

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: Dec. 18, 2002

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Title: BROADBAND NETWORK FOR COAXIAL CABLE USING MULTI-
CARRIER MODULATION

Inter Partes Review No.: IPR2024-00431

**DECLARATION OF JAMES G. BERTONIS IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PAT. NO. 7,295,518**

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I, Mr. James G. Bertonis, declare that I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently.

I. INTRODUCTION

1. I have been retained as an expert witness on behalf of the Petitioner, Comcast Cable Communications, LLC, for the above-referenced *inter partes* review proceeding.

2. I have been asked to provide a declaration with my opinions regarding certain matters pertaining to the patentability of U.S. Patent No. 7,295,518 (“the ’518 patent”). I understand that the ’518 patent is owned by Entropic Communications, LLC (“Patent Owner”).

3. I am being compensated at my usual consulting rate for my work on this matter. My compensation is in no way dependent upon my opinions or testimony or the outcome of this proceeding. I have no financial interest in the parties or in the outcome of this proceeding.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

4. I offer statements and opinions on behalf of Petitioner, generally regarding the validity, novelty, prior art, obviousness considerations, and understanding of a person of ordinary skill in the art (“POSITA”) as it relates to the

'518 patent. Attached hereto as Appendix A, is a true and correct copy of my Curriculum Vitae describing my background, experience, and publications.

5. Currently, I am CEO of Azure Communications Inc. (Azurecomm), which designs and develops wireless broadband solutions and advanced radio technology.

6. I received a B.S. in Electrical Engineering from Syracuse University in 1976, and an MBA from Santa Clara University in 1986. While at Syracuse University, I concentrated my senior year studies on communications engineering, including graduate level courses in this area taken as electives. I also worked for Syracuse University part time as a paid assistant in their communications engineering lab during my last two years at Syracuse University.

7. After graduating from Syracuse University, my entire career has been devoted to the field of communications, including RF and wireless communications, as an accomplished RF circuit design engineer, as well as the founding CEO of four wireless communications companies, and one continuing as the CTO post-merger.

8. I have also worked as a consultant on several occasions, both in the area of wireless circuit/product design engineering, and later during my career as an expert in the field of wireless communications technology.

9. During my time working for ADBS Corp., and also working as a consulting engineer (from 1990 to 2000), I was involved with numerous wireless

local area network (WLAN) engineering activities. This included developing a WLAN module for Toshiba laptop computers (1990-1992) and developing a WLAN for the golfing industry (1995-1996). During this time period (1990-2000), I also consulted on wireline DSL multi-carrier product engineering and development, and actively participated in and contributed to the IEEE 802.11 WLAN standards setting body.

10. During this time developing multiple WLAN products, I was involved with designing all of the RF and analog circuitry. This included designing the RF signal modulators and demodulators. These modulators and demodulators were configured to process the FSK, MSK, QPSK, QAM, and CDMA signals, which were the modulation formats that were used with Wi-Fi during that period.

11. In 2000, I presented a paper titled “High Speed Wireless Internet over Unlicensed Radio Bands - An Innovative Approach,” which was published in Private Wireless & Broadband Magazine, June 2000. The paper focused on the application of the cable standard DOCSIS for use in wireless Internet networks.

12. During my time at Advanced Radio Cells Incorporated (ARCi), and later Arcwave Inc., (from [2000] to [2008]) I was involved with numerous DOCSIS related engineering activities. This included developing a RF communications system for the cable industry, which extended the reach of cable modems by using a RF link to bring DOCSIS to areas not served by coaxial or fiber cable

infrastructure. This product was purchased by all of the major cable operators and incorporated into numerous cable services.

13. During my time at Azurecomm (from [2009] to [2012]) I was involved with engineering a mobile WiMAX (802.16e) micro base station product. This work included developing the RF and baseband electronic modules and operating PHY and MAC software compliant to the WiMAX standard, to be sold and licensed to other wireless infrastructure manufacturers. During this time period I also actively participated in and contributed to, the IEEE 802.16 wireless MAN/WAN standards setting body.

14. During this time developing a WiMAX (802.16e) product, I was involved with designing the multi-carrier RF modulators and demodulators, which were configured to process an OFDMA signal. OFDMA was the specified modulation and multiplexing format used by WiMAX.

15. Among my work related achievements, I was awarded four U.S. patents (from 2003 to 2011, as listed in my CV) in the area of DOCSIS and wireless communications stemming from my work adapting the DOCSIS cable modem protocol, by now the leading broadband standard in the world, to operate over wireless communications channels. This technology was successfully employed by ARCi, and later Arcwave, where I was involved with designing and bringing this technology to market. I believe that my extensive industry experience and

educational background qualify me as an expert in the relevant field of signal processing and communication systems/networks. I am knowledgeable of the relevant skill set that would have been possessed by a hypothetical person of ordinary skill in the art at the time of the alleged invention of the '518 patent.

III. MATERIALS REVIEWED

16. In connection with my study of this matter and reaching the opinions stated herein, I have reviewed a number of documents including the exhibits listed below:

- | | |
|-----------|---|
| Ex. 1001: | U.S. Pat. No. 7,295,518 (“the ’518 patent”) |
| Ex. 1002: | <i>Present Document</i> |
| Ex. 1003: | <i>Reserved</i> |
| 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,” <i>IEEE Communication Magazine</i> , 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”)

IV. UNDERSTANDING OF APPLICABLE LEGAL STANDARDS

17. Although I am not an attorney, I have a general understanding of the applicable legal standards pertaining to the patentability issues presented in this proceeding.

18. I understand that in this *inter partes* review (IPR) the Petitioner is challenging the patentability of claims 1-4 of the '518 patent. I understand that Petitioner has the burden of proving that each challenged claim is unpatentable by a preponderance of the evidence.

19. I understand that an analysis of patent claim validity first requires that the patent claims be properly construed, and that claim construction is determined as a matter of law. I address claim construction further as it pertains to my analyses in a subsequent section of my declaration.

20. I understand that to be valid, a (properly construed) patent claim must be “novel,” and is invalid if “anticipated” by a single prior art reference. I further understand that a reference anticipates if it discloses each and every element as

arranged in the claim, so as to enable a person of ordinary skill in the art (a “POSITA”) to make and use the claimed invention without undue experimentation.

21. I understand that a patent claim is unpatentable if, at the time of the invention, it would have been obvious to a POSITA to combine the teachings of the prior art to yield the patent claim. I also understand that it is not required (although it is acceptable) that each element/limitation of a patent claim be found in a single reference in order to find a patent claim obvious. For a patent claim to be found obvious, all the elements/limitations of the patent claim may be found in a combination of references at which a person of ordinary skill in the art would have been reasonably expected to arrive. I understand that a proper analysis of whether an invention is unpatentable for obviousness includes a review of the scope and content of the prior art, the differences between the patent claims at issue and the prior art, the level of ordinary skill in the field of the invention at the time of the invention, and other objective considerations identified below.

22. It is my understanding that the prior art and claimed invention should be viewed through the knowledge and understanding of a person of ordinary skill in the art at the time of the invention – one should not use his or her own insight or hindsight in deciding whether a claim is obvious. I further understand that a claim may be rendered obvious if a person of ordinary skill in the art could have implemented the claimed invention as a predictable variation of a known product. I

also understand that a person of ordinary skill in the art is presumed to have knowledge of the relevant prior art at the time of the claimed invention, which comprises any prior art that was reasonably pertinent to the particular problems the inventor faced.

23. I understand that a showing of obviousness requires some articulated reasoning with a rational underpinning to support the combination of the references. I understand that in consideration of the issue of obviousness it is important to identify whether a reason existed at the time of the invention that would have led a POSITA to combine elements of the references in a way that yields the claimed invention.

24. I understand that a claim may be considered unpatentable for obviousness for various reasons. I have been informed that the following exemplary rationales may support a finding of obviousness:

- (A) combining prior art elements according to known methods to yield predictable results;
- (B) simply substituting one known element for another to obtain predictable results;
- (C) use of a known technique to improve similar devices in the same way;
- (D) applying a known technique to a known device ready for improvement to yield predictable results;

- (E) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- (F) known work in a field that prompts variations in the work in the same or a different field that leads to predictable results; and
- (G) some teaching, suggestion, or motivation in the prior art that would have led a person of ordinary skill in the art to modify a prior art reference or combine multiple prior art references or teachings to arrive at the claimed invention.

25. I understand that various objective or “real world” factors, also referred to as secondary considerations, may be indicative of non-obviousness. I understand that such factors/considerations include:

- (A) the commercial success of the claimed invention;
- (B) the existence of a long-felt, unresolved need for a solution to the problem solved by the claimed invention;
- (C) failed attempts to solve the problem solved by the claimed invention;
- (D) copying of the claimed invention;
- (E) unexpected results of the claimed invention;
- (F) praise for the claimed invention by others in the relevant field; and
- (G) willingness of others to accept a license under the patent because of the merits of the claimed invention.

26. It is my understanding that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but other times the link may be common sense. I further understand that the obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that is sufficient motivation to combine references.

27. It is my understanding that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. For example, common sense is a good reason for a person of ordinary skill to pursue known options when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions.

28. I further understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, it is my understanding that any need or problem known in the field at the time of invention and addressed by the patent can provide a reason for combining the limitations in the manner claimed.

V. TECHNICAL BACKGROUND

A. Digital Data Modulation

29. A basic understanding of digital data transmission modulation techniques is important to an appreciation of the issues presented. A brief summary is presented here, with references to the industry text *Modern Cable Television*

Technology: Video, Voice, and Data Communications by Walter Ciciora, First Ed. (1999). Ex. 1024, pages 161-192.

30. The objective of digital data transmission in a network is to get a stream of bits from one network location (i.e., node) to one or more others. It is possible to transmit bits of data over an RF carrier, using the same variables as are used in analog transmission. One can vary, that is modulate, the amplitude, frequency, or phase of the carrier, with the information to be transmitted. *Id.*, page 162 (§ 4.2).

31. A measure used for comparing different modulation formats is “spectral efficiency.” Spectral efficiency is expressed in bits per Hertz, that is, the number of bits per second of data, divided by the bandwidth required to transmit it. A modulation format with high spectral efficiency can transmit more bits per second of data in the same number of Hertz of RF bandwidth. On the other hand, formats with higher spectral efficiency can generally be expected to cost more and be less robust (i.e., more susceptible to noise and transmission distortion). *Id.*, page 162 (§ 4.2.1).

32. A brief summary of some of the types of digital data modulation well known at the time of the alleged invention of the ’518 patent is now presented, generally progressing from lowest to highest in terms of spectral efficiency. Generally, each format builds on the previous in terms of its structure and required processing.

33. First, we have **frequency shift keying (FSK)**. In this simplest commonly used modulation method, information is transmitted by shifting an oscillator between two frequencies. *Id.*, page 163 (§ 4.2.2). FSK modulation is used for relatively low-speed data transmissions, including certain downstream data transmissions to addressable cable TV set-top terminals. The spectral efficiency of FSK is very poor, but this is relatively unimportant in low-speed applications. On the positive side, the transmission is robust, meaning it is not easily damaged by noise or distortion. Also, the required hardware is relatively low in cost. For further detail regarding FSK, see *Id.*, pages 163–167.

34. Next, we have **bi-phase shift keying (BPSK)**. In a BPSK system, the phase is shifted 180° between transmission of a zero and a one. BPSK modulation provides very good immunity to noise, is simple, and is low in cost. Its downside is that, similar to FSK, it is inefficient in its use of the spectrum. For further detail, see *id.* at pages 167–175.

35. In order to make better use of the spectrum, possible states can be represented by different analog levels and/or phases, transmitting more than one bit at a time. The next modulation formats to be discussed are expansions of BPSK, which improve on the spectrum efficiency by transmitting more than one bit at a time. The penalties are an increasing complexity and reduced immunity to noise and other transmission impairments. *Id.*, Page 175 (4.2.8).

36. The first expansion of BPSK to be discussed is **quadrature phase shift keying (QPSK)**, which is a technique specifically referenced in the '518 patent. Ex. 1001, 8:51-63, 7:21-58. With QPSK, and as shown in Ciciora's Figure 4.6, data into the transmitter is split into two channels. Those two channels are called the I (in-phase) and Q (quadrature) channels. Two bits are transmitted simultaneously, one in each channel. Spectrum efficiency is improved because the spectrum required to transmit the two bits is no wider than the spectrum required to transmit one bit using BPSK. Ex. 1024, page 175 (§ 4.2.8). However, QPSK does require twice the signal power (+3 dB) versus BPSK to achieve the same bit error rate (BER).

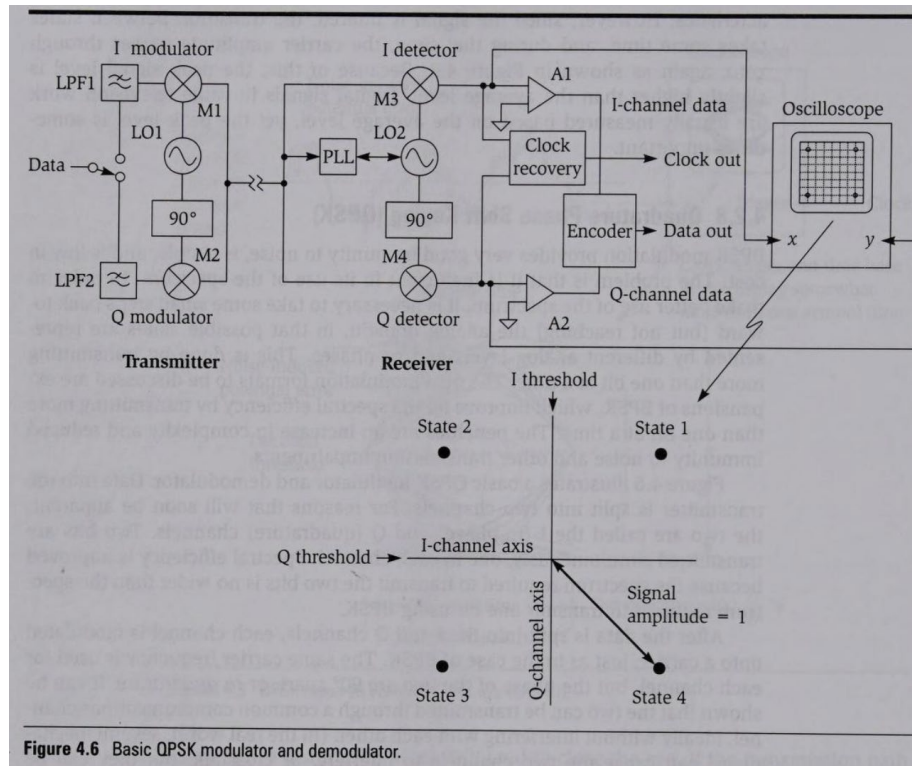
37. After the data is split into the I and Q channels, each channel is modulated onto a carrier, just as in the case of BPSK. The same carrier frequency is used for each channel, but the phase of the two are 90° apart, or in quadrature. *Id.*

38. On the receiver side, the signal is split into the in-phase (I) and quadrature (Q) components, and sent to respective demodulators. An encoder combines the two bits from the I and Q channels into the resulting data stream. *Id.* See Ciciora's Figure 4.6 (reproduced below) for a basic QPSK modulator/demodulator arrangement. *Id.*, page 176.

39. The rate at which bits are transmitted (the bit rate) is measured in bits per second. However, in QPSK, and most other (higher-order) modulation methods, more than one bit is transmitted at a time. The bits that are transmitted

simultaneously are grouped into what is called a “symbol. “The rate at which symbols are transmitted is the baud rate. For additional detail in this regard, see *id.*, pages 175-176 (§ 4.2.8).

40. A particularly useful representation of QPSK and higher-order signals/modulation schemes is the constellation diagram, such as seen (for QPSK) at the bottom of Ciciora’s Figure 4.6 (reproduced below). *Id.*, pages 176-177. Therein, each of the four possible positions of the symbol is formed from the I and Q channel data. The position along the X axis is determined by the I data, while the position along the Y axis is determined by the Q data. The peak amplitude of the signal is proportional to the length of the vector from the origin to any one of the four possible states. In the case of QPSK, these lengths are equidistant from the origin, reflecting equal peak amplitudes. *Id.*, page 177.

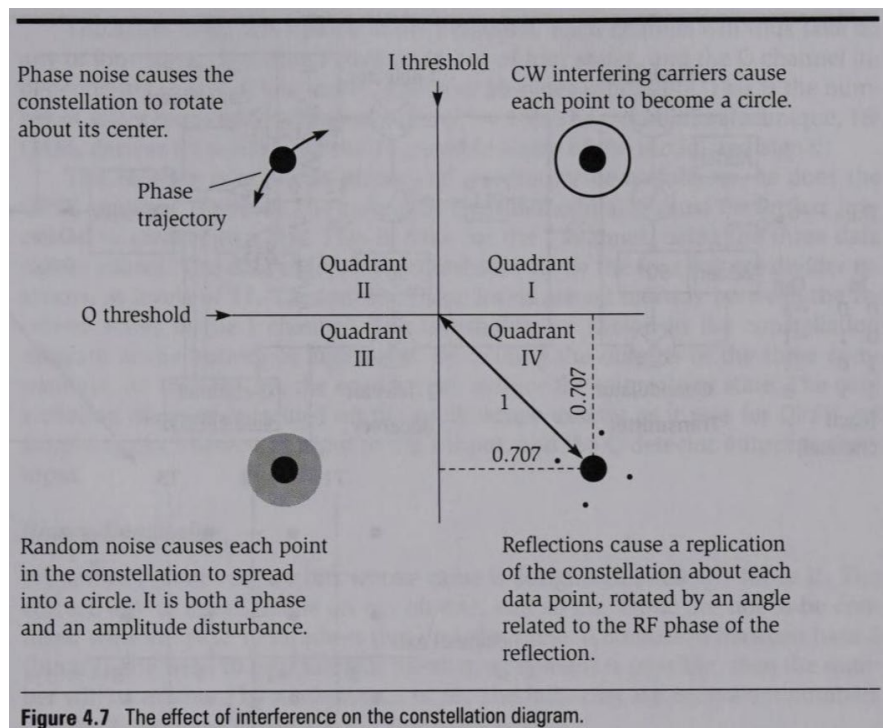


Ex. 1024, Fig. 4.6

41. “The Y axis forms the decision threshold for the I channel since it is halfway between the I channel states. Similarly, the decision threshold for the Q channel is defined by the X axis. Computation of a bit error rate (BER) is based on determining the proportion of time that any one ‘spot’ in the constellation could be forced to cross a threshold into another state’s place in the constellation. When this happens, at least one, and sometimes more, bits are received an error.” *Id.* It will be appreciated that the closer together the states in the constellation, that is the denser the modulation, the less noise or other disturbance can be tolerated before a state can be misinterpreted as another. *Id.*

42. Thus, a defining characteristic of QPSK is that it has four signal states, all of the same amplitude. It is interesting to observe in this regard that QPSK is nothing more than two BPSK signals combined 90° out of phase. Also of note, QPSK is also called 4-state quadrature amplitude modulation (i.e., 4-QAM), a reference to its four signal states and use of two sinusoidal waveforms in quadrature (QAM is discussed further below). *Id.*, pages 177, 181.

43. Ciciora describes the effects of interference on the constellation diagram with a helpful illustration provided in Figure 4.7 (reproduced below). *Id.*, pages 178-179, Fig. 4.7. The different types of interference include carrier wave, (CW) interference, phase noise interference, and random noise interference.



Ex. 1024, Fig. 4.7

44. With QPSK, the signal state thresholds are defined by the axis of the constellation diagram. With more dense (higher-order) modulation, the thresholds are closer, so less interference will cause the thresholds to be crossed. Thus, it will be appreciated that higher-order modulation formats are more susceptible to signal interference. *Id.*

45. The next denser (higher-order) modulation format commonly found in cable television networks is **16-QAM** (16-state quadrature amplitude modulation). *Id.*, page 179 (§ 4.2.9) 16-QAM is similar to QPSK, except that each axis is divided into four levels, so that each channel (I and Q) can carry the information of two bits at a time. Each of the two phases carries two bits at a time, so there are four bits per symbol; the baud rate is 1/4 of the bit rate. Each channel of the 16-QAM modulator can take on not only the two phases of QPSK, but also the intermediate amplitude values (represented by differing distances from origin), as seen in the lower part of Figure 4.8 (reproduced below). *Id.*, pages 179-180.

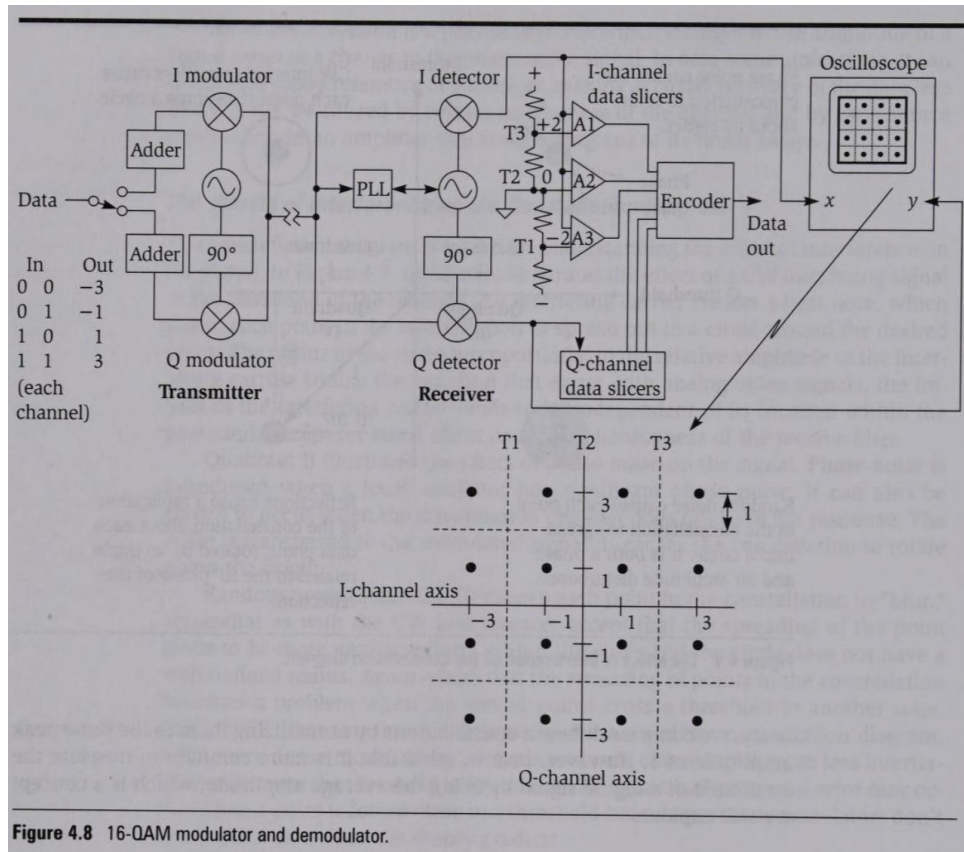


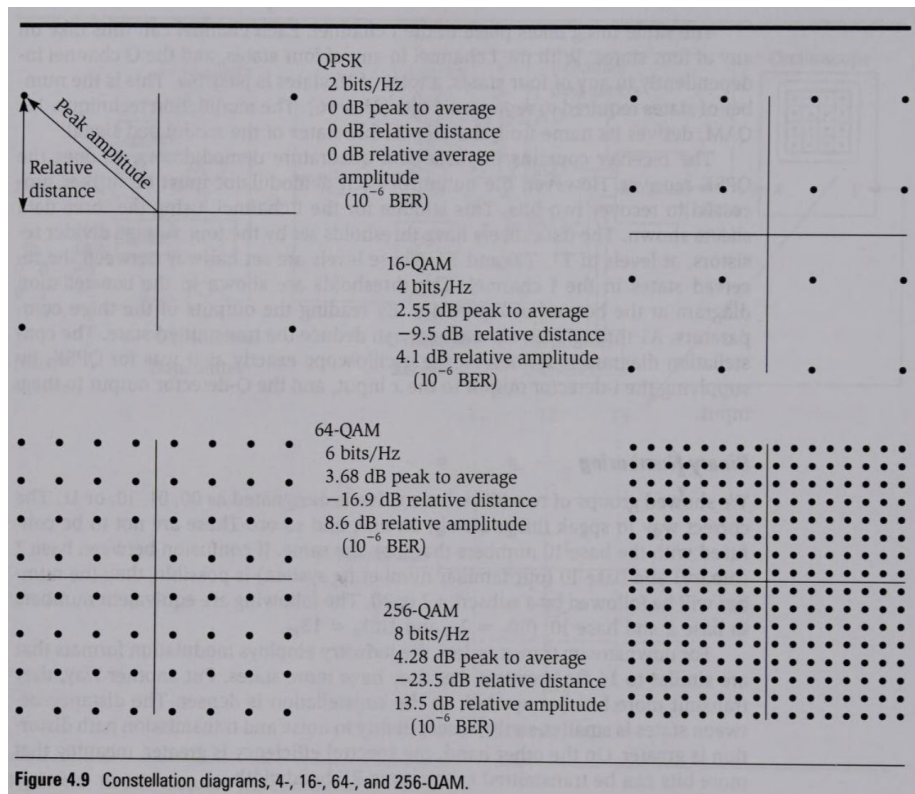
Figure 4.8 16-QAM modulator and demodulator.

Ex. 1024, Fig. 4.8

46. Thus, with 16-QAM, instead of only one bit being routed to each channel at a time, two bits are routed to each. Each channel can take on any of four states. With the I channel in any of four states, and the Q channel independently in any of four states, a total of 16 states is possible. This is the number of states required to represent four bits ($2^4 = 16$). The modulation technique 16-QAM derives its name from the 16 possible states of the modulated signal. *Id.*, pages 180-181.

47. Continuing to move up the modulation density scale, we next have **64-QAM** and **256-QAM**. Figure 4.9 (reproduced below) of Ciciora illustrates the constellation diagrams for 4-QAM (that is, QPSK), 16-QAM, 64-QAM, and 256-

QAM, allowing those to be compared. *Id.*, page 182. Here, the differences in density are readily apparent. The distance between states is smaller as the order of QAM gets higher, so the susceptibility to noise and transmission path distortion increases. On the other hand, the spectral efficiency also increases, meaning that more bits can be transmitted in the same RF bandwidth.



Ex. 1024, Fig. 4.9

48. Ciciora's Figure 4.9 indicates (among other things), the theoretical spectral efficiency in bits per hertz for each modulation type. Again, this indicates how many bits per second can be transmitted per hertz of RF bandwidth. For

additional information regarding these constellation diagrams, *see id.*, pages 181–182.

B. Multi-Carrier Transmission

49. Thus far, the modulation techniques discussed have been described in terms of how data is modulated for transmission on a specific carrier. It was also known to use these modulation techniques in conjunction with multi-carrier transmission schemes. Two well-known and closely related multi-carrier transmission schemes were **Discrete Multi-Tone (DMT)** and **Orthogonal Frequency Division Multiplexing (OFDM)**. With these techniques, instead of modulating a bitstream onto a single relatively wide carrier band, the bitstream is divided-up and spread across multiple sub-carriers within the band for transmission in parallel with each other. Ex. 1012, 1:18-33; *see also* Ex. 1007, ¶¶3-4, 17; Ex. 1011, pages 392-394.

50. DMT protocols had been developed, in large part, to increase the data transmission rates achievable over conventional telephone lines, for the provision of high-speed data networking. These known protocols include, e.g., Asymmetric Digital Subscriber Loop (ADSL), High bit rate Digital Subscriber Loop (HDSL) and Very fast asymmetric Digital Subscriber Loop (VDSL). Ex. 1007, ¶ 3.

51. With DMT, a frequency bandwidth for data transmission is divided into multiple sub-channels, with each sub-channel having a relatively narrow bandwidth

(e.g., 4 kHz) to reduce distortion within the sub-channel signal. Each sub-channel corresponds to a sub-carrier frequency of the multiple carriers for simultaneous data transmission. A sending modem breaks a data stream into packets for simultaneous transmission on the separate sub-channels, independently modulating that data onto the sub-channels, e.g., using QAM. A receiving modem demodulates the separate sub-channel signals, and reassembles the data. *Id.*, ¶ 4 (use of QAM for modulating data onto the sub-channels).

52. As Mirfakhraei further describes, “[a] concern for DMT protocols is differences between the separate channels. Specifically, sub-channels having low carrier frequencies may perform differently from sub-channels having high carrier frequencies. Accordingly, some sub-channels may be able to accurately carry more data than others.” *Id.*

53. Similarly, with OFDM, data is transmitted in parallel using modulated-sub-carriers. Ex. 1011, pages 392-393. In particular, like DMT, in a typical OFDM transmitter, an incoming serial stream of bits is mapped by a serial-to-parallel converter into N parallel lines, with each line corresponding to a particular sub-carrier. Ex. 1012, 1:18-58, Fig. 1. The bits for each sub-carrier are then separately modulated, for example, using a modulation scheme such as QPSK or QAM as discussed above. Ex. 1011, pages 392-394, Fig. 2.

54. A coaxial cable communication medium can be a harsh environment for communication as the frequency response of a coaxial cable can vary significantly. Ex. 1018, pages 305-306. Another source of signal degradation is interference from other signals. *Id.* Jacobsen 94 explains that multi-carrier modulation techniques such as DMT and OFDM are well-suited to combat channel impairments typically found in coaxial cable mediums:

In contrast to traditional frequency-division multiplexing (FDM) techniques, multicarrier modulation does not constrain the number of bits per subchannel to be equal for all subchannels. Instead, bits are originally assigned to subchannels just after training during system initialization in direct proportion to the subchannel signal-to-noise ratios. As a result, subchannels that suffer from little attenuation and/or little noise carry the most bits, while subchannels that are severely attenuated and/or very noisy might not carry any bits. This property can be used to alleviate the problems caused by both frequency-domain ripple and interferers such as ham radio signals. Because the bit distribution is continuously updated during transmission as the receiver sends the required information to the transmitter on secure overhead channels, even severe and unpredictable interference like ham can be tolerated by a multicarrier system. If the noise on a subchannel becomes severe while the system is in use, the transmitter simply assigns fewer or no bits to that subchannel while the noise persists. Each subchannel then supports its own QAM constellation, and, because the subchannels are essentially independent and memoryless, a memoryless detector is used for each in the receiver.

Ex. 1018, pages 306-307, Fig. 1.

55. The technique of adjusting the number of bits modulated onto a subcarrier based on the degradation of a subcarrier is often referred to as “bit-loading.” Ex. 1007, Abstract, ¶¶ 5-8. In this regard, for example, Mirfakhraei discloses an arrangement wherein “a modem or transceiver that implements a DMT protocol [] employs a ‘bit-loading’ process that characterizes the capabilities of sub-channels and determines the number of bits-per-symbol transmitted over the channel. The gains of the sub-channels are adjusted to achieve a desired data rate with acceptable signal-to-noise ratios and bit error rates in each channel.” Ex. 1007, ¶ 14. Mirfakhraei describes adjusting the modulation order for a subcarrier based on channel characteristics determined for the frequency channel or bin corresponding to the subcarrier. Ex. 1007, Abstract, ¶¶ 5-8, 14, 17-18, 22-25. One manner to estimate the reliability of a frequency channel is to calculate the signal-to-noise ratio (SNR) for the frequency channel. *Id.* SNR is a measure of a received signal power compared to received noise power over a certain frequency range. Ex. 1019, pages 314-316; Ex. 1024, page 836.

C. Envelope Detectors

56. A simple way of detecting signal activity is to use an envelope detector. An envelope detector typically includes a diode and a capacitor. An RF signal is typically provided to the envelope detector from a tuned circuit (e.g., an inductor

plus a capacitor) or bandpass filter, so that the channel or frequency band targeted for detection of possible signal activity is selected. The RF signal is rectified by the diode. The rectified DC signal is smoothed by the capacitor, which removes the RF components from the signal while retaining the “envelope” representing amplitude variations of the signal waveform. The capacitor along with the inherent resistance of the diode and the load it is coupled to form a “low-pass filter.” The amplitude variations at the output of the envelope detector can provide a measurement of a signal amplitude across a frequency range, allowing a power of a received signal to be determined. Ex. 1019, pages 129-131.

VI. SUMMARY OF THE '518 PATENT

57. U.S. Patent No. 7,295,518 (Ex. 1001) was filed on December 18, 2002, and issued on November 13, 2007. Ex. 1001, cover. I understand that the '518 patent indicates that it is a continuation of Application No. 10/230,687. Ex. 1001, cover. I also understand that the '518 patent also indicates that it claims priority to Provisional Application No. 60/385,361, filed on June 3, 2002, Provisional Application No. 60/363,420, filed on March 12, 2002, and Provisional Application No. 60/316,820, filed on August 30, 2001. Ex. 1001, cover.

58. The '518 patent is entitled “Broadband Network for Coaxial Cable Using Multi-Carrier Modulation” and relates to “broadband communication networks and specifically to communications using coaxial cable building wiring.”

Ex. 1001, 1:27-29. The '518 patent acknowledges that “[i]n a coaxial cable based local area network (LAN), communication between nodes occurs over a shared coaxial cable.” Ex. 1001, 1:33-35. Specifically, the '518 patent admits that “[w]hen the coaxial cable used for the LAN is shared with a community aerial television or cable TV (CATV) service the signals must be separated to avoid interference.” Ex. 1001, 1:35-37. According to the '518 patent, “[t]he LAN signal can use one band of frequencies and the cable TV service can use a different band.” Ex. 1001, 1:38-39.

59. The '518 patent acknowledges that “[s]ignal splitters are used to distribute downstream signals from the point of entry (POE) to the various terminals in the home, which can include cable converter boxes, televisions, and cable modems, generally referred to as customer premise equipment (CPE).” Ex. 1001, 1:40-45. The '518 patent admits that “[e]ach terminal device may have the ability to transmit as well as receive” and that “upstream signals transmitted by the terminal device flows through the signal splitters back to the POE and into the cable plant and are received by the head end.” Ex. 1001, 1:45-49.

60. The '518 patent further acknowledges that “[s]ignal splitters are commonly used in home and other building type coaxial cable wiring” and that signal splitters have an input port, which is also considered to be a common port, and multiple output ports, which are also considered to be tap ports. Ex. 1001, 1:53-57. The '518 patent admits that a “characteristic of interest in signal splitters is the

isolation between output ports” and explains that “[t]his isolation attenuates signals communicating between tap ports.” Ex. 1001, 2:28-31. The ’518 patent states that “[i]n a conventional cable TV or cable modem use, this isolation is desirable because terminal devices do not communicate with each other, they only communicate through the POE with the cable head-end.” Ex. 1001, 2:35-38. The ’518 patent alleges that “[i]n a LAN system, terminal devices must communicate directly with each other, therefore attenuation between tap ports in the signal splitters results in an undesirable signal loss.” Ex. 1001, 2:38-41. The ’518 patent further alleges that terminal to terminal communications suffer due to variations in the level of attenuation between terminal devices as well as due to multipath signals created by reflections in the cable wiring. Ex. 1001, 2:41-3:20, 4:19-28.

61. To address the alleged “impairments present in the home wiring that restricts high bandwidth communication between devices within the home,” the ’518 patent purports to provide “a form of multi-carrier modulation ... to transmit digital data signals through the coaxial cable wiring installed in homes.” Ex. 1001, 4:28-32, 4:36-39. The ’518 patent alleges that “[c]ommunication is achieved through splitters” and that “[b]it loading, along with power loading, adaptive power control, and frequency coordination can be used individually or in combination to implement a network that overcomes the problem of multipath and high attenuation in building

cable wiring that would restrict the ability of terminal devices to communicate with each other.” Ex. 1001, 4:39-47.

62. Further, the ’518 patent states that “[c]hannel probing messages formed using a predetermined bit sequence and length are transmitted between network devices to estimate the channel characteristics, including the multipath characteristics and a profile of the signal to noise ratio over the frequency band of interest.” Ex. 1001, 4:48-52. The ’518 patent explains that a “receiving device processes the probe messages as received and determines the impairment present at each carrier frequency,” and that “[b]ased on the estimate of the channel, bit loading is applied to increase the modulation order at carriers with high signal to noise ratio and lower the modulation order at carriers with low signal to noise ratio.” Ex. 1001, 4:57-62.

63. The ’518 patent illustrates an exemplary LAN in Figure 2, where LAN devices transmit signals to each other over coaxial cable. Ex. 1001, 5:36-43. I have annotated Figure 2 below:

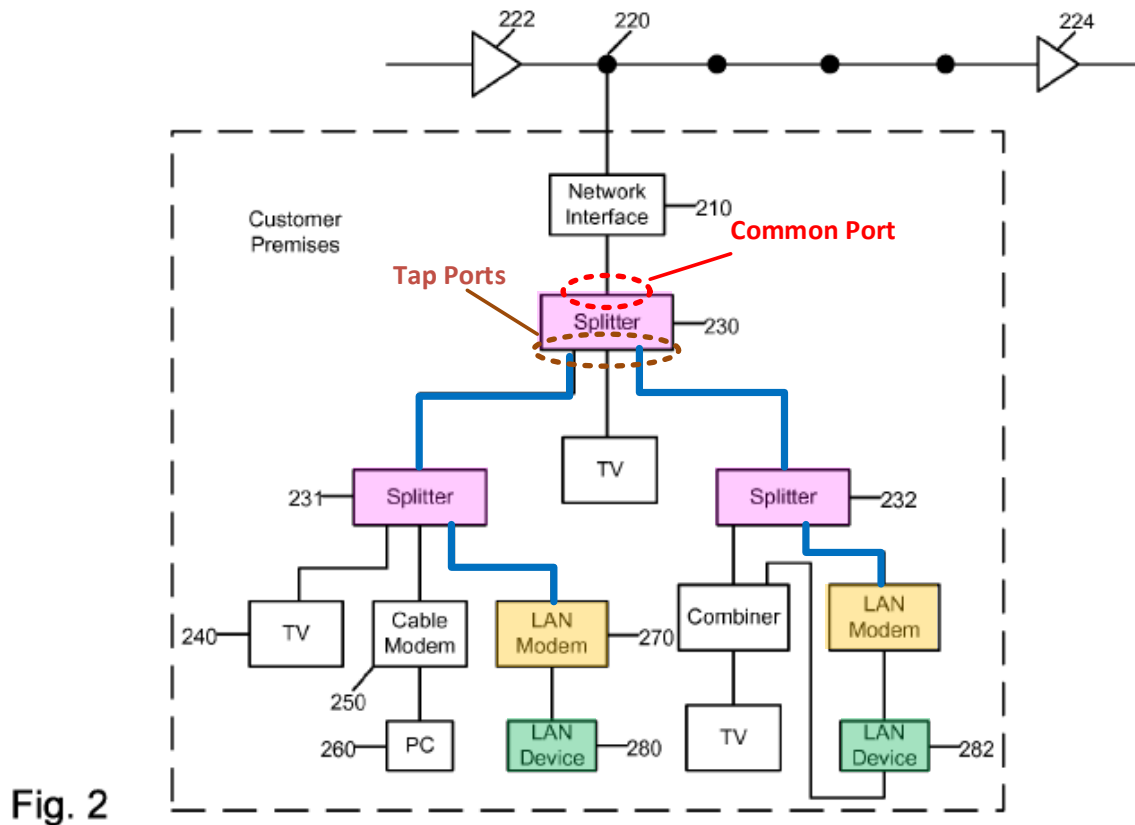


Fig. 2

Ex. 1001, Fig. 2 (annotated)

64. Figure 2 depicts a coaxial cable network in a customer premise and shows how LAN devices (e.g., 280, 282) (**green**), which may be PCs, are interconnected. Ex. 1001, 5:36-50. Each LAN device is connected to a LAN modem (**orange**). Ex. 1001, 5:36-50, Fig. 2. The LAN modem (**orange**) is a network device that modulates data originating from the LAN device and converts the modulated data into RF signals suitable for transmission over the cable wiring. Ex. 1001, 5:36-50, 8:4-8, 8:51-9:12. When receiving signals from the network, the LAN modem provides the inverse operations by down-converting the RF signals and

demodulating the signals to recover the original data. Ex. 1001, 5:36-50, 8:4-8, 8:51-9:12, 9:22-27.

65. The LAN modems (**orange**), and hence LAN devices (**green**), are connected to one another using one or more splitters (e.g., 230, 231, and 232) (**pink**) and a plurality of segments of cable wiring (**blue**). Ex. 1001, 5:36-6:3. As noted above, the '518 patent acknowledges that the splitters used in home coaxial cable wiring have a common port as an input port to receive signals and multiple tap ports as output ports to distribute the received signals. Ex. 1001, 1:53-2:16. The '518 patent also acknowledges that the splitters are generally bi-directional, which means that the splitters can also function as signal combiners, using the tap ports as input ports and the common port as an output port. Ex. 1001, 2:5-16. I have annotated Figure 2 to show the common port (**red**) and multiple tap ports (**brown**) of the splitter 230. Ex. 1001, 1:53-2:16.

66. As shown in Figure 2, the splitters (**pink**) and the cable wiring (**blue**) are also used to provide cable TV services (e.g., cable TV services to TV 240) and/or other services (e.g., Internet services to cable modem 250). Ex. 1001, 5:36-6:3. To reduce interference, the LAN signals use a frequency band that is not used by the existing services (e.g., cable TV services and/or cable modem services). Ex. 1001, 1:35-37, 5:57-60. Figure 4 (annotated below) shows the frequency band used by existing cable services and the frequency band used by the cable LAN. Ex. 1001,

6:4-10. As shown in Figure 4, upstream and downstream signals from the existing cable services (e.g., cable TV services and/or cable modem services) use a frequency band ranging from 0 to 750MHz (**green**), while cable LAN signals use a frequency band starting from 750MHz and above (**red**). Ex. 1001, 6:4-10.

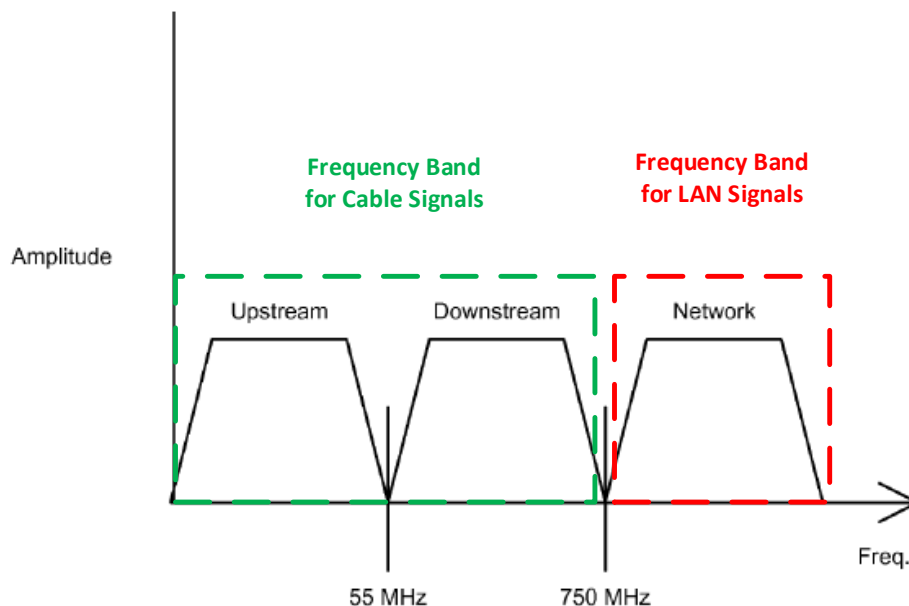


Fig. 4

Ex. 1001, Fig. 4 (annotated)

67. The '518 patent explains that “[w]hen a terminal device is powered up, it scans the available frequency band to determine if there is communication activity occurring and determine the frequencies that are already in use.” Ex. 1001, 11:8-12. The '518 patent describes different techniques for detecting signal activity, including using an FFT, an envelope detector, an automatic gain control (AGC) detector, or a demodulator/decoder. Ex. 1001, 11:8-47.

68. The '518 patent describes the use of a multi-tone (or multi-carrier) modulation protocol to transmit a block of encoded data onto multiple carriers. Ex. 1001, 7:21-27, 7:59-8:3, 8:36-39. The '518 patent states that “[m]ulti-tone modulation is also called discrete multi-tone (DMT) and orthogonal frequency division multiplexing (OFDM).” Ex. 1001, 7:25-27. The '518 patent explains that the multi-tone modulation uses quadrature amplitude modulation (QAM) (including quadrature phase shift keying (QPSK) as a subset of QAM), whereby data bits are transmitted by each carrier as a QAM symbol. Ex. 1001, 7:22-43. The '518 patent explains that one QAM symbol can represent a bit sequence of varying length, depending on the order of the QAM constellation. Ex. 1001, 8:54-59. The order of the QAM constellation refers to the number of possible amplitude and phase combinations in a QAM scheme. For example, a lower order constellation, such as QPSK (essentially a 4-QAM), has 4 (2^2) constellations, meaning each symbol represents 2 bits. Ex. 1001, 8:9-12, 8:54-59. By contrast, a higher order constellation, such as a 256-QAM, has 256 (2^8) constellations, meaning each symbol represents 8 bits. Ex. 1001, 8:9-12, 8:54-59.

69. Additionally, the '518 patent describes a bit loading technique as “a method of allocating a higher order signal constellation to carriers that have higher signal to noise ratio [(SNR)] and a lower order constellation to carriers that have lower signal to noise ratio.” Ex. 1001, 8:9-12. The '518 patent acknowledges that

multi-tone modulation systems employ bit loading to enable carriers with higher SNRs to transmit modulated symbols (e.g., 256-QAM symbols) corresponding to more bits, while carriers with lower SNRs transmit modulated symbols (e.g., QPSK symbols) corresponding to fewer bits. Ex. 1001, 8:9-26, 8:54-59. In this way, the higher SNR carriers can be better utilized to achieve a higher data rate. Ex. 1001, 8:9-28. Indeed, the '518 admits that several prior art references disclose multi-carrier modulation with bit-loading:

U.S. Pat. No. 6,438,174 "Multi-carrier transmission systems" incorporated herein by reference, discloses discrete multi-tone modulation and a technique for bit loading applied to point-to-point twisted pair wiring. U.S. Pat. No. 6,259,746 "Method for allocating data and power in a discrete multi-tone communication system" discloses a technique for bit loading applied to discrete multi-tone modulation.

Ex. 1001, 8:19-26.

70. Figure 10 of the '518 patent illustrates how bit loading is applied. Ex. 1001, 10:61-63. The X-coordinate of Figure 10 represents the frequency. Ex. 1001, 10:63-66, Fig. 10. As shown in Figure 10 below, a frequency band used to transmit a signal is segmented into a plurality of frequency bins or channels (annotated by dashed lines), with each frequency bin corresponding to a carrier in an OFDM system. Ex. 1001, 10:61-66. The Y-coordinate represents the response of the

channel, for each frequency bin, over which signals are transmitted and received. Ex. 1001, 10:66-11:1, Fig. 10. The '518 patent explains that the response of the channel in each frequency bin corresponds to the SNR of each frequency bin. Ex. 1001, 10:66-11:1. Based on the SNR determined in each frequency bin, relatively higher or lower orders of modulation are used to transmit information. Ex. 1001, 11:1-6. As an example, as shown in Figure 10, 256-QAM is used in frequency bins with the highest SNR (**blue**), 64-QAM is used in frequency bins with the second highest SNR (**green**), 16-QAM is used in frequency bins with the third highest SNR (**yellow**), 4-QAM is used in frequency bins with the fourth highest SNR (**red**), and no bit loading/modulation is used in frequency bins with the lowest SNR.

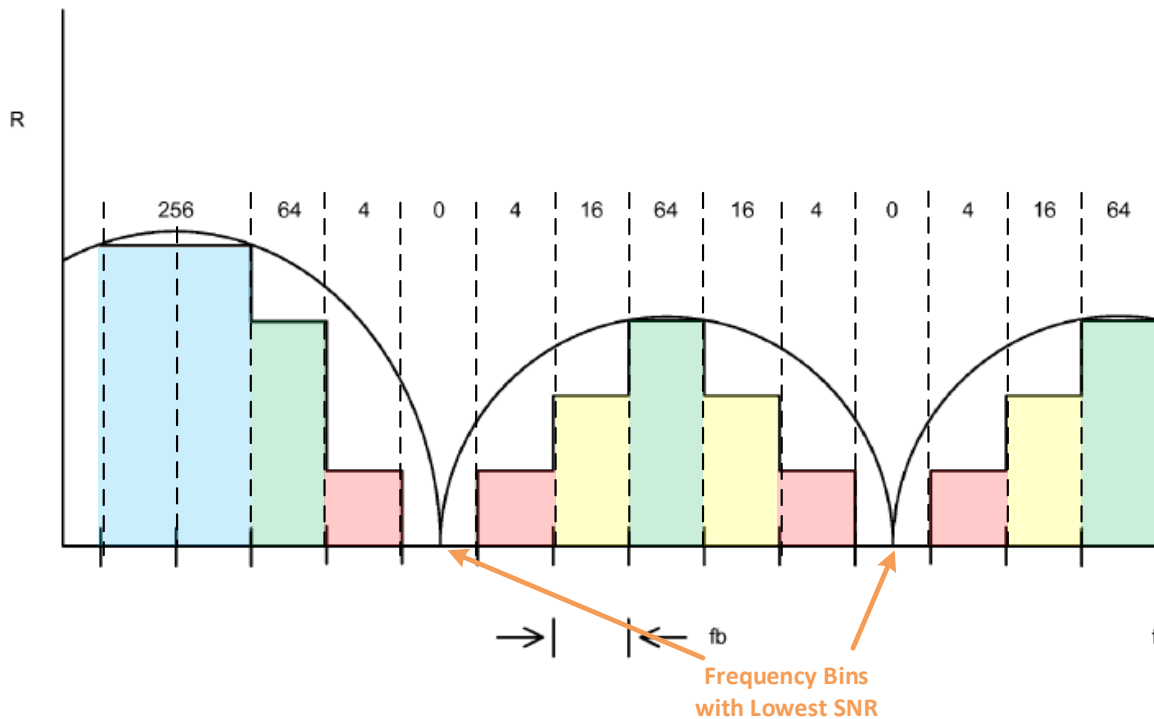


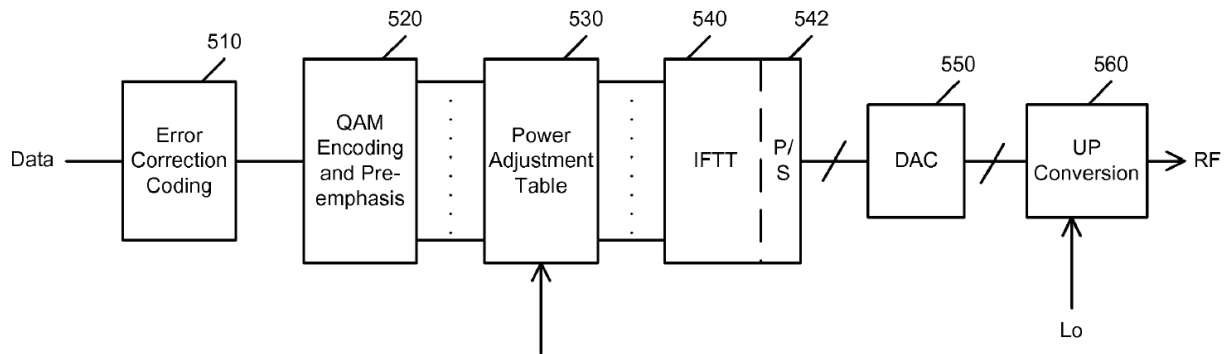
Fig. 10

Ex. 1001, Fig. 10 (annotated)

71. The '518 patent further describes that an SNR profile, which indicates the SNRs of the different frequency bins over a frequency band of interest, is determined by using channel probing messages. Ex. 1001, 4:48-62, 9:35-41. To do so, a first device transmits, to a second device, a channel probing message. Ex. 1001, 4:48-62; 9:35-41. The '518 patent states that “[c]hannel probing messages [are] formed using a predetermined bit sequence” that is already known to the receiving device. Ex. 1001, 4:48-52. After receiving the channel probing message, the second device determines the SNRs of each of the frequency bins using the known predetermined bit sequence of the probing message, and then determines a bit

loading profile indicating bit loadings for each subcarrier based on the corresponding determined SNR. Ex. 1001, 4:48-62, 9:35-59. The determined bit loading profile is then provided from the second device back to the first device, which is then used in subsequent communications from the first device to the second device. Ex. 1001, 4:48-62; 9:35-59

72. Figure 5 of the '518 patent illustrates a modulator used in the cable LAN network. Ex. 1001, 5:36-40, 8:51-52.

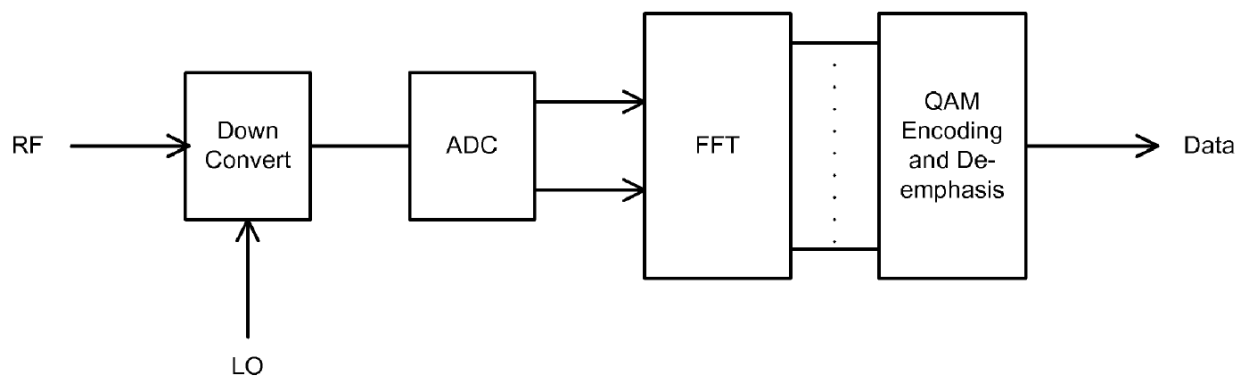


Ex. 1001, Fig. 5

73. The modulator of the '518 patent transforms data into radio frequency signals by using a multi-tone modulation technique such as orthogonal frequency division multiplexing (OFDM) or discrete multi-tone (DMT). Ex. 1001, 7:22-27, 7:59-60, 8:51-52. As shown in Figure 5, input data is optionally coded with check bits by the error correction coder 510. Ex. 1001, 8:52-54. The QAM encoder 520 then divides the data into multiple bit-streams, each being modulated independently and transmitted via a corresponding subcarrier. Ex. 1001, 8:54-59. The QAM

encoder 520 maps the data into each bit stream to a sequence of QAM symbols. *Id.* The QAM symbols in each bit stream are then processed by the power adjustment unit 530, the inverse fast Fourier transform (IFFT) unit 540, the parallel to serial converter 542, and the digital to analog converter (DAC) 550, resulting in analog signals that are suitable for being upconverted to a suitable RF carrier frequency. Ex. 1001, 8:59-9:12. The up converter 560 translates the analog signals in each stream to the suitable RF carrier frequency, resulting in RF signals that are to be transmitted over the network. Ex. 1001, 9:5-12.

74. The '518 patent further illustrates a demodulator of the cable LAN network in Figure 6. Ex. 1001, 5:36-40, 9:22-27. The '518 patent explains that the demodulator performs inverse operations compared to each corresponding unit in the modulator. Ex. 1001, 8:51-52, 9:22-27.



Ex. 1001, Fig. 6

VII. THE '518 PATENT'S PROSECUTION HISTORY

75. I understand that the '518 patent was filed as Application No. 10/322,834 (“the '834 application”) on December 18, 2002. Ex. 1001, cover; Ex. 1004, 2-41. As filed, I understand that the '834 application included 10 claims, with claims 1, 5, 8, and 10 as independent claims. Ex. 1004, pages 24-26. I understand that the '518 patent indicates that it is a continuation of Application No. 10/230,687 (“the '687 application”). Ex. 1001; Ex. 1004, 2-41; Ex. 1005.

76. On March 19, 2007, I understand that the Examiner issued a Restriction Requirement requiring election between claims 1-4 and 10 and claims 5-9. Ex. 1004, pages 61-66. On April 3, 2007, I understand that the Applicant filed a response to the Restriction Requirement electing claims 1-4 and 10 for prosecution and canceling claims 5-9. Ex. 1004, pages 68-73.

77. On September 6, 2007, I understand that the Examiner issued a Notice of Allowance. Ex. 1004, pages 75-83. The Notice of Allowance included an Interview Summary indicating that an interview was conducted on April 10, 2007, and stating: “In order to expedite the allowance, Applicant’s attorney agreed to amend claim 1 per Examiner’s suggestion and cancel claim 2. also, amend claims 3 and 4 to correct the dependency.” Ex. 1004, page 82. I understand that the Notice of Allowance also included an Examiner’s Amendment that incorporated the limitations of dependent claim 2 into independent claim 1, canceled claim 2, and

amended dependent claims 3 and 4 to depend from independent claim 1. Ex. 1004, page 79. The Notice of Allowance further included the following Examiner's Statement of Reasons for Allowance:

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, page 80.

78. On November 13, 2007, I understand that the '834 application issued as the '518 patent. Ex. 1001, cover; Ex. 1004, page 110.

VIII. OVERVIEW OF THE RELIED UPON PRIOR ART

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

79. I understand that Afshary (Ex. 1006) was filed on January 3, 2006, as a continuation of U.S. Application No. 09/164,427 (now abandoned), filed on September 30, 1998. Afshary published on September 28, 2006. Ex. 1006, cover. I understand that Afshary is prior art under pre-AIA 35 U.S.C. § 102(e). I understand Afshary was not before the Patent Office during the prosecution of the '518 patent. Ex. 1001, cover. Afshary is in the field of network communication and therefore in my opinion analogous to the '518 patent. Ex. 1006, ¶ 2.

80. Afshary “relates to a coaxial cable local area network (LAN) for digitally communicating client generated data between clients of the cable LAN.” Ex. 1006, ¶ 7. Afshary explains the need to distribute data around the home among various home client devices such as “content devices such as televisions, ... personal computers, and ... monitor and control devices such as climate-control devices, security devices, and home automation devices.” Ex. 1006, ¶ 4. Afshary states that a goal of its cable LAN is to provide cost-effective and high-speed communications over an in-home coaxial cable. Ex. 1006, ¶¶ 6, 12.

81. Figure 1 (annotated below) depicts “an in-home coaxial cable LAN.” Ex. 1006, ¶ 8. As shown, client devices (e.g., set top boxes 30 and 44, and personal computers 36 and 48) (**green**) in a home coaxial cable LAN are connected to each other by splitters (e.g., splitters 22 and 38) (**purple**) and segments of cable wire 24 (**blue**). Ex. 1006, ¶¶ 14, 18, Fig. 1. A cable LAN adapter 32 (**orange**) is “[c]oupled between cable wire 24” (**blue**) and each of the client devices (**green**), to process (e.g., receive and/or transmit) data to and/or from a respective client device. Ex. 1006, ¶¶ 18, 23, Figs. 1-2.

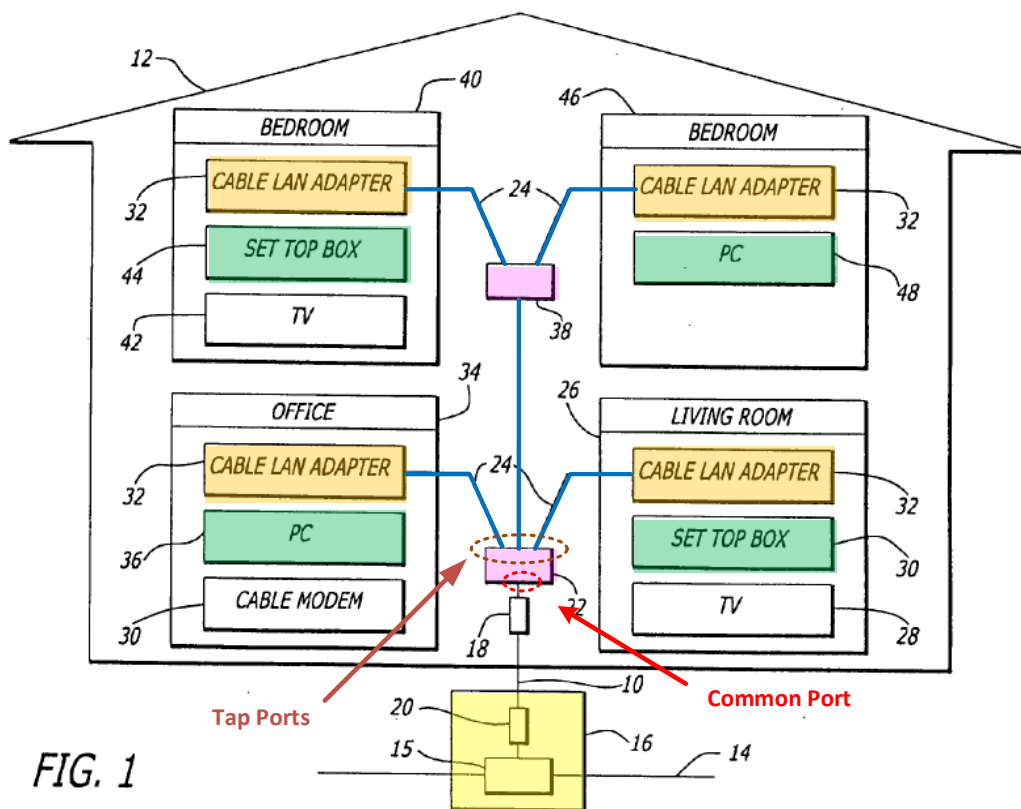


FIG. 1

Ex. 1006, Fig. 1 (annotated)

82. Afshary explains that, “from the point at which drop cable 10 enters home 12, drop cable 10 is split by splitter 22 [(pink)] into different cable wires 24 [(blue)], [with] each cable wire 24 being routed to different rooms in home 12.” Ex. 1006, ¶ 18. The cable wire 24 split by splitter 22 (pink) is then routed to office 34 and living room 26. Ex. 1006, ¶ 19. “To communicate with cable LAN adapter 32 in bedroom 40 and bedroom 46, cable wire 24 is further divided from splitter 22 by splitter 38 into two cable wires 24.” Ex. 1006, ¶ 19.

83. When the signals flow downstream from the main trunk 14 to home 12, a common port (red) of the splitter 22 (pink) operates as an input port to receive the

signals, and a plurality of tap ports (**brown**) of the splitter 22 operate as output ports to send the signals to “more than one client.” Ex. 1006, ¶¶ 14, 18, 19. When the signals flow upstream from home 12 to the main trunk 14, these tap ports (**brown**) operate as input ports to receive signals from the clients, and the common port (**red**) operates as an output port to send the signals to the main trunk 14. Ex. 1006, ¶¶ 14, 18, 19.

84. Afshary explains that the cable LAN shares the same coaxial cable with conventional cable services such as conventional TV and/or Internet services. Ex. 1006, Abstract, ¶¶ 4, 5, 7, 24-28. So as to not interfere with those conventional services, the cable LAN uses an operating frequency that is “not used by [those] conventional cable services.” Ex. 1006, ¶ 25. For example, as shown in Afshary Figure 3 (annotated below), the conventional cable services are provided over an operating frequency range of 0-950 MHz (**green**), and the coaxial cable LAN is provided over a non-overlapping operating frequency range of 1000-2000 MHz (**red**), with a center frequency of 1300 MHz (**orange**). Ex. 1006, ¶¶ 24, 25.

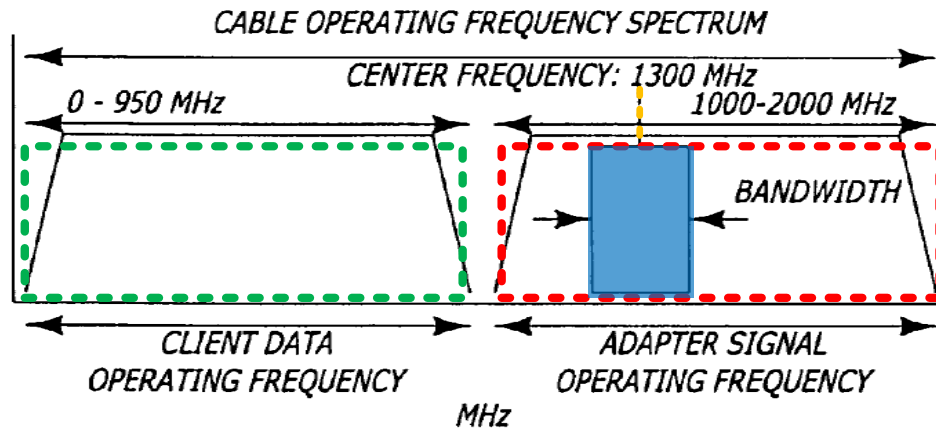
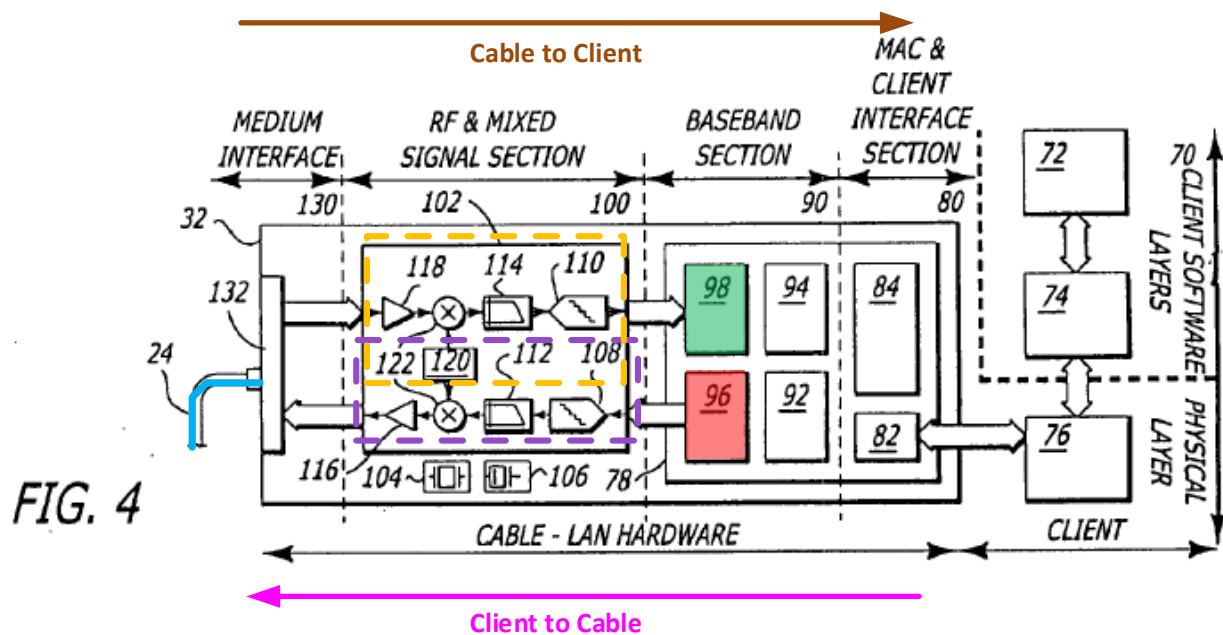


FIG. 3

Ex. 1006, Fig. 3 (annotated)

85. Figure 4 (annotated below) of Afshary illustrates the architecture of a cable LAN adapter 32. Ex. 1006, ¶ 29. Afshary explains that when the cable LAN adapter 32 processes data flowing (pink arrow) from a client device to the coaxial cable wire 24 (blue), digital data originating from a cable LAN client is received by the cable LAN adapter via the Media Access Control (MAC) & Client Interface section 80 and is then passed to the Baseband section 90. Ex. 1006, ¶¶ 30-32, 35. In the Baseband section 90, the received data is encoded by the Forward Error Correction (FEC) encoder 92 and then modulated by the modulator 96 (red). Ex. 1006, ¶¶ 36, 37. The modulator 96 (red) modulates the encoded data using a digital modulation scheme, such as Quadrature Phase Shift Keying (QPSK). Ex. 1006, ¶ 37. The QPSK modulated data is further processed by the RF & Mixed Signal section 100.

86. Afshary explains that 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). Ex. 1006, ¶¶ 38, 39. These components (dashed purple) in the RF & Mixed Signal section 100 operate to up-convert the modulated data from the Baseband section 90 to a 1300 MHz radio frequency signal for transmission through the coaxial cable network. *Id.*



Ex. 1006, Fig. 4 (annotated)

87. Afshary also explains how the cable LAN adapter, as depicted in Figure 4 above, processes data flowing (brown arrow) from the coaxial cable wire 24 to the client device. Ex. 1006, ¶¶ 41-42. Specifically, Afshary explains that after receiving the RF signal from the coaxial cable wire 24 (blue), the RF & Mixed

section comprising low noise amplifier (LNA) 118, LO 120, mixer 122, down converter 114, and analog to digital converter (ADC) 110 (dashed orange) down convert the received RF signal to a baseband signal. *Id.* The baseband signal is further demodulated at the demodulator 98 (green), and then decoded and corrected at FEC decoder 94 before being sent to the cable LAN device. Ex. 1006, ¶ 42.

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

88. I understand that Mirfakhraei (Ex. 1007) is a European patent application published on March 28, 2001. Ex. 1007, cover. I understand that Mirfakhraei is prior art under pre-AIA 35 U.S.C. § 102(a). I understand that Mirfakhraei was not before the Patent Office during prosecution of the ’518 patent. Ex. 1001, cover. Mirfakhraei is in the field of network communication and therefore in my opinion analogous to the ’518 patent. Ex. 1007, ¶ 1.

89. 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.

90. Mirfakhraei explains that DMT is a multi-carrier modulation technique that “simultaneously uses multiple carrier frequencies [for data transmission] where each carrier frequency corresponds to a subchannel.” 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.

91. Mirfakhraei’s modems also 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-channel having a higher SNR, which indicates a sub-channel being more reliable. Ex. 1007, ¶¶ 4, 17-18, 23-24. In contrast, fewer bits are assigned to a sub-channel having lower SNR, indicating the sub-channel being less reliable. 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-channel 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 on a corresponding sub-channel, 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-channel, resulting in lower bit-loading. Ex. 1007, ¶¶ 4, 17-18, 23-24.

92. 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. 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.

93. 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.

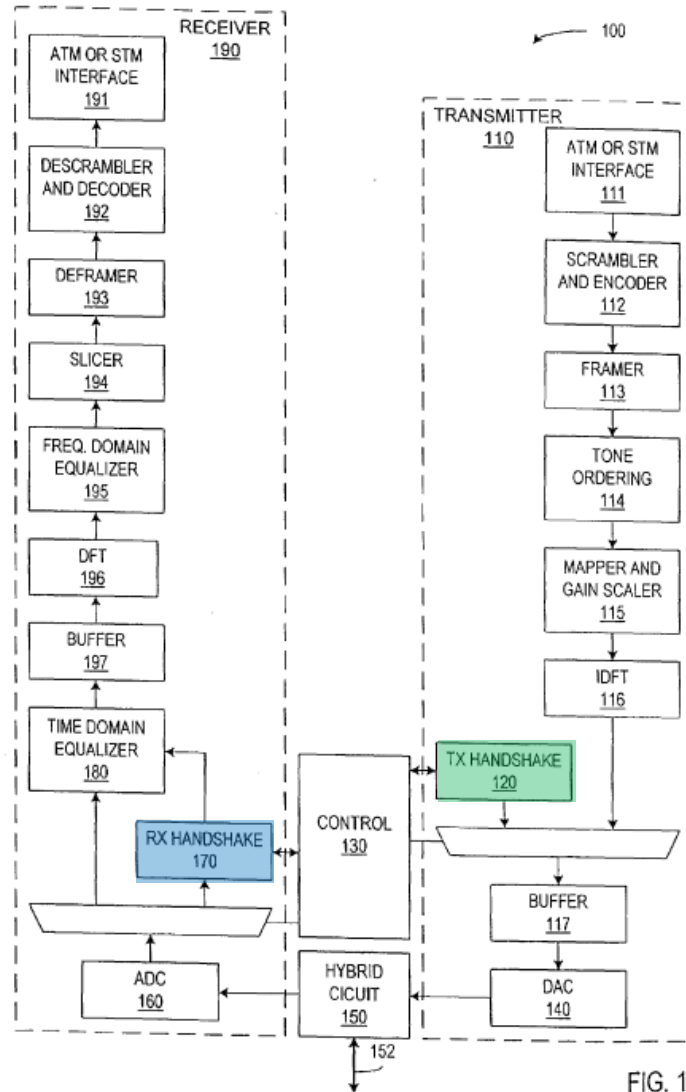


FIG. 1

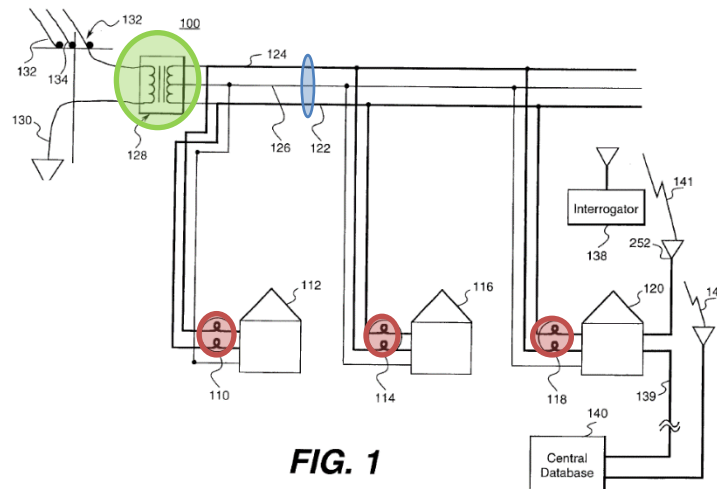
Ex. 1007, Fig. 1 (annotated)

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

94. I understand that Welles (Ex. 1022) is a U.S. Patent filed on March 10, 2000, and issued on May 18, 2004. Ex. 1022, cover. I understand that Welles is a continuation-in-part of U.S. Application No. 09/132,080, filed on August 10, 1998, and claims priority to U.S. Provisional Application No. 60/055,904, filed on August 15, 1997. Ex. 1022, cover. I understand that Wells is prior art at least under pre-AIA 35 U.S.C. § 102(e). I understand that Welles was not before the Patent Office during prosecution of the ’518 patent. Ex. 1001, cover. Welles is in the field of local area network (LAN) communication and therefore in my opinion analogous to the ’518 patent. Ex. 1022, 1:14-17.

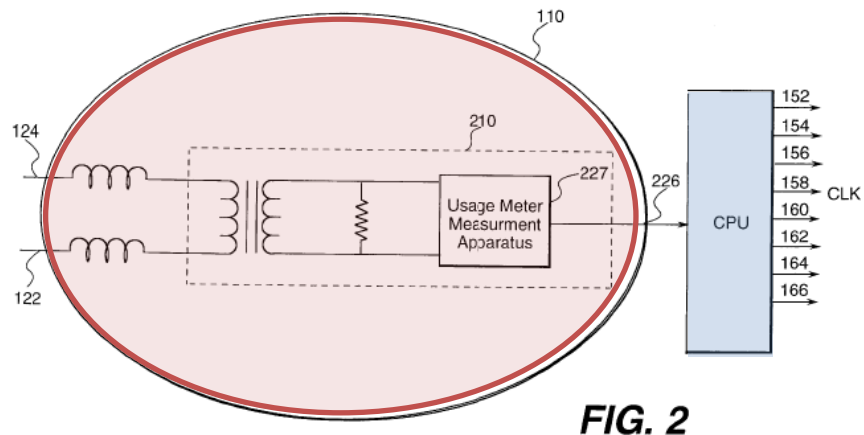
95. Welles relates to “a power line communication system utilizing a local area network [(LAN)]” that “enables utility meters to communicate with one another over power lines.” Ex. 1022, 1:15-17, 1:56-59. Welles explains the need to select desirable frequencies for data transmission to avoid noise and other interference on the power line. Ex. 1022, 2:4-9, 5:23-35. To achieve this goal, Welles explains that a transceiver coupled to each utility meter includes envelope detectors to determine “whether the power line is in use by another transceiver in the local area network,” so that the transceiver can select a clear frequency band not used by other devices for data transmission. Ex. 1022, 5:27-31; *see also* Ex. 1022, 1:15-17, 2:4-9, 5:5-16, 7:1-11.

96. Welles's Figure 1 (below) illustrates "a utility meter communication system 100." Ex. 1022, 2:55-61. Welles explains that the system includes "a plurality of utility customers, e.g., 112, 116 and 120, each having corresponding utility meters [(e.g., 110, 114, and 118) (**brown**)] on the secondary side of a distribution transformer 128 [(**green**)] have the ability to communicate with one another via a power line communication system within a 'local area network'" formed by power lines (e.g., 122, 124, and 126) (**blue**). Ex. 1022, 2:56-60.



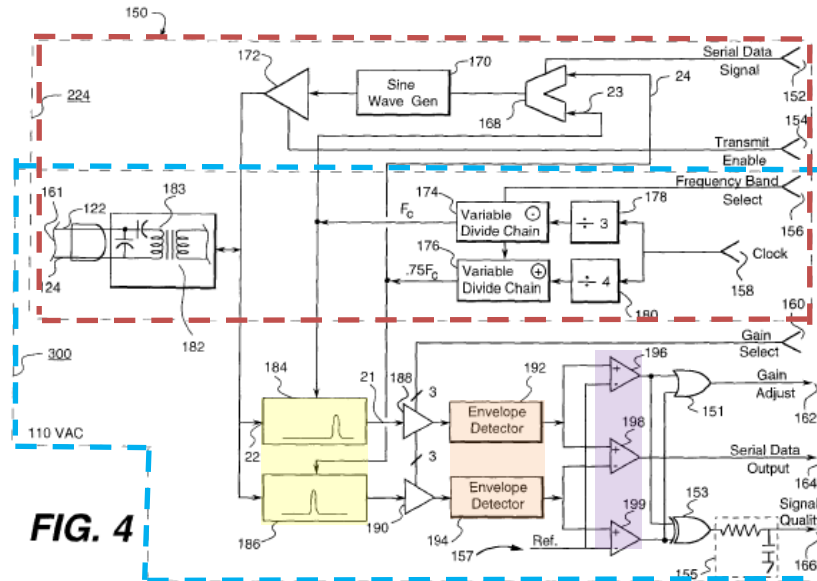
Ex. 1022, Fig. 1 (annotated)

97. Figure 2 of Welles shows a utility meter 110 (**brown**) illustrated in Welles's Figure 1. Ex. 1022, 2:21-24, Figs. 1-2. Welles explains that a CPU 900 (**blue**) is configured to receive data from the utility meter 110. Ex. 1022, 3:51-59.



Ex. 1022, Fig. 2 (annotated)

98. Figure 4 of Welles shows an architecture of a power line transceiver 150, which is configured to couple with a utility meter (e.g., utility meter 110 shown in Figure 2) to transmit/receive data from/to the utility meter via the power line LAN. Ex. 1022, 3:30-50, 4:6-15. The transceiver 150 comprises a transmitter 224 (**dashed brown**) and a receiver 300 (**dashed blue**). Ex. 1022, 4:6-15. The power line transceiver 150 “is configured to operate in one of two alternative modes, transmit mode and receive mode.” Ex. 1022, 4:7-11. Welles further explains that the transceivers 150 in the LAN utilize frequency shift keying (FSK) modulation. Ex. 1022, 4:6-54. FSK modulation uses two frequencies to represent binary data (e.g., a center frequency representing “1”, and another non-center frequency representing “0”). Ex. 1022, 4:16-54.



Ex. 1022, Fig. 4 (annotated)

99. Welles explains that in transmit mode, in order to select a clear frequency band not in use by another device to transmit data, the receiver 300 “scan[s] power line ... over a [frequency band] to gather information. . . about noise levels on the power line and whether the power line is in use by another transceiver in local area network 100 for radio frequency transmission.” Ex. 1022, 5:23-32.

100. Welles also explains that, in the receive mode, the receiver 300 detects the presence of data from other power line transmitters 224 in the LAN and demodulates the detected data. Ex. 1022, 5:36-45. Specifically, Welles describes that a selected frequency range is scanned and envelope detectors of the receiver 300 are used to detect the presence of a valid signal. Ex. 1022, 5:36-39, 5:65-6:7, 6:18-51. Welles teaches that when the receiver 300 is used in the transmit mode to scan the power lines to find a clear frequency band not in use, as described above, the

envelope detectors operate in the same way as in the receiving mode to detect the presence of a signal on the power line. Ex. 1022, 5:21-35, 6:18-29.

101. Welles explains that, in the receiving mode, received signals are provided to band pass filters (e.g., 184, and 186) (yellow) respectively. Center frequency band pass filter 184 allows signals with a center frequency (f_c) (representing logical “1”) to pass through, while non-center frequency band pass filter 186 allows signals with a non-center frequency ($0.75 f_c$) (representing logical “0”) to pass through. Ex. 1022, 4:47-54, 5:46-48, 6:8-10, Fig. 4. Welles explains that the filtered signals from each band pass filters 184 and 186 are provided to envelope detectors 192 and 194 (orange) respectively to determine whether a valid signal is presented. Ex. 1022, 6:14-30, Fig. 4. Welles explains that, based on the received filtered signal, each envelope detector (e.g., 192 or 194) generates an “envelope detector signal,” which is then compared to a signal power reference 157. *Id.* Welles teaches that the “envelope detector signal” output by an envelope detector represents the received power of the signal passing through the corresponding filter. *Id.* As an example, when the envelope detector signal from the envelope detector 192 is greater than a signal power threshold level indicated by the signal power reference 157 and the envelope detector signal from the envelope detector 192 is lower than the signal power threshold level, a valid signal (logical one) is detected. Ex. 1022, 6:18-51. Alternatively, when the envelope detector signal from the

envelope detector 192 is lower than the signal power threshold level and the envelope detector signal from the envelope detector 194 is greater than the signal power threshold level, a valid signal (logical zero) is detected. Ex. 1022, 6:18-51. Otherwise, the receiver 300 determines that no valid signal is detected. Ex. 1022, 6:39-51. Welles therefore teaches that each envelope detector (e.g., either the envelope detector 192 or the envelope detector 194) measures a received power of a signal of a particular frequency, which is then compared to a reference power level (e.g., indicated by reference signal 157) to determine if the particular frequency is being used to transmit data.

102. Welles explains that the power line receiver 300 can “scan [a wide range of] frequency spectrum ... by sequentially stepping through pairs of pass frequencies” of band pass filters 184 and 186. Ex. 1022, 7:3-8. Welles explains that scanning a wide range of frequency spectrum is used in “transmit mode ... to find a clear frequency pair,” which is not in use by another device, to transmit data. Ex. 1022, 7:6-8. Welles teaches that, when scanning for a clear frequency band in the transmit mode, the envelope detectors 192 and 194 operate in the same way as when detecting a valid signal in the receiving mode. Accordingly, a clear frequency band is found if the output of “envelope detector 192” and “envelope detector 194” indicate no valid signal is detected within this frequency band. Ex. 1022, 6:8-7:11. Accordingly, Welles teaches that each envelope detector (e.g., either the envelope

detector 192 or the envelope detector 194) measures a received power of a signal of a particular frequency, which is then compared to a reference power level (e.g., indicated by reference signal 157) to determine if any signal was detected. Welles explains that the transmitter 224 can use a detected clear frequency to transmit data via the LAN. Ex. 1022, 7:1-11.

IX. THE RELEVANT ART AND LEVEL OF ORDINARY SKILL IN THE RELEVANT ART

103. I understand that the following four factors may be considered when identifying the appropriate level of a POSITA: (i) the types of problems encountered by those working in the field and prior art solutions thereto; (ii) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (iii) the educational level of active workers in the field; and (iv) the educational level of the inventor. I understand that a POSITA is one who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

104. In my opinion, 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. In this Declaration, wherever I refer to a POSITA, it

should be understood that I'm referring to a hypothetical person at the time of the alleged invention of the '518 patent meeting the description I have provided. I understand that the time of the alleged invention is March 12, 2002, the filing date of Provisional Application no. 60/363,420. Ex. 1001, cover. My opinions herein would not change if the time of the alleged invention is August 30, 2001, the filing date of Provisional Application no. 60/316,820. Ex. 1001, cover. I offer no opinions on the priority date (i.e., time of the alleged invention) of the '518 patent.

X. CLAIM CONSTRUCTION

105. I understand that my analyses require a proper understanding of the claims of the '518 patent. I understand that absent some other definition provided in the patent, the claim terms are to be given their plain and ordinary meaning to a POSITA, in light of the patent specification and prosecution history. Therefore, in my analysis below, and except as otherwise noted, I have assumed that all claim terms are to be given their plain and ordinary meaning as would have been understood by a POSITA reading the patent specification at the time of its effective filing date (i.e., March 12, 2002 – *see supra* Section IX).

106. I understand that U.S. patent law allows for claiming with means-plus-function limitations. In particular, I understand that a “means-plus-function” limitation should be interpreted to cover the corresponding structure described in the specification for performing the recited function, and equivalents thereof. I also

understand that a limitation will be presumed to be a means-plus-function limitation if (a) the claim limitation uses the phrase “means for”; (b) the “means for” is modified by functional language; and (c) the phrase “means for” is not modified by sufficient structure for achieving the specified function.

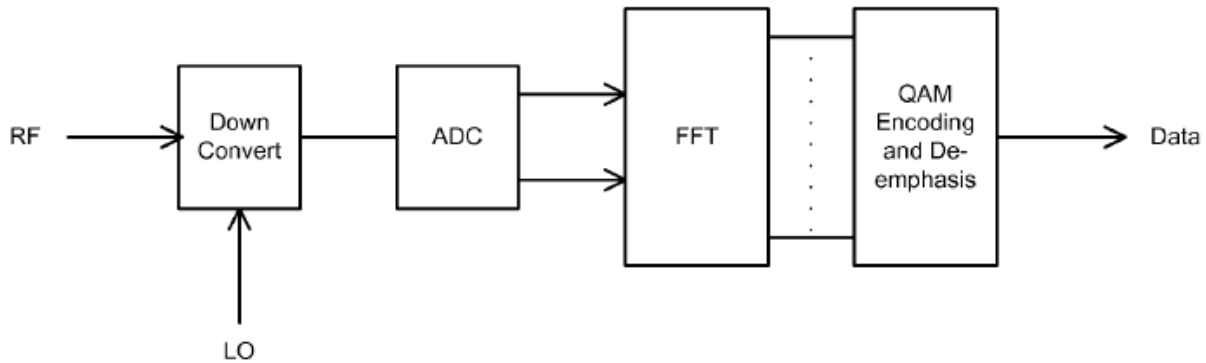
107. I have been informed that the following three terms use the words “means for” followed by a statement of function, and thus presumptively constitute means-plus-function limitations. I understand that construing these terms requires first identifying the claimed function, then identifying the corresponding structure described in the specification. Specifically, I understand that the means-plus-function terms are to be construed “to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.”

A. “means for determining signal activity”

108. This term appears in dependent claim 2. Ex. 1001, claim 2. I understand that the function of this term is “determining signal activity.”

109. I also understand that the ’518 patent describes at least four different approaches for determining signal activity. Ex. 1001, 11:7-43. I understand one approach is to perform an 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. I understand the ’518 patent describes Figure 6 (below) as a receiver signal path used for data communication. Ex. 1001, 8:51-9:27, Fig. 6. As shown, the receiver signal

path performs an FFT on data samples from an ADC. *Id.* Accordingly, I understand that one corresponding structure for “determining signal activity” is a receiver that performs an FFT on data samples from an A/D converter.



Ex. 1001, Fig. 6

110. I understand that another approach described by the '518 patent for determining signal activity is to measure received signal power with an envelope detector. Ex. 1001, 11:24-30. Accordingly, I understand that another corresponding structure for “determining signal activity” is an envelope detector.

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

111. This term appears in independent claim 4. Ex. 1001, claim 4. I understand that the function of this term is “producing and transmitting a probe message.”

112. I understand that the '518 patent explains that a probe message is a “signal known by the receiving device” that is used “to estimate the channel characteristics” such as SNR. Ex. 1001, 4:48-62; 7:22-42, 8:9-35, 9:34-10:20. I

understand that 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. Accordingly, I understand that one corresponding structure for “producing and transmitting a probe message” is a processor. Further, I understand that 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.

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

113. This term appears in independent claim 4. Ex. 1001, claim 4. 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. I understand that 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, 9:17-19, 9:34-10:20, 10:61-11:6, Fig. 10. I also understand that 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. I understand that the function for this term is "receiving and analyzing a probe message to determine a bit loading profile used to transmit data."

114. As discussed above, I understand that, based on the specification of the '518 patent above, one corresponding structure for this function is a processor. Further, I understand that 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.

XI. ANALYSIS

115. For the reasons that I discuss in detail below, it is my opinion that each of claims 1-4 of the '518 patent would have been obvious to a POSITA. In short, it is my opinion that:

- Claims 1-4 would have been obvious based on Afshary in view of Mirfakhraei;
- Claim 2 would have been obvious based on Afshary-Mirfakhraei in view of Welles.

116. I understand that Petitioner has assigned labels (e.g., [1pre], [1A], [1B], etc.) to different limitations of the claims to facilitate analysis of the claims. Accordingly, in my analysis below, I have referred to the claim limitations using those same labels, which are shown in the Claim Listing Appendix attached to this declaration as Appendix B.

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

117. As set forth below, it is my opinion that Afshary in view of Mirfakhraei renders obvious claims 1-4.

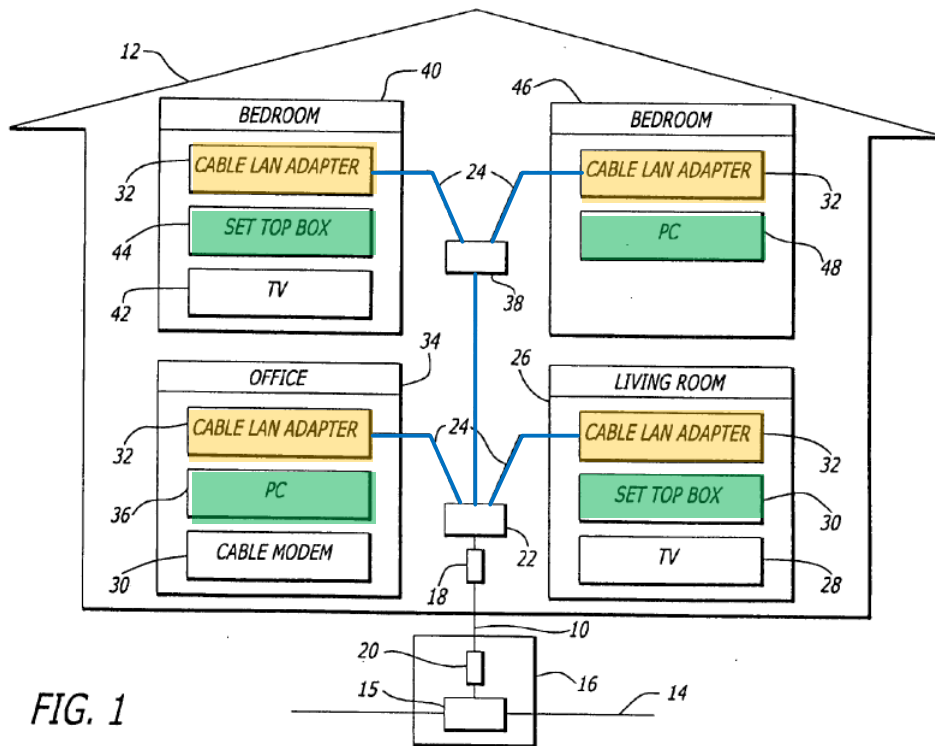
1. Independent Claim 1

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

118. I understand that [1pre] is the preamble of independent claim 1. I understand that preambles are not necessarily limiting. Regardless, it is my opinion that Afshary teaches [1pre].

119. As I discussed above in Section VIII.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 also id.*, Abstract, ¶¶ 2, 12, 14, 19-23, 41, Figs. 1-2. Figure 1 (annotated below) shows the “in-home coaxial cable LAN” disclosed by Afshary. Ex. 1006, ¶

14. 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. Afshary explains that when two LAN clients communicate with each other, the transmitting client sends data to its corresponding cable LAN adapter 32 (**orange**) for processing. *Id.* The processed data is then transmitted through the coaxial cable wire 24 (**blue**) to a second LAN adapter 32 (also **orange**) coupled to a second client. *Id.* The second LAN adapter 32 “further processes the transmitted data into a form usable by [the] second client.” Ex. 1006, ¶ 33; *see also* Ex. 1006, ¶¶ 18-19, 21, 41, Figs. 1-2.



Ex. 1006, Fig. 1 (annotated)

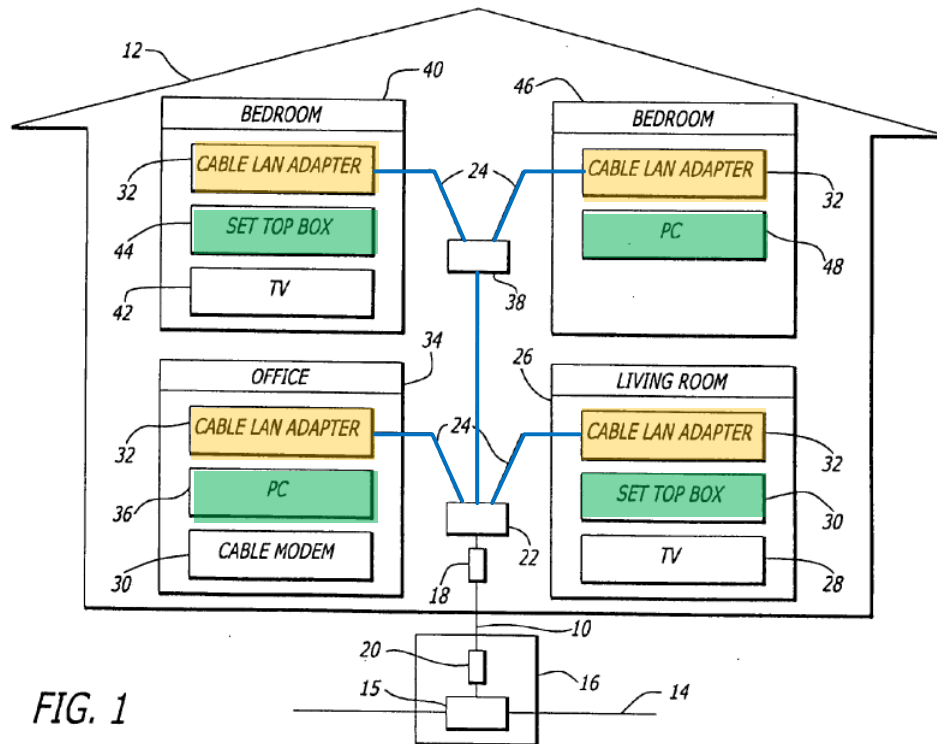
120. Therefore, it is my opinion that Afshary teaches [1pre].

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”

121. It is my opinion that Afshary in view of Mirfakhraei teaches [1A].

Referring to Afshary’s Figure 1 (annotated below), Afshary discloses that multiple cable LAN adapters 32 (orange) (claimed “at least two network devices”) are connected to each other by the coaxial cable LAN. Ex. 1006, ¶¶ 18-19, 21-23, 41,

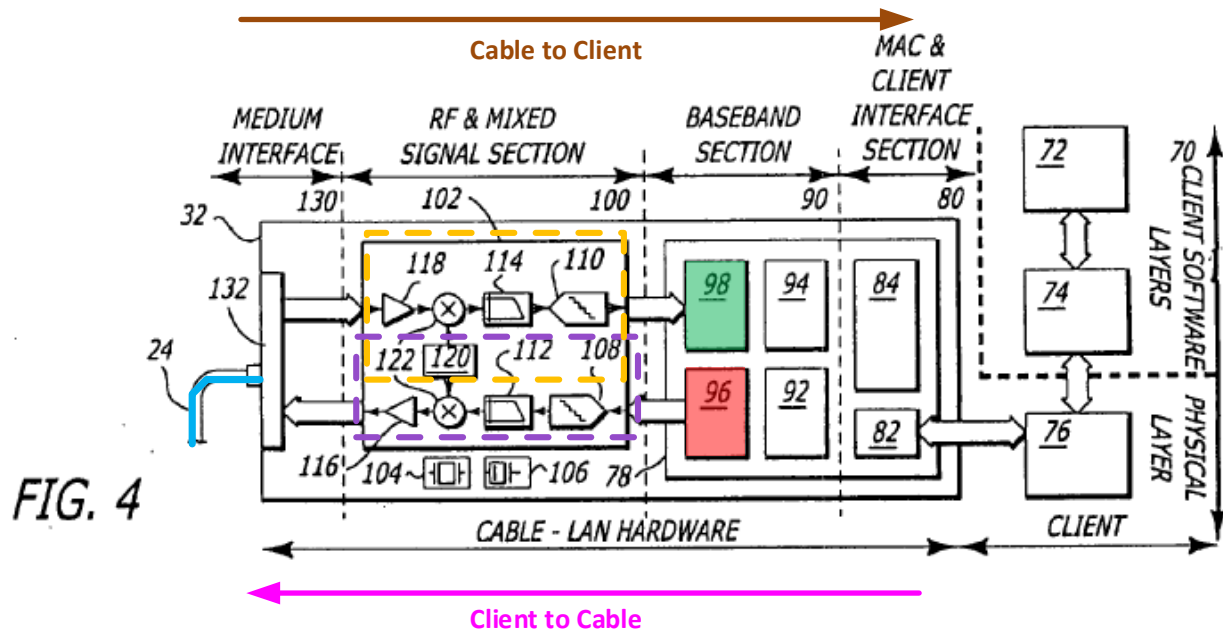
Figs. 1-2. As I explained above for the preamble [1pre] (Section XI.A.1.a), Afshary teaches that the cable LAN adapters 32 enable client devices – such as PCs 36 and 48 (**green**) – to communicate with each other via coaxial cable 24 (**blue**). *Id.*.



Ex. 1006, Fig. 1 (annotated)

122. Figure 4 (annotated below) of Afshary shows the architecture of a cable LAN adapter 32. Ex. 1006, ¶ 29. Afshary explains that when the cable LAN adapter 32 processes data flowing from a client device to the coaxial cable 24 (**pink arrow**), digital data from the client is received via the Media Access Control (MAC) & Client Interface section 80 and passed to the Baseband section 90. Ex. 1006, ¶¶ 30-32, 35. In the Baseband section 90, the received 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. 1006, Fig. 4 (annotated)

123. The modulated data from modulator 96 (**red**) is provided to the Radio Frequency (RF) & Mixed Signal section 100, where the modulated data is translated to an RF signal for transmission through the cable wire 24 (**blue**). Ex. 1006, ¶¶ 38-39. Afshary explains that 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). *Id.* Afshary teaches that these components (**dashed purple**)

in the RF & Mixed Signal section 100 operate to up convert 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, ¶¶ 23, 26, 38-39, 41. Specifically, Afshary explains that the modulated data is first converted, by the DAC 108, to an analog signal having an intermediate frequency (IF) of around 44 MHz. Ex. 1006, ¶¶ 38-39. The IF signal is up-converted to an RF signal using an RF carrier frequency of 1300 MHz and the resulting RF signal is then transmitted to another cable LAN adapter 32 to facilitate communication between client devices. *Id.* Afshary also explains that the RF carrier frequency is not limited to 1300 MHz and that “the signal operating frequency could be anywhere above 1000 MHz” to avoid interference with the existing cable services. Ex. 1006, ¶ 28, *see also* Ex. 1006, ¶¶ 2, 27, 38-39, Fig. 3.

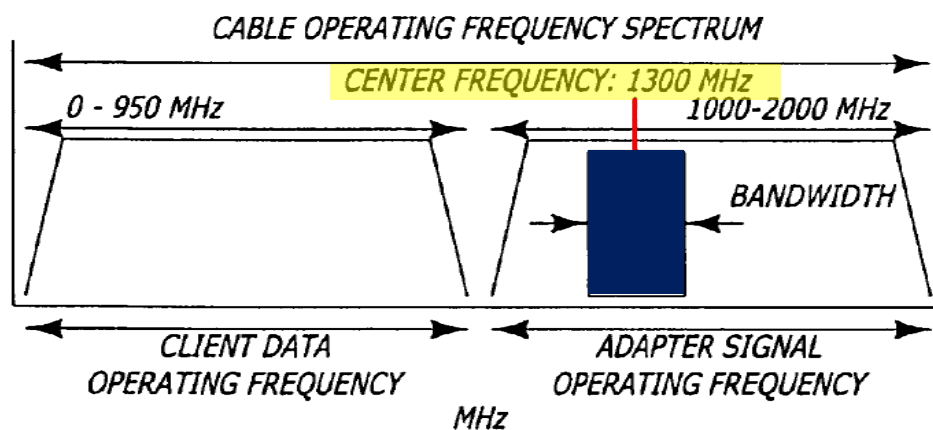


FIG. 3

Ex. 1006, Fig. 3 (annotated)

124. I note that Afshary indicates component 112 as an up converter that up converts the modulated data to an RF signal. Ex. 1006, ¶¶ 38-39. I further note that Afshary's Figure 4 depicts component 112 as a filter, which is a common component used in the RF transmitter section of a communication device. It is my opinion that a POSITA would understand that component 112 along with the other components described above in the RF & Mixed Signal section 100 collectively operate to up-convert modulated data to an RF frequency, with component 112 being a contributing component to the up-conversion process. Ex. 1006, ¶¶ 38-39, Fig. 4.

125. Referring back to Figure 4 (annotated above), Afshary explains that RF modulated data transmitted by a first cable LAN adapter 32 is received over coaxial cable 24 (blue) by a second cable LAN adapter 32. Ex. 1006, ¶¶ 38-39, 41. The cable LAN adapter 32 processes the received RF signal to recover digital data that is then provided to Media Access Control (MAC) & Client Interface section 80 (brown arrow). *Id.* For processing the received RF signal, 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"). *Id.* Afshary explains that these components operate to translate (or down-convert) the received RF signal to a baseband signal. *Id.* Afshary teaches that the down-converted signal from the RF & Mixed Signal section 100 is demodulated by demodulator 98 (green). Ex. 1006, ¶¶

41-42. The demodulated data from demodulator 98 (**green**) is decoded and corrected by FEC decoder 94 to recover digital data that is then provided to the MAC & Client Interface section 80. *Id.*

126. Similar to component 112, I note that Afshary indicates component 114 as a down converter. Ex. 1006, ¶¶ 38-39, 41. I further note that Afshary's Figure 4 depicts component 114 as a filter, which is a common component used in the RF receiver section of a communication device. It is my opinion that a POSITA would understand that component 114 along with the other components described above in the RF & Mixed Signal section 100 collectively operate to down-convert an RF signal, with component 114 being a contributing component to the down-conversion process. Ex. 1006, ¶¶ 38-39, 41, Fig. 4.

127. 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. Indeed, the art is replete with the use of the multiple carrier modulation techniques and their benefits over single carrier modulation. *See, e.g.,* Ex. 1008, ¶¶ 3-5 (describing certain telecommunication standards for discrete multi-tone (DMT) modulation employing “multiple carriers for both upstream and downstream communications” such that

“the available channel capacity can be maximized thereby optimizing performance of the transmission bandwidth”); Ex. 1009, page 5 (explaining that signals using multicarrier modulation (MCM) “produce[] a much greater immunity to impulse noise and fast fades” compared to single-carrier signals); Ex. 1010, pages 374-376 (discussing various advantages of DMT over single-carrier techniques for optimizing the transmission bandwidth on communication channels with significant impairments such as cable networks, including a higher data rate and a greater immunity to noises); Ex. 1011, pages 392-395 (explaining that OFDM and DMT multicarrier techniques provide better resistance to interference and multipath distortion compared with signal-carrier modulation); Ex. 1018, pages 305-307, 312 (explaining that multicarrier techniques such as DMT are more adaptable and more reliable than single-carrier techniques and so better suited for use in harsh cable environments).

128. Mirfakhraei describes modem transceivers that communicate using discrete multi-tone (DMT) modulation, a multi-carrier communication protocol using multiple carriers to transmit and receive modulated data. Ex. 1007, Abstract, ¶¶ 1-3, 5-8, 14-25, Figs. 1-2. Mirfakhraei explains that, compared with single carrier modulation protocols, the DMT protocol, like OFDM, provides various advantages including increased data rate and more reliable communications. Ex. 1007, Abstract, ¶¶ 1-8, 14-25, Figs. 1-2; Ex. 1008, ¶ 5; Ex. 1009, page 5; Ex. 1010, page 374-376;

Ex. 1011, page 392-294; Ex. 1012, Abstract, 1:10-59, Figs. 1-2; Ex. 1013, Abstract, 2:30-5:39, Figs. 1-2; Ex. 1014, page 142; 1015, pages 5-8, Figs. 4, 9. Mirfakhraei provides an overview of DMT and explains the relationship between multiple carriers and subchannels as follows:

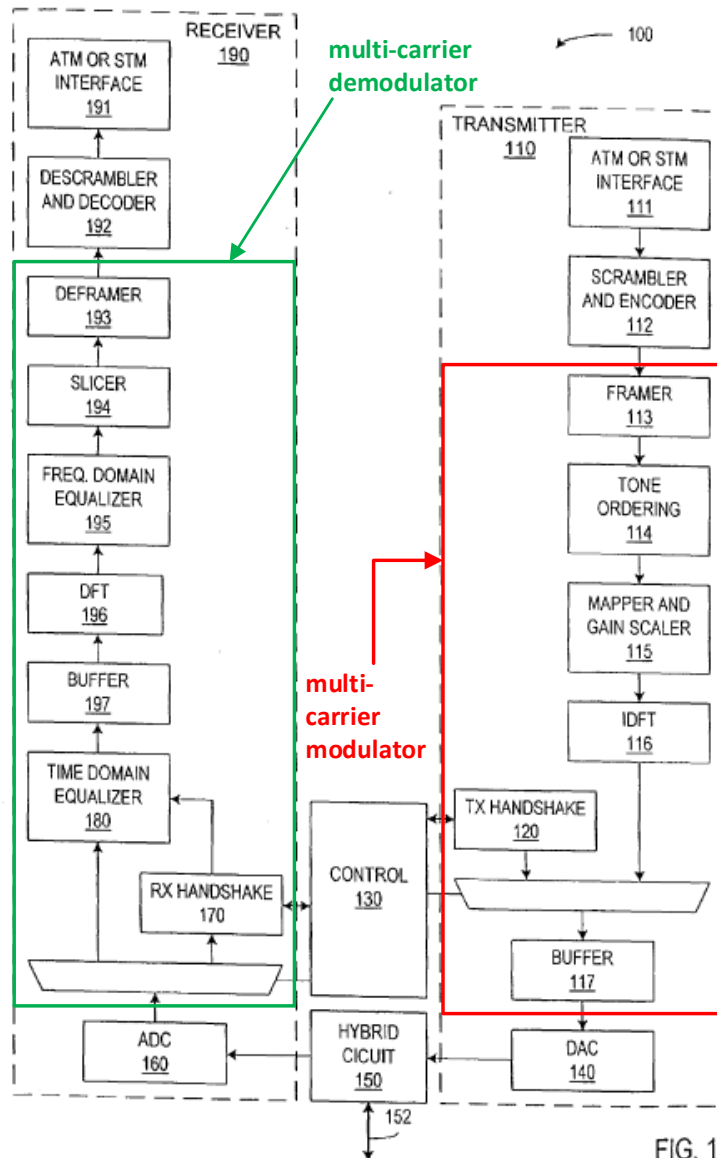
A DMT protocol simultaneously uses multiple carrier frequencies where each carrier frequency corresponds to a subchannel. Each signal for a sub-channel has relatively narrow bandwidths (e.g., 4 kHz) to reduce distortion within the sub-channel signal. For data transmission, a sending modem breaks transmitted 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.

129. Further, Mirfakhraei explains that “a ‘bit-loading’ process is employed by its modem transceivers in their implementation of DMT to further improve data rate and robustness of communications. Ex. 1007, ¶¶ 2, 5. Mirfakhraei explains that the bit loading process “characterizes the capabilities of sub-channels and determines the number of bits-per-symbol transmitted over the channel.” Ex. 1007, ¶ 14. In contrast to having each subcarrier (or subchannel) transmit the same number of bits, Mirfakhraei’s bit loading process enables each subcarrier to transmit different numbers of bits based on the signal to noise ratio (SNR) determined for each subcarrier. Ex. 1007, ¶¶ 17-18, 22-25. Using bit loading, a greater number of

bits are transmitted by a subcarrier with a higher SNR, while a lower number of bits are transmitted by a subcarrier with a lower SNR. Ex. 1007, Ex. 1007, ¶¶ 17-18, 22-26. Mirfakhraei implements its bit-loading scheme by assigning a larger symbol set (or constellation map) to a subcarrier with a higher SNR, and assigning a smaller symbol set (or constellation map) to a subcarrier with a lower SNR. Ex. 1007, ¶¶ 4, 6, 17-19. 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. Ex. 1007, ¶¶ 4, 6, 17-19.

130. As shown in Figure 1 of Mirfakhraei (annotated below), a modem transceiver 100, which communicates using Mirfakhraei's DMT and bit-loading scheme, includes a transmitter 110 and a receiver 190. Ex. 1007, ¶¶ 5-8, 14-15. Mirfakhraei teaches that the transmitter 110 includes a multi-carrier modulator (**red**) that includes framer 113, tone ordering block 114, constellation mapper 115, Inverse Discrete Fourier Transform (IDFT) block 116, buffer 117, and TX handshake 120 (collectively, claimed "multi-carrier modulator for modulating data"). Ex. 1007, ¶¶ 15-19.



Ex. 1007, Fig. 1 (annotated)

131. Mirfakhraei explains a series of operations conducted by its multi-carrier modulator (**red**) after an initial encoding of data by encoder 112. Ex. 1007, ¶¶ 17-18, 23-24. Specifically, Mirfakhraei explains that “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. The number of bits in each bit set is dictated by the bit loading for the corresponding sub-channel, which, in turn, is based on the SNR of the corresponding sub-channel. *Id.* A sub-channel with a higher SNR is assigned a bit set having a larger number of bits, while a sub-channel with a lower SNR is assigned a bit set having a smaller number of bits. Ex. 1007, ¶¶ 4, 17-18, 23-24. As I explain below, Mirfakhraei explains that different constellation sizes are used to map different numbers of bits into a QAM symbol. *Id.* Tone ordering block 114 “orders the bit sets by sub-channel for a constellation mapper 115.” Ex. 1007, ¶ 17.

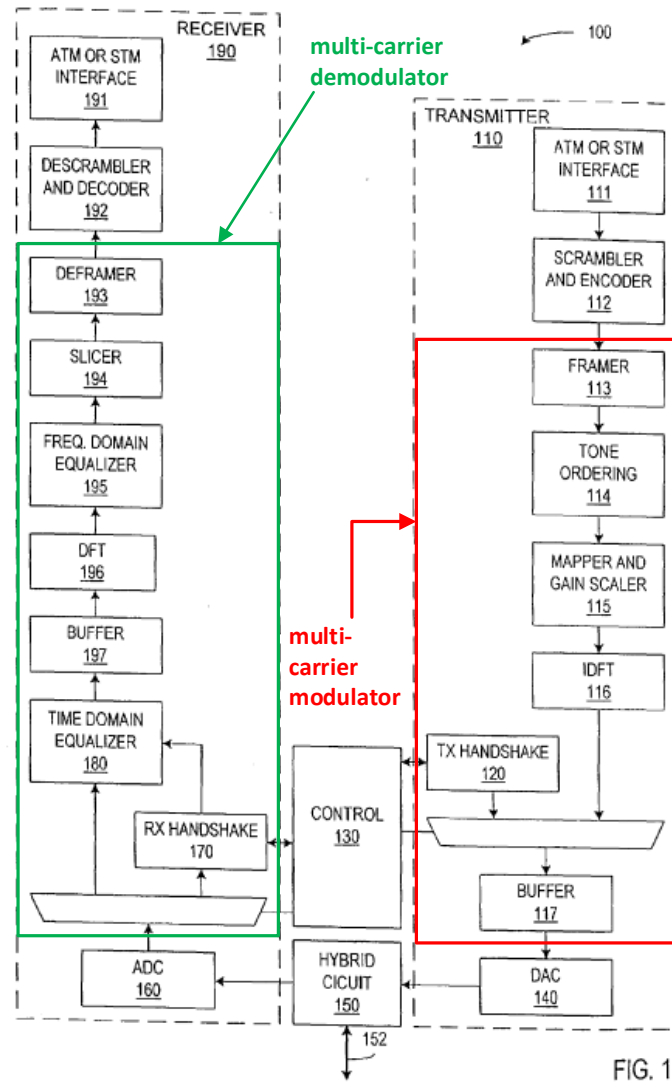
132. Next, “[f]or each bit set, constellation mapper 115 determines a QAM symbol associated with the bit set for the quadrature amplitude modulation (QAM) of the assigned sub-channel.” Ex. 1007, ¶ 18. The constellation mapper 115 uses different constellation schemes to determine QAM symbols that represent different numbers of bits. Ex. 1007, ¶¶ 4, 17-18, 23-24. A larger QAM constellation, which has a larger set of possible QAM symbols, maps more bits into a QAM symbol for transmission via a higher SNR sub-channel. *Id.* Conversely, a smaller QAM constellation, which has a smaller set of possible QAM symbols, maps fewer bits into a QAM symbol for transmission via a lower SNR sub-channel. *Id.* As an example (referring to Section V.A), 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. *Id.* 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. *Id.*

133. Mirfakhraei further 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. The time domain samples are buffered in the buffer 117 and sequentially provided to the digital to analog converter (DAC) 140, where the samples are converted to an analog signal for transmission. Ex. 1007, ¶ 19.

134. To determine the SNR and, consequently, the bit loading for each subchannel, TX handshake block 120 of the instant transceiver transmits a handshake signal to an RX handshake block 170 of another transceiver, for example, while a connection is being established or retained between the instant transceiver and the other transceiver. Ex. 1007, ¶¶ 14, 18, 20-21. Accordingly, Mirfakhraei teaches that the multi-carrier modulator (**red**) of the transmitter 110 operates to modulate data using Mirfakhraei’s 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.

135. Mirfakhraei further teaches that the receiver 190 includes a multi-carrier demodulator (green) that 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. 1007, Fig. 1 (annotated)

136. Mirfakhraei explains a series of operations conducted by its multi-carrier demodulator (**green**) after a received signal is digitalized by an analog-to-digital converter (ADC) 160. Ex. 1007, ¶¶ 21-24. Specifically, Mirfakhraei explains that the digitalized signal is forwarded to the RX handshake block 170 if it is a handshake signal, or to the TEQ 180 if it is a data signal. *Id.*

137. The data signal forwarded to the TEQ 180 is filtered by TEQ 180 and then stored in the buffer 197. *Id.* From the buffer 197, the DFT block 196 obtains the filtered time-domain samples and performs a discrete Fourier transform (DFT) on time-domain samples associated with each DMT symbol to “determine frequency components associated with the sub-channels” of the respective DMT symbol. Ex. 1007, ¶ 24. The frequency components of a DMT symbol are further filtered by the frequency domain equalizer 195 and then scaled by the slicer 194. *Id.* The slicer 194 “then identifies QAM symbols from the constellation maps corresponding to [bit] loadings [] of the sub-channels.” *Id.* The “deframer [193] converts the QAM symbols into a bit stream,” which is then decoded to provide the final recovered data. *Id.*

138. The handshake signal forwarded to the RX handshake block 170 is used by the RX handshake block 170 to estimate the SNR for each sub-channel, which is then used to determine the bit-loadings for each sub-channel, as I explain in greater detail below (see analysis for [1D] below, *see* Section XI.A.1.e). Ex. 1007, ¶¶ 14, 18, 20-23. Accordingly, Mirfakhraei teaches that the multi-carrier demodulator

(green) of the receiver 190 operates 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.

139. It is my opinion that a POSITA would have been motivated to modify Afshary's cable LAN adapter to implement the DMT bit-loading protocol of Mirfakhraei because doing so would increase the data transmission rate of Afshary's coaxial cable network, as taught by Mirfakhraei. Ex. 1007, ¶ 3. Further, it is my opinion that a POSITA would understand that implementing Mirfakhraei's DMT bit-loading protocol in Afshary's cable LAN adapter would result in more robust communications – for example, making the communications less susceptible to channel impairments present in coaxial cable networks as was well known. *See e.g.*, Ex. 1008, ¶¶ 3-5 (describing certain telecommunication standards for discrete multi-tone (DMT) modulation employing “multiple carriers for both upstream and downstream communications” such that “the available channel capacity can be maximized thereby optimizing performance of the transmission bandwidth”); Ex. 1009, page 5 (explaining that signals using multicarrier modulation (MCM) “produce[] a much greater immunity to impulse noise and fast fades” compared to single-carrier signals); Ex. 1010, pages 374-376 (discussing various advantages of DMT over single-carrier techniques for optimizing the transmission bandwidth on communication channels with significant impairments such as cable networks,

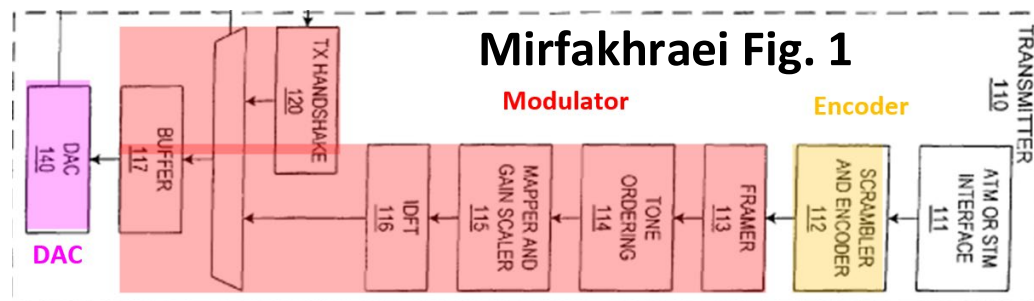
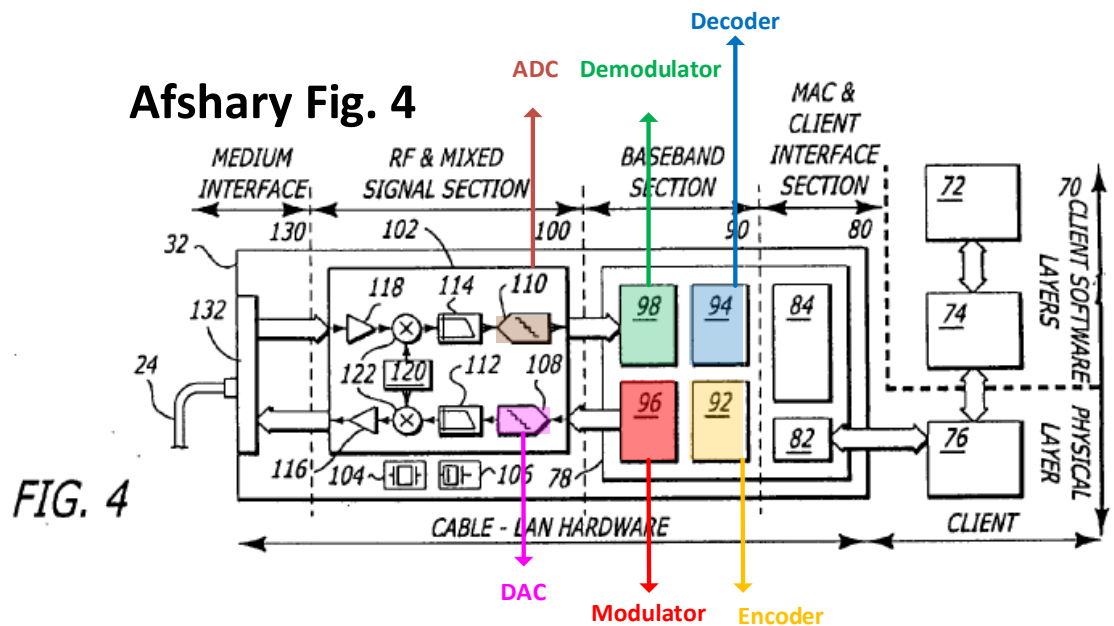
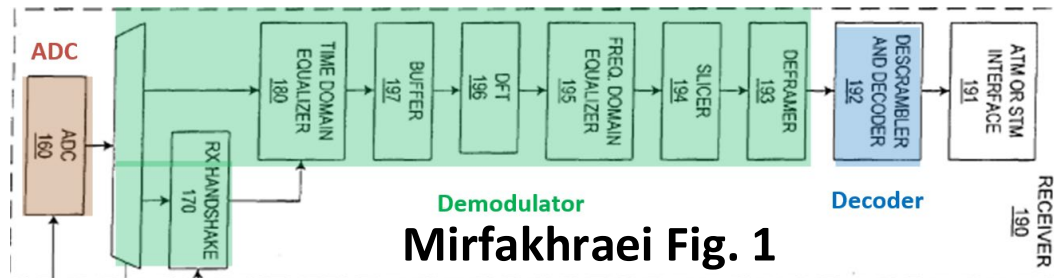
including a higher data rate and a greater immunity to noises); Ex. 1011, pages 392-395 (explaining that OFDM and DMT multicarrier techniques provide better resistance to interference and multipath distortion compared with signal-carrier modulation); Ex. 1018, pages 305-307, 312 (explaining that multicarrier techniques such as DMT are more adaptable and more reliable than single-carrier techniques and so better suited for use in harsh cable environments).

140. While Mirfakhraei describes its DMT bit-loading scheme in relation to communication over a conventional telephone line, it is my opinion that a POSITA would have understood that Mirfakhraei's DMT bit-loading scheme could be implemented over a variety of mediums, including coaxial cable. *See, e.g.*, Ex. 1010, page 374 (describing DMT for data communication over cable networks); Ex. 1013, Abstract, 2:30-5:39, Figs. 1-2 (describing DMT being used in wired environments); Ex. 1016, Abstract, 1:9-16, 3:34-59, 6:66-7:46, Fig. 1 (describing use of OFDM over coaxial cable); Ex. 1017, pages 74, 76 (describing use of OFDM for cable networks); Ex. 1018, pages 305-307, 312 (discussing high performance of "discrete multitone [DMT] modulation ... for [] transmission of digital data over CATV channels").

141. It is my opinion that 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. 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. 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. It is my opinion that a POSITA would have understood that modifying Afshary's cable LAN adapter 32 to implement the DMT bit-loading protocol of Mirfakhraei would, for example, 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. 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, pages 305-307, 312. 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.

142. Below, as a reference and visual aid, I have provided a figure comparing Afshary's cable LAN adapter 32 from Figure 4 of Afshary to Mirfakhraei's transceiver from Figure 1 of Mirfakhraei.

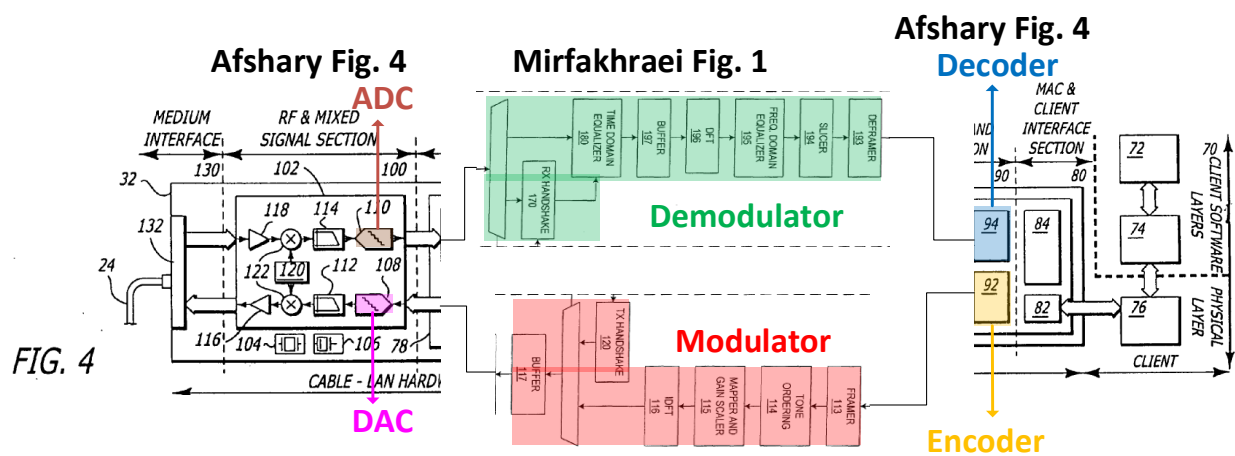


Ex. 1007, Fig. 1 (top, cropped); Ex. 1006, Fig. 4 (middle, cropped); Ex. 1007, Fig. 1 (bottom, cropped)

143. As shown in the annotated figures and as I explained above, Afshary's digital data is encoded by Forward Error Correction (FEC) encoder 92 (**orange**) and then modulated by modulator 96 (**red**) using a modulation scheme such as QPSK (a type of 4-QAM). Ex. 1006, ¶¶ 26, 35-41. Afshary's modulated symbols from modulator 96 are then provided to the DAC 108 (**pink**) for conversion to analog signals. Ex. 1006, ¶¶ 38-39. Similarly, Mirfakhraei's digital data is encoded by encoder 112 (also **orange**) to interleave the data and the error detection and correction codes, and then modulated by its multi-carrier modulator (also **red**) using QAM modulation. Ex. 1007, ¶¶ 17-19. Mirfakhraei's modulated symbols are then provided to the DAC 140 (also **pink**) for conversion to an analog signal. *Id.* When data flows from the reverse direction, a received signal is converted by Afshary's ADC 110 (**brown**) to a digital signal, which is further demodulated by Afshary's demodulator (**green**) and then decoded by Afshary's FEC decoder 94 (**blue**) to obtain the original data. Ex. 1006, ¶¶ 41-42. Similarly, a received signal is converted by Mirfakhraei's ADC 160 (also **brown**) into a digital signal, which is further demodulated by Mirfakhraei's demodulator (also **green**) and then decoded by Mirfakhraei's decoder 192 (also **blue**) to obtain the original data. Ex. 1007, ¶¶ 21-25. This figure, as I mentioned above, is a way to visualize how Afshary's cable LAN adapter would incorporate the functionality of Mirfakhraei's multi-carrier

modulator (also **red**) and the functionality of Mirfakhraei's multi-carrier demodulator (also **green**).

144. Below, as another reference and visual aid, I have provided a figure that indicates how Afshary's cable LAN adapter 32 would be modified to incorporate the functionality of Mirfakhraei's DMT bit-loading scheme:



Ex. 1006, Fig. 4 (annotated, cropped); Ex. 1007, Fig. 1 (annotated, cropped)

145. It is my opinion that 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). Moreover, in doing so, a POSITA in my opinion 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.

146. It is also my opinion that a POSITA would also have 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). 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. Mirfakhraei discloses a multi-carrier communication protocol that uses bit-loading to improve data throughput and communication robustness. A POSITA would have recognized, in my opinion, 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

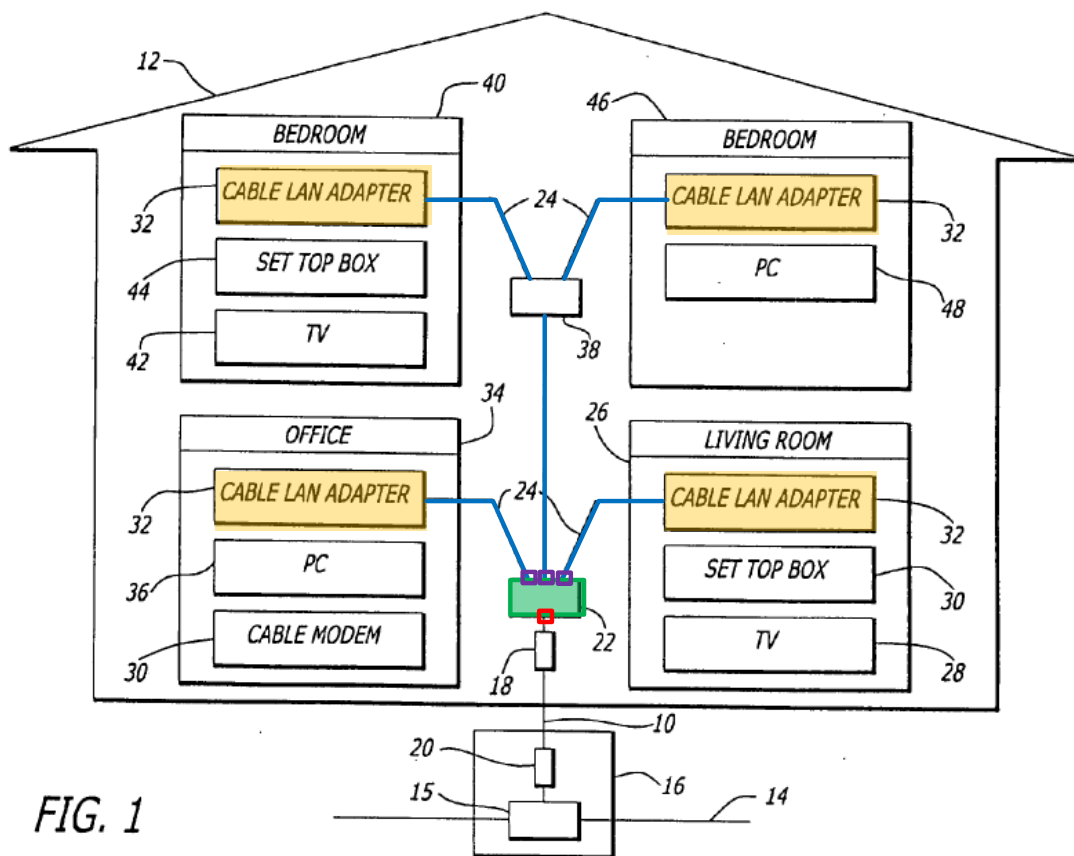
demodulator that implement Mirfakhraei's DMT bit-loading protocol (e.g., by incorporating the DMT bit-loading protocol of Mirfakhraei's transceiver into the ASIC 78) would provide the predictable result of Afshary's cable LAN adapter communicating using multi-carrier DMT modulation with bit-loading as taught by Mirfakhraei. Further, it is my opinion that a POSITA would have recognized that modifying Afshary's cable LAN adapter 32 in this manner would have resulted in increased data throughput, more reliable communications within the harsh coaxial cable environment, and improved spectral and power efficiencies.

147. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches [1A].

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;”

148. It is also my opinion that Afshary in view of Mirfakhraei teaches [1B]. As I discussed for [1A] (Section XI.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. Afshary explains that cable drop 10 is provided to splitter 22 within home 12. Ex. 1006, ¶¶ 16, 18-19. 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.

149. As I noted in Section VI (summary of the '518 patent), the '518 patent explains that “[s]ignal splitters ... have an input port and multiple output ports,” where “[t]he input port can also be considered a common port” and “[t]he output ports can also be considered tap ports.” Ex. 1001, 1:53-57. Accordingly, 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, Fig. 1; Ex. 1001, 1:53-57, Fig. 1. 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, Fig. 1; Ex. 1001, 1:53-57, Fig. 1.



Ex. 1006, Fig. 1 (annotated)

150. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches [1B].

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

151. It is my opinion that Afshary in view of Mirfakhraei teaches [1C]. As I discussed for [1pre]-[1B] (Sections XI.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. Further,

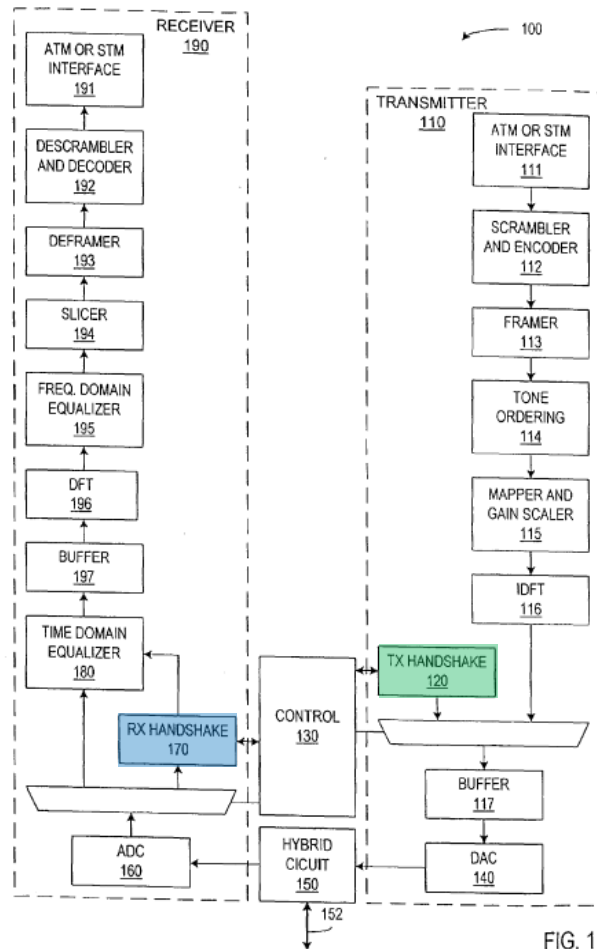
as I explained for [1A], the cable LAN adapters 32 in the Afshary-Mirfakhraei system communicate with each other using the DMT bit-loading protocol taught by Mirfakhraei. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-15, Fig. 1. As I noted for [1A], Mirfakhraei explains that DMT is a multi-carrier communication technique (claimed “communicat[ing] ... using multi-carrier signaling”). Ex. 1007, Abstract, ¶¶ 2-3, 5-6, Fig. 1.

152. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches [1C].

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.”

153. It is also my opinion that Afshary in view of Mirfakhraei teaches [1D]. As I discussed for [1A] (Section XI.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. 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. 1007, Fig. 1 (annotated)

154. 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, 9:35-10:38. Mirfakhraei describes and uses its handshake signals in the exact same manner. Ex. 1007, ¶¶ 20-23. 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 id.*, ¶ 22. Mirfakhraei further teaches that RX handshake block 170 of the second transceiver estimates the signal-to-noise ratio (SNR) (claimed “channel characteristics”) for each sub-channel based on received handshake signals (claimed “analyze received probe message signals”). Ex. 1007, ¶¶ 21-23.

155. 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. Mirfakhraei teaches the same—in particular, that the size of a constellation map for a channel, and hence the number of bits represented by each transmitted signal, is based on the SNR of the channel. Ex. 1007, ¶¶ 4-8, 14, 17-18, Figs. 1-2. 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. 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. 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

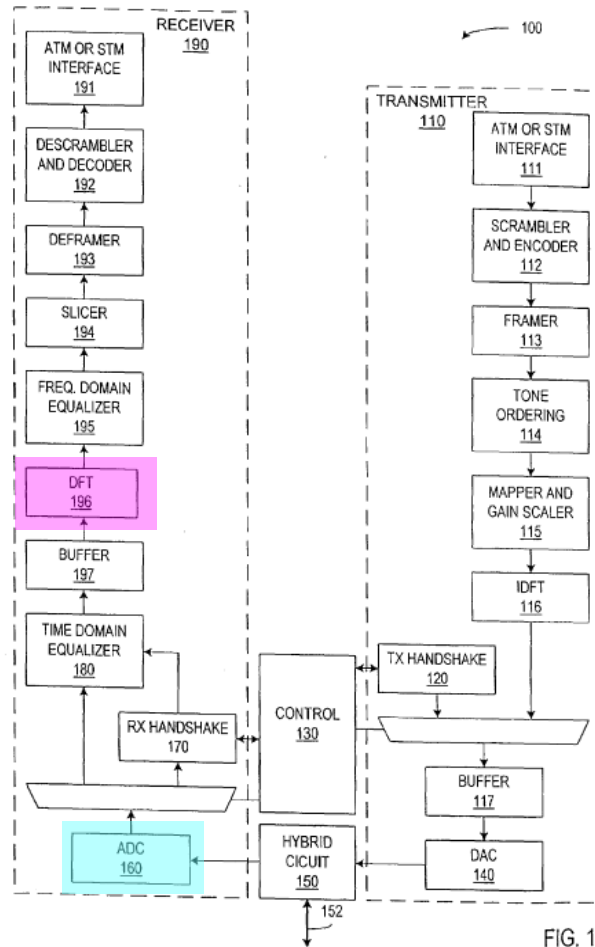
characteristics”). Ex. 1007, ¶¶ 5-8, 14, 17, 20, 22-23, 25-32, Figs. 1-2. Specifically, sub-channels having higher SNRs are assigned a higher order modulation constellation to modulate more bits for transmission. Ex. 1007, ¶¶ 5-8, 14, 17, 20, 22-23, 25-32, Figs. 1-2. Sub-channels having lower SNRs are assigned a lower order modulation constellation to modulate fewer bits for transmission. *Id.* As an example (referring to Section V.A), 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. 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.

156. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches [1D], and that Afshary in view of Mirfakhraei teaches claim 1.

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.”**

157. Claim 2 of the '518 patent is dependent from claim 1 and further requires “[t]he 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.” Ex. 1001, claim 2. As I discussed above for [1A] (Section XI.A.1.b), Mirfakhraei’s receiver includes DFT block 196 (pink) which receives data samples from ADC 160 (blue). Ex. 1007, Abstract, ¶¶ 15, 19, 24, Fig. 1. 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. The '518 patent acknowledges that 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, 11:14-18, Fig. 6; Ex. 1007, ¶ 24.



Ex. 1007, Fig. 1 (annotated)

158. As I 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 taken from the 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. 1001, 11:16-18.

159. It is my opinion that 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. 1019, pages 100-109 (“[T]he discrete Fourier transform (DFT) ... can be implemented most efficiently using a class of algorithms, called fast Fourier transform (FFT) algorithm”); Ex. 1020, pages 554-561 (Fast Fourier transform (FFT) is an algorithm that reduces the number of computations required in performing DFT); Ex. 1021, pages 581-585 (Fast Fourier transform (FFT) algorithms are “a particularly efficient class of algorithms for the digital computation of the N-point DFT”). Accordingly, it is my opinion that 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).

160. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches the “means for determining signal activity” as required for claim 2.

161. Further, as discussed above in Section VIII.A (summary of Afshary), 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. As shown in Figure 3 (below), Afshary explains that existing cable services, including the conventional cable TV service, are provided over an operating frequency range of 0-950 MHz (green). Ex. 1006, ¶ 25. In contrast, the coaxial cable LAN is provided over a non-overlapping operating frequency range of 1000-2000 MHz (red). Ex. 1006, ¶ 25. Afshary explains that the “cables [] are a very clear, clean medium capable of handling operating frequencies of up to 2000 MHz,” and “most of this operating frequency spectrum goes unused by [existing service] data suppliers.” Ex. 1006, ¶ 24. Accordingly, a goal of Afshary’s cable LAN network is to “take advantage of the [unused] operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the [existing service] client data within the coaxial cable.” Ex. 1006, ¶ 2; *see also id.* ¶¶ 4-7, 12, 24-25, Figs. 1, 3. To achieve this goal, Afshary teaches that RF & Mixed Signal section 100 of its cable LAN modem up-converts modulated data of the coaxial cable LAN to a desired RF carrier frequency of 1300 MHz (blue), 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. 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”).

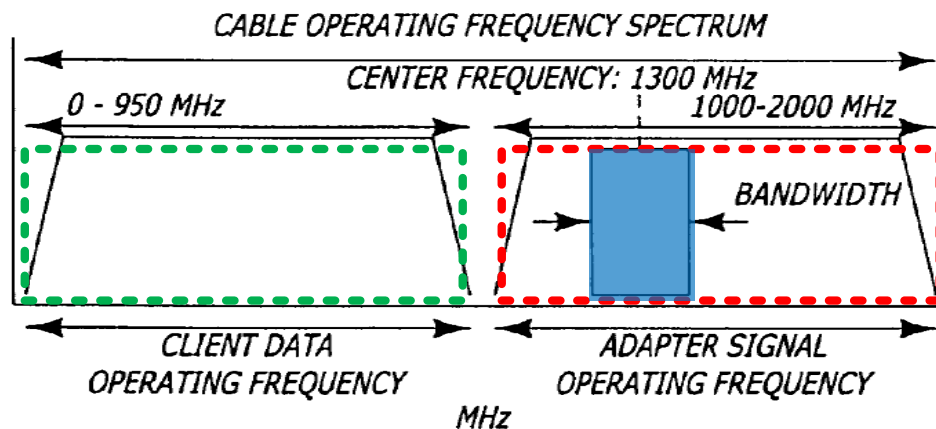


FIG. 3

Ex. 1006, Fig. 3 (annotated)

162. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches claim 2.

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.”

163. Claim 3 of the '518 patent is dependent from claim 1 and further requires “[t]he 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.” Ex. 1001, claim 3. As I discussed above in Section

VIII.A (summary of Afshary), and as I discussed for [1B] (Section XI.A.1.c) and claim 2 (Section XI.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. 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. 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. 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.

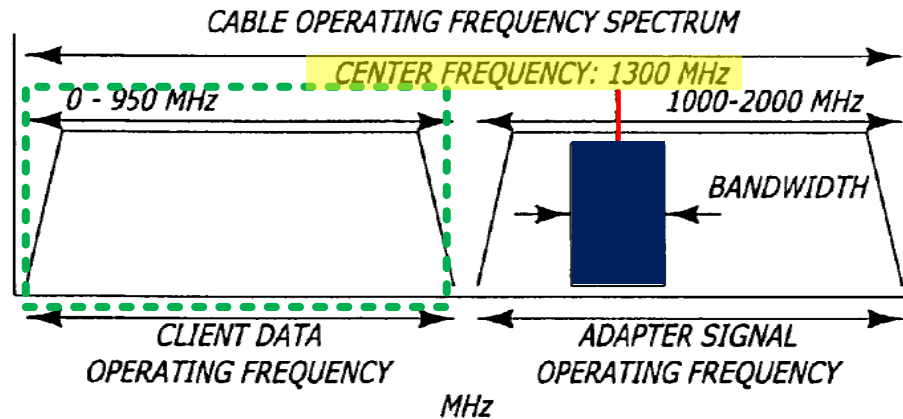


FIG. 3

Ex. 1006, Fig. 3 (annotated)

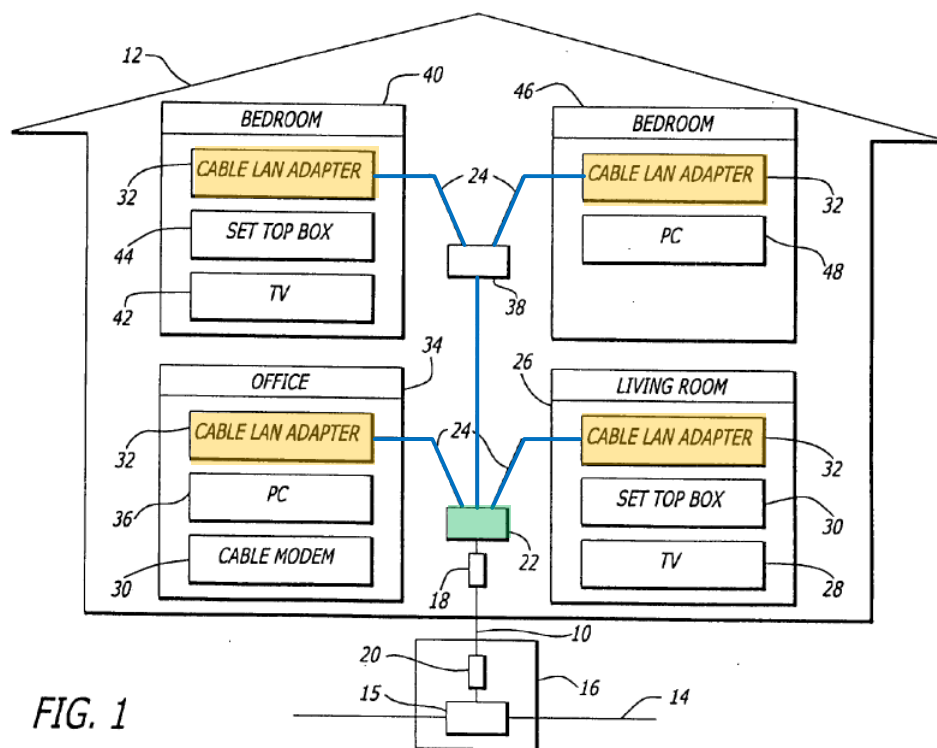
164. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches claim 3.

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:”

165. It is my opinion that Afshary teaches [4pre]. As I previously explained with respect to [1pre]-[1A] (Sections XI.A.1.a-b), Afshary discloses a coaxial cable LAN that includes a plurality of cable LAN adapters (**orange**) (claimed “network device for communicating data to other network devices”) communicating with each other via coaxial cable wire 24 (**blue**) and splitters 22 (**green**) (collectively claimed “a coaxial wiring system”). Ex. 1006, Abstract, ¶¶ 2, 7, 12, 14, 18-23, Figs. 1-2. As I discussed for [1B] (Section XI.A.1.c), Afshary explains that multiple segments of

cable wire 24 (blue) are each connected between the splitter 22 (green) and a respective cable LAN adapter 32 (orange) (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.



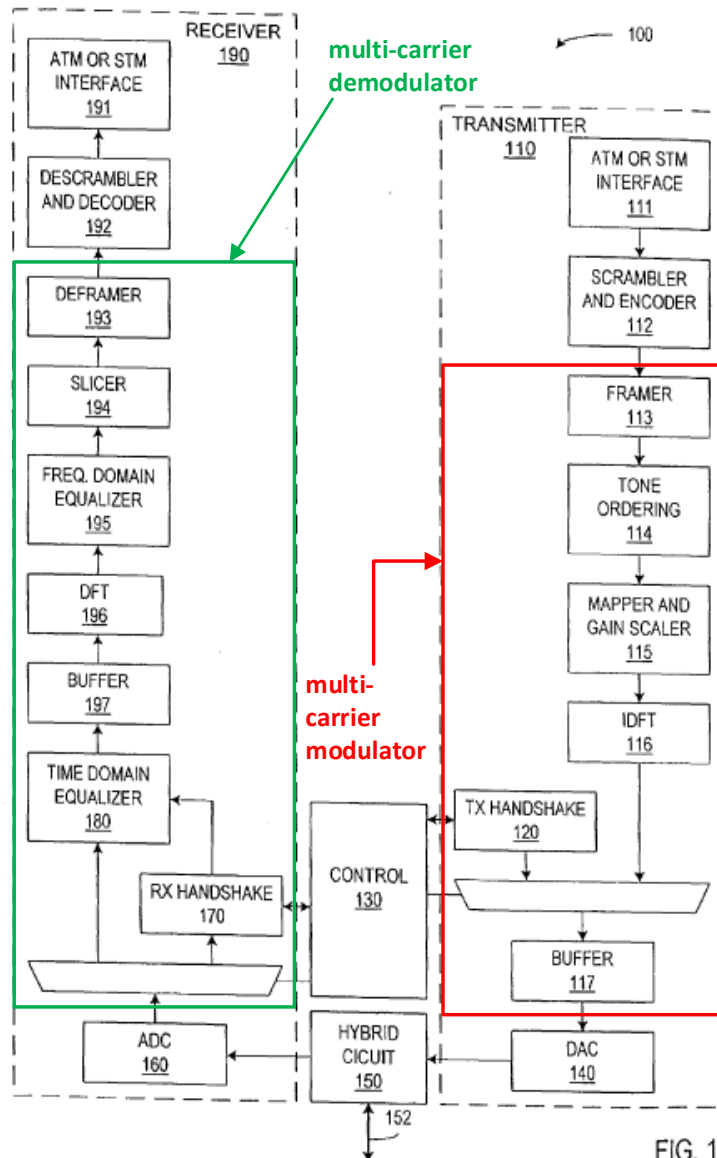
Ex. 1006, Fig. 1 (annotated)

166. Therefore, it is my opinion that Afshary teaches [4pre].

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

167. It is my opinion that Afshary in view of Mirfakhraei teaches [4A]. As I discussed for [1A] (Section XI.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. As I further explained with respect to [1A] (Section XI.A.1.b), 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") (red) that generate a multi-carrier modulated signal based on Mirfakhraei's DMT bit-loading scheme. Ex. 1007, ¶¶ 14-19, Fig. 1. Mirfakhraei teaches that these components (red) 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.

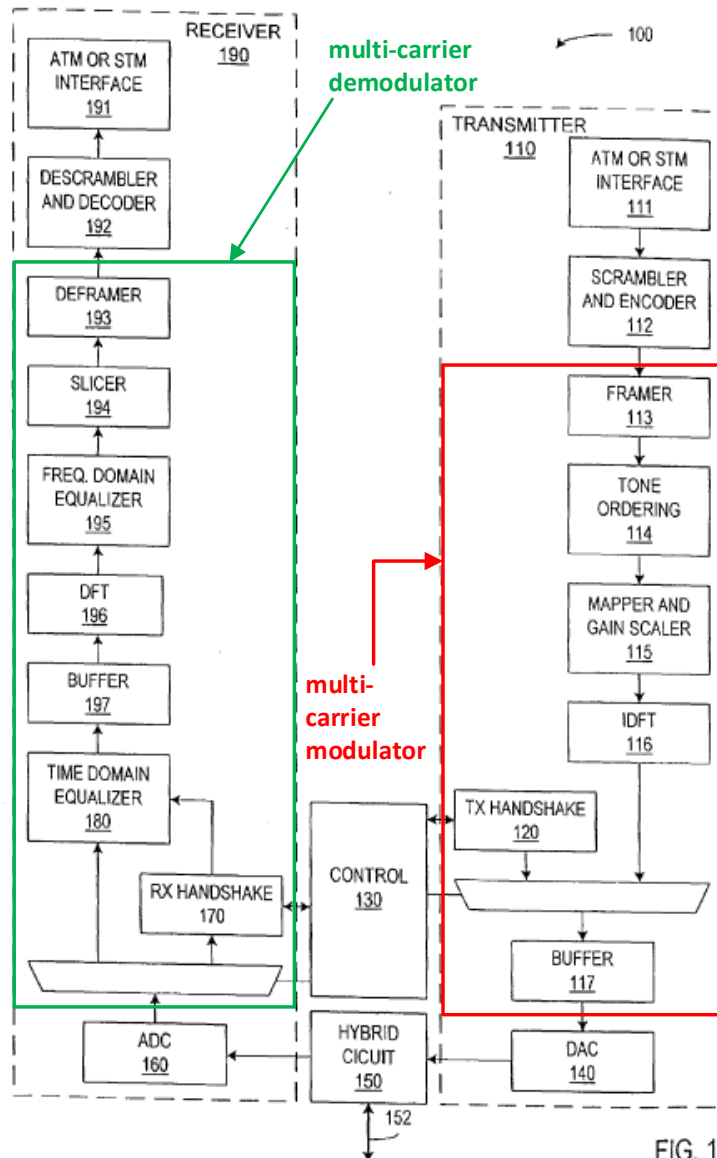


Ex. 1007, Fig. 1 (annotated)

168. Therefore, it is my opinion that Afshary in view of Mirfakhraei teaches [4A].

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

169. It is also my opinion that Afshary in view of Mirfakhraei teaches [4B]. As I discussed for [1A] (Section XI.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. As I further explained with respect to [1A] (Section XI.A.1.b), 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”) (**green**). Ex. 1007, ¶¶ 20-24. Mirfakhraei explains that these components (**green**) 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. 1007, Fig. 1 (annotated)

170. Therefore, it is also my opinion that Afshary in view of Mirfakhraei teaches [4B].

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

171. It is also my opinion that Afshary in view of Mirfakhraei teaches [4C]. As I explained with respect to [1D] (Section XI.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. Accordingly, in the Afshary-Mirfakhraei system, to implement the DMT bit loading scheme, each cable LAN adapter includes the TX handshake block 120 (pink). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3. 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 comprises a “known pseudo-random signal” or known signal pattern that is used for “estimat[ing] ... the present signal-to-noise ratio (SNR) for each sub-channel” (corresponding to the function of “producing and transmitting a probe message” of the term “means for producing and transmitting a probe message”). Ex. 1007, ¶¶ 15, 20-22.

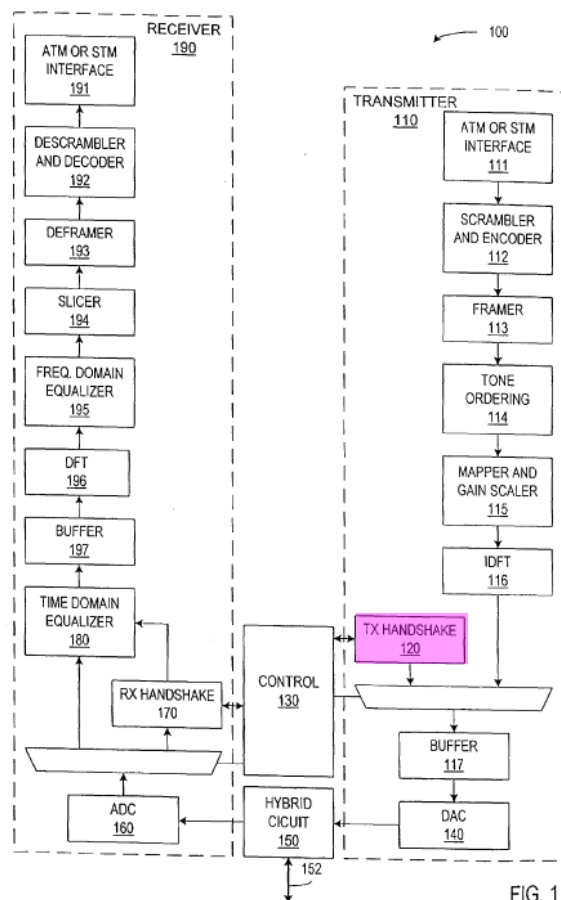


FIG. 1

Ex. 1007, Fig. 1 (annotated)

172. Mirfakhraei teaches that TX handshake block 120 may be implemented in software by a host computer. Ex. 1007, ¶ 15, Fig. 1. It is my opinion that 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. 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

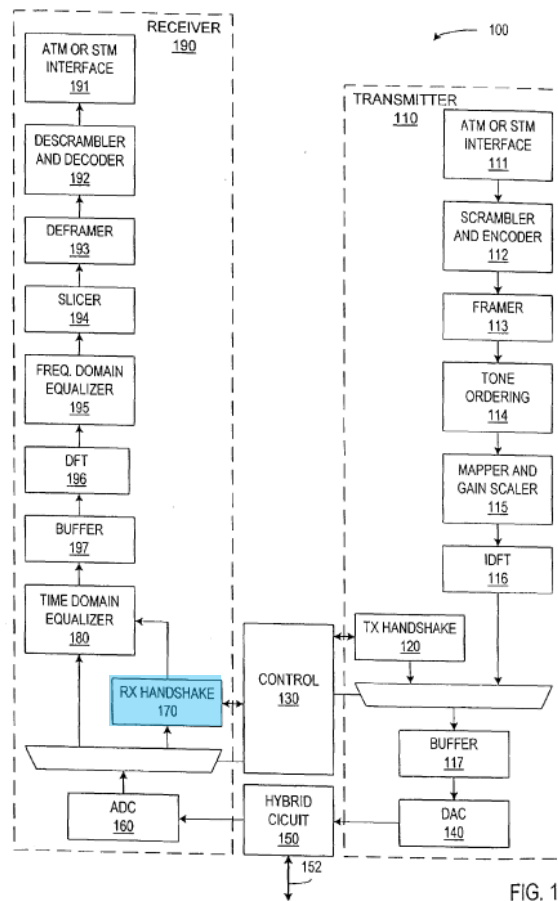
known signal to the remote transceiver (corresponding to the algorithm of “(a) generating a signal known to a receiving device; and (b) transmitting the known signal,” identified as the algorithm performed by the corresponding structure of a “processor”). Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3.

173. Accordingly, it is my opinion that Afshary in view of Mirfakhraei teaches the “means for producing and transmitting a probe message” of [4C].

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

174. As I discussed for [1D] and [4C] (Sections XI.A.1.e, XI.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. 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. Mirfakhraei teaches that the RX handshake block 170 receives a handshake signal from a TX handshake block 120 of another cable LAN adapter 32. Ex. 1007, ¶ 22. The handshake signal comprises a known signal. Ex. 1007, Abstract, ¶¶ 2-3, 5-8, 14-25, Figs. 1-3. Mirfakhraei teaches that the RX handshake block 170 compares the received handshake signal to the signal known by the RX handshake block 170 to estimate the SNR for each sub-channel, which is 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. I also note that 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. 1007, Fig. 1 (annotated)

175. Mirfakhraei teaches that RX handshake block 170 may be implemented in software by a host computer. Ex. 1007, ¶ 15, Fig. 1. In my opinion, 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. 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. Accordingly, it is my opinion that 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” of [4D].

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

176. As I describe below, it is my opinion that Afshary-Mirfakhraei in view of Welles renders obvious claim 2.

1. Dependent Claim 2

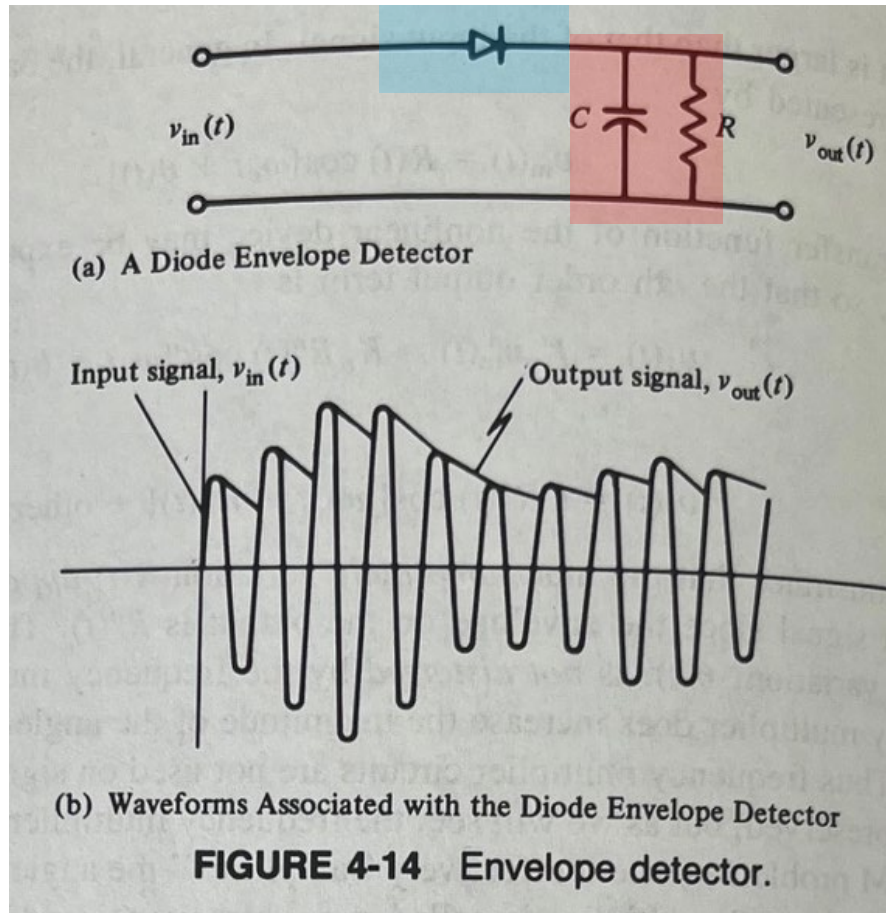
a) **“The data communication network of claim 1 wherein a network device comprises a means for determining signal activity and selects a frequency band for operation that is not used by other services.”**

177. Claim 2 of the '518 patent is dependent from claim 1 and further requires “[t]he 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.” Ex. 1001, claim 2. As I discussed above (Section XI.A.2), it is my opinion that Afshary-Mirfakhraei teaches claims 2. To the extent that it is argued that Afshary-Mirfakhraei does not teach a “means for determining signal activity,” it is my opinion that Welles does.

178. As I discussed above in Section VIII.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. 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. 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. Welles teaches that a large frequency range may be scanned

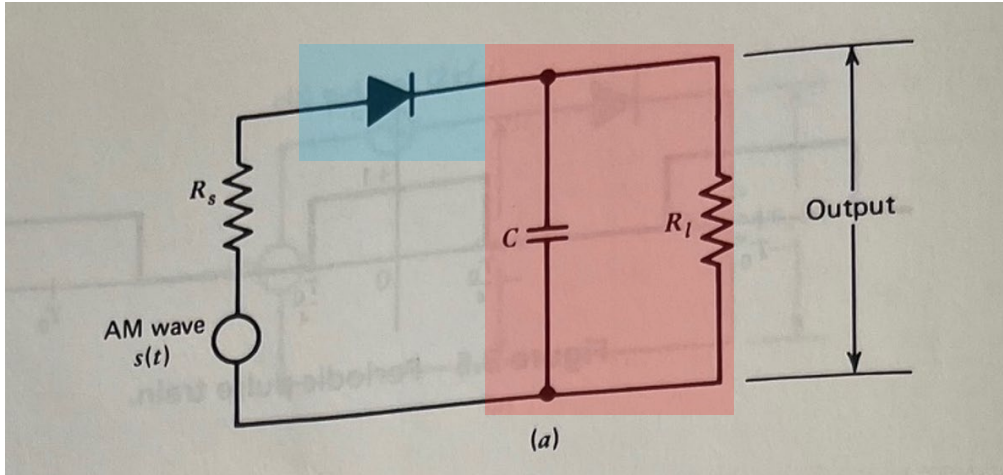
using the envelope detector to determine a clear frequency range that may be used for data transmission, to avoid noise or interference from other transceivers or systems. Ex. 1022, 5:5-6:17, 7:2-11.

179. It is my opinion that a POSITA would have been motivated to modify the Afshary-Mirfakhraei cable LAN adapter to include Welles' envelope detector because doing so would provide a simple and straightforward manner to determine whether a range of frequencies would be suitable for data transmission, as taught by Welles. Ex. 1022, 5:5-6:17, 7:2-11. It is my opinion that a POSITA would understand that Welles' envelope detector would include a simple diode and filter circuit and that such an envelope detector would enable signal activity over a range of frequencies to be determined, 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, pages 129-131; Ex. 1023, pages 281-282. For example, Couch's Figure 4-14(a) shows an envelope detector including a diode (blue) and a low pass RC filter (red), which matches the description of an envelope detector provided in the '518 patent. Ex. 1023, pages 281-282; Ex. 1001, 11:23-29. Couch explains that the envelope detector "produces a waveform at its output that is proportional to the [] envelope of its input," which is illustrated by Couch's Figure 4-14(b) below:



Ex. 1023, Fig. 4-14(a) (annotated, top), Fig. 4-14(b) (bottom)

Ex. 1023, page 281; *see also*, Ex. 1023, page 282, Figs. 4-14(a), (b). Similarly, Haykin's Figure 3.7(a) (annotated below) shows an envelope detector that includes a diode (also blue) and a resistor-capacitor (RC) filter (also red). Ex. 1019, pages 129-131. Haykin similarly explains that the envelope detector outputs a waveform that is approximate to the envelope of its input signal. Ex. 1019, pages 129-131.



Ex. 1019, Figure 3.7(a) (annotated)

180. By using Welles' envelope detector to detect signal activity, a clear range of frequencies for communication would be determined, as desired by Afshary and Welles. Ex. 1006, ¶ 7 (“[The cable LAN] adapters generate and communicate data transmitting signals that take advantage of the operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the client data within the coaxial cable.”); *see also*, Ex. 1006, ¶¶ 2, 12, 15, 16, 24-25, 28; Ex. 1022, 5:5-7:11, Figs. 1-2, 4.

181. It is my opinion that 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). In doing so, it is my opinion that 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.

182. It is also my opinion that a POSITA would have 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). Further, it is my opinion that 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. Therefore, it is my opinion that Afshary-Mirfakhraei-Welles teaches the "means for determining signal activity" as required for claim 2.

183. As I discussed above for claim 2 (Section XI.A.2), Afshary teaches a “network device... [that] selects a frequency band for operation that is not used by other services.” It is also my opinion that Welles also teaches this feature. As I 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. Accordingly, it is my opinion that Afshary-Mirfakhraei-Welles teaches this feature, and renders claim 2 obvious.

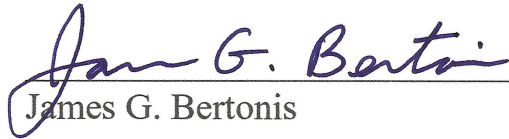
XII. EVIDENCE OF NON-OBVIOUSNESS

184. It is my understanding that in order for evidence of non-obviousness or secondary considerations to be relevant, there must be a nexus between the claimed invention and the evidence. I am not aware of any evidence of non-obviousness or secondary considerations.

XIII. CONCLUSION

185. All of the statements made in this declaration of my own knowledge are true. All statements made based on information and belief are believed to be true. Further, these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code.

Date: 2-15-2024


James G. Bertonis

Appendix A

PROFESSIONAL EXPERIENCE

2009 to
Present **Azure Communications Inc.**
CEO

Azurecomm designs and develops wireless broadband solutions and advanced radio communications technology. The company has deep technical experience over the vast array of wireless protocols, devices, and systems employed across the RF and microwave frequency spectrum. Participation in the IEEE 802.11, 802.15, and 802.16 standards. Azurecomm has a proven track record having developed and sold broadband wireless equipment in use by major broadband service providers worldwide. The company is currently developing wireless designs and systems for new 5G, and IoT applications.

2003 to
2008 **Arcwave Inc.**
Chief Technical Officer

Arcwave was created by the merger of Advanced Radio Cells Inc., and CoWave Networks. Managed all technology and product development efforts of the company. Architected and led the design team for the evolution of a DOCSIS based broadband wireless system originally for Wireless ISP's, to address the requirements of cable system operators (MSOs) to provide broadband wireless extension to their cable plants. This product strategy created a new market segment, and enabled Arcwave in one year to become the recognized industry leader in wireless solutions for the cable industry.

2000 to
2003 **Advanced Radio Cells Incorporated (ARCi)**
CEO and Founder

Lead the company from inception to over \$1 million in sales and raised over \$7 million in corporate and venture capital investment. Assembled the management team, developed corporate partners and key customer relationships. Performed successfully in a difficult business environment to adapt plans to reflect changing market and financial conditions. Successfully drove the merger of ARCi with CoWave Networks in March 2003.

ARCi developed and brought to market a high performance broadband wireless delivery system operating in the license-free 5.3, and 5.8 GHz frequency bands. ARCi concentrated its development effort on RF system engineering, and adapting the DOCSIS cable modem standard for wireless Internet capability, creating wireless DOCSIS. This leveraged solution enabled ISPs to deliver profitable wireless broadband service to communities, providing affordable high-speed wireless Internet delivery. ARCi has a wireless ISP and Telco installed system customer base, serving both business and residential users.

1986 to
2000 **ADBS CORPORATION**
CEO

Wireless consulting firm specializing in design and engineering of Wireless LAN, WAN, Satellite, Cellular handset design, and base stations. Technology includes 802.16/WiMAX, 802.11/Wi-Fi, CDMA, DOCSIS, DBS, VSATs, OFDM, Spread Spectrum, FSK, MSK, QPSK to 256QAM modulation. Patent analysis, assessment and litigation support including James Bertonis testifying as a wireless technology expert in several litigations.

1981 to
1984 **TELECOM INDUSTRIES CORPORATION**
CEO/Co-founder

Manufacturer of satellite communications products and a pioneer in the home satellite TV industry. Innovative products included the first 4 GHz integrated low noise satellite down-converter, an award winning TVRO receiver design, and a portable collapsible dish antenna. Lead company through product development, manufacturing start-up, sales development, and corporate financing. Company was sold to its largest customer.

1978 to
1980 **NATIONAL SEMICONDUCTOR CORPORATION**
Design Engineer/Project Manager, Module Products Group

Developed specialized analog and RF functional circuit modules for high volume production in consumer, cable television, and industrial product applications. Managed project design, customer engineering, and the release to manufacturing.

1976 to
1978 **BLONDER-TONGUE LABORATORIES, INC.**
RF Design Engineer, Advanced Cable Products Division

On the development team for the world's first broadcast wireless Cable-TV system, deployed from transmitters located on the World Trade Center tower, providing pay television throughout the New York metropolitan area. Responsible for RF and video circuit design for descrambling systems, modulators, and set-top box development.

EXPERT WITNESS AND LITIGATION SUPPORT EXPERIENCE

Case: **Motorola Solutions v. Hytera Communications**
Matter: Trade Secret theft
Court: United States District Court, N. Illinois, Case No. 1:17 CV-1973
Project: Technical expert - Analysis and report on scope of development for digital two-way radio product engineering, impact of stolen trade secrets on the cost, timeline.
Date: 2019
Client: Kirkland and Ellis LLP; Justin Singh, Attorney for Motorola

Case: **Apple Inc. v. Nokia**
Matter: Patent Litigation (US and EU)
Court: United States Patent and Trademark Office, and European Patent Office
Project: Technical expert for Inter Partes Review (IPR) challenging validity of multi-mode cellphone receiver patent. Client reached global settlement before filing of IPR.
Date: 2017
Client: Ropes and Gray LLP; Carolyn Redding, Attorney for Apple

Case: **Provident - Pomona Properties v. SolSource**
Matter: Service Contract Litigation
Court: California Superior Court, Los Angeles, Case No. KC068239
Project: Performed on site performance testing of campus Wi-Fi network; Prepared report categorizing wireless system architecture and user upstream/downstream data rate
Date: 2016
Client: Manly, Stewart & Finaldi, Attorneys for plaintiffs

Case: **Comcast Cable v. British Telecom**
Matter: Patent infringement and invalidity
Court: U.S. District Court, Delaware, Case No. 1:11-cv-00843-SLR
Project: Expert for DOCSIS, OpenCable standards, related patents and technology
Date: 2012
Client: Kecker & Van Nest, Attorneys for plaintiff

Case: **Chavarria v. Trabert**
Matter: Personal injury civil lawsuit
Court: California Superior Court, Santa Clara County, San Jose, CA
Project: Testified at jury trial regarding design and maintenance of electrical equipment.
Date: 2010
Client: Fernando V. Hernandez, Attorney for plaintiff

Case: **Intel Corp. v. Wi-LAN Inc.**
Matter: Patent infringement and invalidity
Court: Federal District Court, Northern California, Case No. 5:08-CV-04555
Project: Non-testimonial expert for WiMAX patents and broadband wireless technology
Date: 2008 - 2009
Client: Kirkland & Ellis LLP, Attorneys for Intel

Case: **Malikyar v. Sramek**
Matter: Federal wiretapping statute, civil jury trial
Court: Federal District Court, Northern California District, San Francisco, CA
Project: Expert witness for wireless telephone wiretapping communications equipment.
Testified in Federal District Court; provided research for plaintiff's attorney.
Date: 2009

Case: **Rembrandt v. Cox Communications**
Matter: Patent infringement matter
Court: Federal
Project: Non-testimonial expert in DOCSIS broadband technology and patent analysis.
Date: 2008
Client: Kilpatrick Stockton LLP, Atlanta, for defendants

Case: **Huff v. Andrew Corporation**
Matter: Patent and business valuation dispute
Court: California Superior Court, Santa Clara County
Project: Testimonial expert witness regarding broadband and VSAT satellite technology.
Testified, provided research, and assisted questioning of opposing experts.
Date: 2005
Client: Bergeson LLP co-w/Gardner, Carton & Douglas for Andrew Corp., defendants.

Case: **CSIRO v. Netgear Inc.**
Matter: Patent infringement matter
Court: United States District Court, Northern District, San Jose, California
Project: Expert consultant regarding 802.11a, 802.11g, 802.11n and OFDM technology
Date: 2005
Client: Wilson, Sonsini, Goodrich & Rosati (Palo Alto) for Netgear, defendants

Case: **Research in Motion v. 3Com/US Robotics Corp.**
Matter: Product defect, product development contract dispute
Court: American Arbitration Association, New York
Project: Testimonial expert witness on wireless modem products and technology; provided technical research, prepared reports, and assisted questioning of opposing experts.
Date: 1998
Client: Barrett, Gravante & Stern, for 3Com

Case: **Network Services Corp. v. Buckner Inc.**
Matter: Product defect, product development contract dispute
Court: American Arbitration Association, San Francisco
Project: Testimonial expert witness on low cost two-way RF pager technology;
Provided research, testified at arbitration; assisted questioning opposing experts.
Date: 1998
Client: Kimble MacMichael & Upton, for Buckner, defendants

Case: **L3 Communications et al v. Titan Comm. et al.**
Matter: Product defect litigation
Court: Arbitration, San Diego, CA
Project: Testimonial expert witness on VSAT satellite technology
Date: 1998
Client: Popelka Allard, for L3

Case: **Life Point et al. v. Cargill, Voyager Technologies et al**
Matter: Patent infringement, trade secret misappropriation
Court: United States District Court, San Jose
Project: Testimonial expert witness on security system using 802.11 technology
Date: 1995 - 2000 inclusive
Client: Cooley Godward, for Voyager Technologies, defendant

EDUCATION

BSEE, Syracuse University, Syracuse, NY, May 1976

MBA, Santa Clara University, Santa Clara, CA, June 1986

PUBLICATIONS

Bertonis, James, and Wilson, Eric "High Speed Wireless Internet over Unlicensed Radio Bands - An Innovative Approach"

Private Wireless & Broadband Magazine, June 2000

Bertonis, James, "Scorecard Tracks PCS Technical Standards"

Electrical Engineering Times, October 21, 1996

Bertonis, James G., "Overview of 3G Personal Communications Technology" IC Expo Applications Conference on Communications Technology - Proceedings, October 1996

AFFILIATIONS AND MEDIA

Board of Directors, Momentum for Health, Santa Clara Valley nonprofit provider of health services offering treatment for adults, teens and families in the community with health issues.

Property Tax Advisory Board, Los Gatos-Saratoga Union High School District

Science and Technology Instructor, USA Prepares, nationally syndicated radio show.

PATENTS

Apparatus and Method for High-Speed Wireless Upstream Data Transmission Using CATV Compatible Modems
6,625,222 Issued Sept. 2003

Apparatus and Method for Extending DOCSIS Cable Modem Service Over Wireless Links
7,596,798 Issued Sept. 2009

Apparatus and Method for Extending a Cable Modem Data Service Over Wireless Links
7,840,989 Issued Nov. 2010

Apparatus and Method for Extending a Cable Modem Data Service Over Wireless Links
7,917,931 Issued Mar. 2011

Appendix B

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.