is Rendered Obvious by Afshary-Mirfakhraei in View of Welles

As set forth below, Afshary-Mirfakhraei in view of Welles renders obvious claim 2. Ex. 1002, ¶¶ 176-183.

1. Dependent Claim 2

- a. **“The data communication network of claim 1 wherein a network device comprises a means for determining signal activity and selects a frequency band for operation that is not used by other services.”**

To the extent it is argued that Afshary-Mirfakhraei does not teach a “means for determining signal activity,” Welles does. Ex. 1002, ¶ 177.

As discussed above in Section IV.C, Welles teaches a LAN communication system over power line cables. Ex. 1022, Abstract, 1:14-18, 1:56-2:9, 2:55-3:8, Figs. 1-2, 4; Ex. 1002, ¶ 178. Welles teaches the use of an envelope detector (*e.g.*, envelope detector 192) by a transceiver of the LAN to measure the received power of a signal, which is then compared to a reference signal power level (corresponding to the function of “determining signal activity” for the term “means for determining signal activity”). Ex. 1022, 5:5-7:11, Figs. 1-2, 4; Ex. 1002, ¶ 178. Welles teaches that when the output of the envelope detector exceeds the reference signal power level, the power line is determined to be in use by another transceiver of the LAN. Ex. 1022, 5:23-35, 6:18-51, Fig. 4; Ex. 1002, ¶ 178. Welles teaches that a large frequency range may be scanned using the envelope detector to determine a clear frequency range that may be used for communication, to avoid noise or interference from other transceivers or systems. Ex. 1022, 5:5-6:17, 7:2-11; Ex. 1002, ¶ 178.

Afshary explains a need to operate a cable LAN over a frequency range of a coaxial cable that is not used by other existing services that also operate over the

coaxial cable. Ex. 1006, Abstract, ¶¶ 2, 7, 21-28, Fig. 3; Ex. 1002, ¶ 84. Welles discloses the use of an envelope detector to detect signal activity over a range of frequencies, to determine whether the range of frequencies is already being used by another communication device or is affected by other sources of interference or noise. Ex. 1022, 1:15-17, 2:4-9, 5:5-16, 5:23-35, 7:1-11; Ex. 1002, ¶¶ 56, 95-102. A POSITA would understand that Welles' envelope detector enables signal activity over a range of frequencies to be determined, so that a clear range of frequencies for operation would be established, thereby ensuring that existing services provided over the same communication medium are not disturbed, which is a goal of Afshary. Ex. 1002, ¶¶ 56, 178-183.

Accordingly, a POSITA would have been motivated to modify the Afshary-Mirfakhraei cable LAN adapter (which operates over a coaxial cable medium that is shared by other services) to include Welles' envelope detector (which is capable of detecting signal activity over a frequency range to determine if the frequency range is occupied by another service or adversely affected by interference or noise) because doing so would provide a simple and straightforward manner to determine whether a range of frequencies would be suitable for communication (*e.g.*, would not disturb existing services provided over the same communication medium), as taught by Welles. Ex. 1022, 5:5-6:17, 7:2-11; Ex. 1002, ¶¶ 56, 179-180. A POSITA would understand that Welles' envelope detector would include a simple diode and

filter circuit and that such an envelope detector would facilitate the detection of signal activity over a range of frequencies, as taught by Welles. Ex. 1022, 5:5-7:11, Figs. 1-2, 4; Ex. 1006, Abstract, ¶¶ 2, 7, 14-28, Fig. 3; Ex. 1019, pp. 129-131; Ex. 1023, pp. 281-282; Ex. 1002, ¶¶ 56, 179-180. In doing so, a clear range of frequencies for communication would be determined, as desired by Afshary and Welles. Ex. 1022, 5:5-7:11, Figs. 1-2, 4; Ex. 1002, ¶¶ 56, 179-180.

A POSITA would have understood that combining the teachings of Welles and Afshary-Mirfakhraei is nothing more than an obvious combination of known elements (Afshary-Mirfakhraei's cable LAN adapter and Welles' envelope detector) according to known methods (modifying Afshary-Mirfakhraei's cable LAN adapter to include Welles' envelope detector – for example, by incorporating Welles' envelope detector and its functionality to detect signal activity over a range of frequencies into an ASIC such as Afshary's ASIC 78) to yield predictable results (Afshary-Mirfakhraei-Welles' cable LAN adapter detects signal activity over a range of frequencies by measuring received signal power to detect a clear frequency range for operation). Ex. 1002, ¶ 181. Moreover, in doing so, a POSITA would have had a reasonable expectation of success because the proposed implementation of Afshary-Mirfakhraei-Welles would be well within the standard skill set of a POSITA. Ex. 1002, ¶ 181.

A POSITA would have also understood that combining the teachings of Afshary-Mirfakhraei and Welles is nothing more than applying a known technique (using an envelope detector to measure power to detect signal activity) to a known device (Afshary-Mirfakhraei's cable LAN adapter) ready for improvement to yield a predictable result (Afshary-Mirfakhraei's cable LAN adapter would implement Welles's techniques for detecting signal activity using an envelope detector to ensure a clear range of frequencies may be used for communication). Ex. 1002, ¶ 182. A POSITA would have understood that the result would have been a low cost and effective way to further Afshary's goal of ensuring its cable LAN does not disturb, and is not disturbed by, other services using the same coaxial cable for communications, thereby improving the Afshary-Mirfakhraei system. Ex. 1002, ¶ 182. Therefore, Afshary-Mirfakhraei-Welles teaches the "means for determining signal activity" as required for claim 2; Ex. 1002, ¶ 182.

As discussed above for claim 2 (Section VI.A.2), Afshary teaches a "network device... [that] selects a frequency band for operation that is not used by other services." Ex. 1002, ¶ 183. Welles also teaches this feature. As discussed above, Welles teaches that its transceiver uses its envelope detector to determine if a range of frequencies is already in use so as to select a frequency range of operation not occupied by communication from other transceivers or systems. Ex. 1022, 5:5-7:11,

Figs. 1-2, 4; Ex. 1002, ¶ 183. Accordingly, Afshary-Mirfakhraei-Welles teaches this feature, and renders claim 2 obvious. Ex. 1002, ¶¶ 176-183.

VII. GROUNDS FOR STANDING & FEE PAYMENT

Petitioner hereby certifies that the '518 patent is available for, and Petitioner is not barred or estopped from requesting, *inter partes* review challenging claims 1-4.

Pursuant to 37 C.F.R. § 42.103, the undersigned authorizes the charge of any required fees to Deposit Account No. 19-0733.

VIII. CONCLUSION

Inter partes review should be instituted and claims 1-4 canceled.

Dated: February 15, 2024

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CERTIFICATION UNDER 37 CFR § 42.24(d)

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for Inter Partes Review totals 13,030 which is less than the 14,000 allowed under 37 CFR § 42.24(a)(1)(i). This total includes 13,005 words as counted by the Word Count feature of Microsoft Word and 25 words used in annotations.

Pursuant to 37 C.F.R. § 42.24(a)(1), this count does not include the table of contents, the table of authorities, mandatory notices under § 42.8, the certificate of service, this certification of word count, the claims listing appendix, or appendix of exhibits.

BANNER & WITCOFF, LTD

Dated: February 15, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.105, I hereby certify that I caused a true and correct copy of this Petition for *Inter Partes* Review in connection with U.S. Patent No. 7,295,518 and supporting evidence to be served via FedEx Priority Overnight on February 15, 2024, on the following:

23446 - MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661
UNITED STATES

Dated: February 15, 2024

By: /Frederic M. Meeker/

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CLAIM LISTING APPENDIX

U.S. Pat. No. 7,295,518

Designation	Claim Language
Claim 1	
[1pre]	A data communication network comprising:
[1A]	at least two network devices, each network device comprising a multi-carrier modulator for modulating data, an up converter for translating the modulated data to an RF carrier frequency, a down converter for translating an RF signal, and a multi-carrier demodulator for demodulating the translated RF signal to produce data; and
[1B]	cable wiring comprising a splitter with a common port and a plurality of tap ports, and a plurality of segments of coaxial cable connecting between the splitter tap ports and the network devices;
[1C]	whereby network devices communicate with each other through the cable wiring using multi-carrier signaling;
[1D]	wherein network devices transmit probe messages through the cable wiring and analyze received probe message signals to determine channel characteristics and bit loading is selected based on the determined channel characteristics.
Claim 2	
2	The data communication network of claim 1 wherein a network device comprises a means for determining signal activity and selects a frequency band for operation that is not used by other services.
Claim 3	
3	The data communication network of claim 1 wherein the network shares the cable wiring with a cable television service and the network device up converter translates the modulated data to an RF carrier frequency above the frequency used by the cable television service.
Claim 4	
[4pre]	A network device for communicating data to other network devices over a coaxial wiring system comprising a splitter and a plurality of cable segments connected between the splitter and the network devices, the network device comprising:
[4A]	a data modulator to produce a multicarrier modulated

Designation	Claim Language
	signal;
[4B]	a demodulator for multicarrier modulated signal to produce data;
[4C]	means for producing and transmitting a probe message; and
[4D]	means for receiving and analyzing a probe message to determine a bit loading profile used to transmit data.