

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMCAST CABLE COMMUNICATIONS, LLC,
Petitioner,

v.

ENTROPIC COMMUNICATIONS, LLC,
Patent Owner.

Case IPR2024-00431
Patent 7,295,518 B1

**REPLY DECLARATION OF JAMES G. BERTONIS
IN SUPPORT OF PETITIONER'S REPLY**

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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. MATERIALS REVIEWED

1. In connection with my study of this matter and reaching the opinions stated herein, I have reviewed the documents listed in my previous Declaration (Ex. 1002) and all the exhibits listed therein. I stand by my testimony in my previous Declaration. In addition, to reach my opinion on the instant Declaration, I also reviewed the Patent Owner Reply (“POR”) and the Declaration of Mr. Albert Garrett (Ex. 2001), as well as the following additional documents:

- Ex. 1028: U.S. Pat. No. 5,959,967 (“Humphrey”)
- Ex. 1029: U.S. Pat. No. 6,438,174 (“Isaksson”)
- Ex. 1030: U.S. Pat. No. 6,259,746 (“Levin”)
- Ex. 1031: Rauschmayer, Dennis. J., ADSL/VDSL Principles, A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines, Macmillan Technical Publishing, 1999 (Chapters 2, 8 and 9)
- Ex. 1032: Transcript of February 28, 2025 deposition of Albert Garrett in *Comcast Cable Communications, LLC v. Entropic Communications, LLC*, IPR2024-00431 (USP 7,295,518)

- Ex. 1033: Tanenbaum, Andrew S., *Computer Networks*, 3rd ed., Prentice Hall PTR, 1996, § 1.2 (pp. 7-16), § 2.2 (pp. 82-94), § 4.3 (pp. 275-304) (“Tanenbaum”)
- Ex. 1034: Brebner, Gordon, *Computers in Communication*, 1st ed., McGraw-Hill International (UK) Limited, 1997, Ch. 1 (pp. 1-34), Ch. 5 (pp. 138-167), Ch. 6 (pp. 168-221) (“Brebner”)
- Ex. 1035: Ciciora, Walter S. *Modern Cable Television Technology: Video, Voice, and Data Communications*. San Francisco, Calif: Morgan Kaufmann Publishers, 1999, § 9.2.3 (Chapter 9, pp. 386-88) (“Ciciora”).

II. MIRFAKHRAEI IS ANALOGOUS ART

A. Mirfakhraei Is from the Field of Endeavor of the ’518 Patent

2. As I stated in my first Declaration, it is my opinion that both the ’518 patent and Mirfakhraei are in the field of network communication, and therefore Mirfakhraei is analogous art. Ex. 1002, ¶88.

3. In determining the field of endeavor, I understand that a holistic approach should be taken by considering the patent’s title, background, field of invention, claims, and detailed descriptions, and considering what a POSITA would turn to for a solution to the problem facing the inventors using knowledge demonstrated by prior art references and common sense.

1. The Field of the '518 Patent Is Not Limited to On-premises Local Area Broadband Coaxial Cable Networks

4. It is my opinion that the field of the '518 patent is not limited to “on-premises,” “local area,” or “broadband” as alleged by PO. POR, 16. I understand that those limitations are imposed by the PO and are not concurred with by Mr. Garrett. Ex. 2001, ¶58 (Mr. Garrett stating, “[i]t is my opinion that the '518 Patent's field of endeavor is ‘wired networking systems using coaxial cables.’”). Indeed, neither “on-premises” nor “local area” appears in the title, the technical field, or the preambles of either independent claim. Ex. 1001, 1:1-3 (the title of the '518 patent is “broadband network for coaxial cable using multi-carrier modulation”); Ex. 1001, 1:26-28 (the “Technical Field” is “broadband communication networks”); Ex. 1001, claims 1 and 4 (claim 1 is directed to “[a] data communication network” and claim 4 is directed to a “network device.”). While the term “broadband” appears in the title and the technical field, it is a very broad term that can refer to any high-speed communications and therefore does not impose any meaningful limitation on the field of endeavor. Ex. 2002, 15:18-20; Ex. 1033, p. 85 (“Although the term ‘broadband’ comes from the telephone world, where it refers to anything wider than 4 kHz, in the computer networking world ‘broadband cable’ means any cable network using analog transmission”).

5. In addition, it is also my opinion that the '518 patent's description of coaxial cable as a transmission medium does not limit its field of endeavor to coaxial

cable. Using common sense, a POSITA would turn to network communication prior art to solve the problem faced by the '518 patent's inventors even if the specific physical transmission medium in such prior art reference is different.

6. Prior art knowledge demonstrated by references supports the same, as multicarrier modulation and bit-loading were known to be applied across various transmission mediums including coaxial cables in addition to telephone lines. For example, both Exs. 1010 and 1018 describe DMT multi-carrier modulation applied to a coaxial cable network, as indicated by the title of each and throughout. And both describe bit-loading as part of the multi-carrier modulation. *See, e.g.*, Ex. 1018, pp. 306-307 (“In multicarrier modulation, a channel is divided into N equal-bandwidth subchannels, each with its own carrier, such that the frequency response is roughly constant across each subchannel. [] 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 [radio signals] 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.**) (Emphasis added); Ex. 1010, p. 375, col. 1 (“In general, the channel can be partitioned into any convenient number of subchannels, as long as the condition of nearly-flat frequency responses over the subchannel bandwidths is met. [] In contrast to single-carrier techniques, which support a fixed number of bits over a set frequency band, the number of bits supported by DMT varies with frequency. Subchannels are assigned as many bits as they can support reliably.”), col. 2 (“DMT takes advantage of these high SNR regions by assigning the appropriate number of bits to those regions, thereby maximizing the channel bit rate. DMT also automatically avoids those regions of the spectrum in which meaningful communications cannot be supported. During initialization, the bit distribution is computed based on the observed channel and noise conditions. Those subchannels with SNRs insufficient to support any bit are simply turned off. **By tailoring the bit distribution to the channel characteristics, DMT optimizes the transmit bandwidth. During steady-state operation, the bit distribution is adapted as necessary to maintain a desired performance.** The subchannel SNRs are

monitored in a data-driven manner by the receiver. Upon detecting a degradation in a subchannel SNR, the receiver computes a modified bit distribution that better achieves the desired error performance. Depending on the SNR of a degraded subchannel, some or all of its bits may be moved via a *bit swap* algorithm to one or more other subchannels that can support additional bits. The bit distribution change is reported to the transmitter, which then notifies the receiver when the new bit distribution will be activated. The adaptivity afforded by bit swapping **enables DMT to alleviate problems caused by changes in the channel frequency response or noise while a system operates. Even unpredictable, bursty, high-power noise such as ingress from amateur radio or other radio-frequency interferers can be tolerated by a DMT system ...**) (Emphasis added).

7. In addition, those references (Exs. 1010, 1018) are not limited to a point-to-point network. Ex. 1010 addresses the application of its DMT solution to a multipoint-to-point environment. *See, e.g.,* Ex. 1010, p. 379, Summary; *See also* Ex. 1010, p. 379, col. 2 (“DMT can [] be used effectively in multipoint-to-point environments”). Ex. 1018 applies DMT to bidirectional communications on a coaxial cable distribution network having a headend and multiple subscriber homes. Ex. 1018, p. 307, col. 2.

8. In addition, Ex. 1018 explicitly discusses transmission channel impairments, including ones that are specifically caused by splitters within home

cable wiring. *See, e.g.*, Ex. 1018, p. 305, col. 2 (“**Taps, amplifiers, and splitters can all cause signals to be reflected** at their insertion points. In particular, **splitters in subscriber homes are known to have poor isolation characteristics**. The effect of reflected signals on the frequency transfer characteristic of a CATV channel is passband ripple, which is known to cause ‘ghosting’ in received analog signals. The effects of rippling on digital signals, however, are more severe. Variations in a channel’s frequency response cause successively transmitted symbols to interfere with one another, an effect known as intersymbol interference (ISI).”) (emphasis added). *See also*, p. 306, col. 1 (“A second source of signal degradation in CATV networks is interference from other signals. For example, leaks in a CATV network caused by poorly shielded consumer devices or system hardware allow amateur radio (ham) signals to enter the CATV system. Because the frequency spectrum allocations for CATV and ham overlap, receivers on leaky CATV networks can tune interfering ham signals along with the desired signals. As a result, the received signal is degraded”).

9. Ex. 1018 further discusses the relative merit of two different modulation techniques, single carrier versus multi-carrier. *See, e.g.*, Ex. 1018, p. 306 col. 1 (emphasis added) (“In the next section, we discuss two candidate techniques for multimedia transmission on the CATV network: **single-carrier** quadrature amplitude modulation (QAM) with equalization and **multicarrier**

modulation.”); p. 306, col. 1 (“Our results indicate that for a fixed system throughput, the computational complexity of the **multicarrier** system is significantly less than that of the **single-carrier** system.”). A detailed system comparison (via simulation) is provided at 308-311, and the conclusion in favor of multicarrier is stated at 312. *See, e.g.*, Ex. 1018, p. 310, col. 2 (emphasis added) (“We note that by using a decision feedback equalizer (DFE) ..., the complexity of the **single-carrier system** might be reduced slightly However, our preliminary results from DFE simulations show that the **complexity** of a DFE receiver [associated with single carrier] is **still at least twice that of the multicarrier system.**”) and p. 312, col. 1 (emphasis added) (“The results of our simulations indicate that **discrete multitone modulation** is more computationally efficient than **single-carrier modulation** with equalization for the transmission of digital data over CATV channels with rippled passbands. Furthermore, DMT can easily adapt to a variety of channel degradations, optimizing the system bit rate for a given channel and complexity. Because system reliability is important for any consumer service, a digital transmission system must maintain a certain level of performance under a wide variety of circumstances. Given our simulation results, multicarrier modulation appears to be better equipped than single-carrier modulation to accomplish this objective.”).

10. Ex. 1010 addresses the advantages of DMT multi-carrier over single-carrier modulation as applied to a cable network. *See, e.g.*, Ex. 1010, p. 375, col. 2 (emphasis added) (“Practical **single-carrier** transceivers, such as QPSK, are much less proficient than **DMT** at optimizing the transmission bandwidth and operating in the presence of radio-frequency ingress ...”).

11. The '518 patent itself describes that multi-carrier modulation is implemented in coaxial cable LAN using techniques applied to twisted pair networks, without identifying any technical obstacles that need to be overcome. It cites and incorporates a textbook devoted to the subject of DSL (a protocol including DMT multi-carrier originally developed for carrying data over telephone lines). *See* Ex. 1001, 9:28-33 (“Multi-carrier system architecture is covered in *ADSL/VDSL Principles ...* and *DSL Simulation Techniques and Standards Development for Digital Subscriber Line...*, incorporated herein by reference.”) It is natural and expected that a POSITA confronting the problems addressed by the '518 patent would consult such prior art concerning known applications of DMT multi-carrier modulation, and this includes Mirfakhraei.

12. In fact, various other prior art references incorporated by reference by the '518 patent concern multi-carrier modulation and bit-loading and disclose the application of these techniques across various transmission mediums (e.g., coaxial cable and twisted pair) and various network topologies (e.g., point-to-point and

multipoint-to-point). This further indicates that Mirfakhraei is analogous art to the '518 patent that a POSITA would have considered.

13. For example, U.S. Pat. No. 6,091,932 (“Langlais”) (Ex. 1016) discloses the application of OFDM to address transmission interference in a point-to-multipoint CATV cable network. Ex. 1001, 3:37-40, 56-61. *See, e.g.*, Ex. 1016, 1:9-16 (“This invention relates to a two-way point to multipoint data transmission system, such as a CATV (Cable TV) data transmission system capable of carrying data in both the upstream and downstream directions. The transmitted data can be any digital data, such as computer files or digitized audio or video, for example. The digital data is carried over an analog transmission line, such as a coaxial cable or optical fiber.”), 3:34-55 (“The modems [of the two-way point to multipoint data transmission system] employ multitone orthogonal frequency division multiplexing (OFDM) ... [over a] transmission line [that] can be a coaxial cable, an optic fiber, or similar medium ... [that is] “more robust against ... interference.”).

14. U.S. Pat. No. 5,959,967 (“Humphrey”) (Ex. 1028) discloses “an OFDM transmission system used to communicate over a twisted pair loop” having a “multipoint-to-point” network topology. Ex. 1001, 3:67-4:3. *See, e.g.*, Ex. 1028, 2:11-13, 5:33-35 (“OFDM technique described above can be extended to implement multi-point to point communication”).

15. U.S. Pat. No. 6,438,174 (“Isaksson”) (Ex. 1029) discloses DMT and bit loading applied to twisted pair wiring, and references the distribution of VDSL signals over coaxial cable. Ex. 1001, 8:19-23; Ex. 1029, 2:7-16. U.S. Pat. No. 6,259,746 (“Levin”) (Ex. 1030) is another reference incorporated into the ’518 patent that discloses the use of DMT multi-carrier modulation and bit-loading over twisted pair. Ex. 1001, 8:23-26; Ex. 1030, 1:49-52.

16. Thus, in my opinion, a POSITA would not have excluded Mirfakhraei’s relevant teaching of multicarrier modulation from his consideration even if Mirfakhraei does not specifically describe a coaxial cable network.

2. Mirfakhraei’s Field of Endeavor Is Not Limited to DSL Connections Over Twisted Pair

17. It is also my opinion that Mirfakhraei is not limited to DSL connections over twisted pair telephone lines, as alleged by PO. POR, 18. Here again, I note that PO’s position regarding Mirfakhraei is not consistent with its expert Mr. Garrett’s opinion. See Ex. 2001, ¶61 (stating “Mirfakhraei’s field of endeavor is multi-carrier signaling over twisted pair telephone lines” without mentioning DSL). Regardless, in my opinion, a POSITA would not consider Mirfakhraei’s field of endeavor to be limited to telephone lines. This is indicated, e.g., by Mirfakhraei’s broad title: “[b]it loading process for multicarrier communications” (Ex. 1007, p. 1); broad field of invention: “invention relates to communications and communications systems ... that use multiple carrier frequencies for information transmissions” (*Id.*, p. 1 (¶1));

broad claims, directed to “[a] process for determining bit loadings for subchannels of a communication signal” (*Id.*, pp. 7-9).

18. Mr. Garrett’s evidence purporting to support Mirfakhraei’s field being limited to telephone lines is either weak or misleading. For example, Mr. Garrett cites Mirfakhraei’s summary of the invention, stating, “Mirfakhraei provides a system for ‘determining a bit loading for a discrete multi-tone (DMT) communication signal’ on a two-node, point-to-point, full-duplex, twisted pair network. Ex. 1007 (Mirfakhraei), [0005].” Ex. 2001, ¶62. This is misleading because paragraph five of Mirfakhraei describes DMT without limiting the types of networks to which DMT applies. Ex. 1007, ¶5. Other paragraphs cited by Mr. Garrett regarding Mirfakhraei’s purported limitation to twisted pair telephone lines all come from Mirfakhraei’s “detailed description of the preferred embodiments” section. *See* Ex. 2001, ¶62 (citing paragraphs [0014], [0015], [0019], and [0021] of Mirfakhraei). However, Mirfakhraei explicitly states that this description “is only an example of the invention’s application and should not be taken as a limitation.” Ex. 1007, ¶36.

19. A POSITA would consider both the ’518 patent and Mirfakhraei to be within the same field of endeavor not only because both concern network data communications, but also because both address the use of bit-loaded multi-carrier transmissions for purposes of adapting to channel impairments in a communication network. Ex. 1001, 4:37-42; Ex. 1007, ¶5. For example, the title of the ’518 patent

is “broadband network for coaxial cable using multi-carrier modulation,” while the title of Mirfakhraei is “bit loading process for multicarrier communications.” Both explicitly describe multicarrier as a transmission mechanism used in their systems. Ex. 1001, 1:1-3; Ex. 1007, cover.

20. The ’518 patent and Mirfakhraei only differ in terms of the particular physical transmission medium and specific network configurations, which should not be used to limit the field of endeavor. A POSITA would understand that multicarrier modulation has general applicability across different physical transmission mediums and network configurations. *See, e.g.*, Ex. 1007, ¶3 (describing multicarrier modulation originated from telephone lines); Ex. 1010, p. 374 (describing use of multicarrier modulation in cable networks); Ex. 1009, p. 5 (describing use of multicarrier modulation in cellular networks).

21. Mr. Garrett further highlights various differences between coaxial cables and twisted pairs. Ex. 2001, ¶¶64-72. However, Mr. Garrett fails to explain how those differences would make a POSITA exclude teachings from one network when addressing a problem in another. For example, Mr. Garrett explains that unshielded twisted pairs are different from coaxial cables because unshielded twisted pairs behave as a low-pass filter. Ex. 2001, ¶¶64-65. I find this statement misleading because coaxial cables behave similarly in terms of acting as a low pass filter, because the attenuation of coaxial cable is also proportional to the signal frequency

(i.e., higher attenuation with higher operating frequency). Ex. 1035, p. 387 (“the overall cable attenuation will increase approximately as the square root of frequency”). Mr. Garrett further refers to different bandwidths, operating frequencies, wavelengths and network topologies of coaxial cable networks as compared to twisted-pair telephone line networks. Ex. 2001, ¶¶68-72. However, Mr. Garrett fails to explain how these alleged differences impact the applicability of multicarrier modulation across these two networks. *Id.* For example, Mr. Garrett explains that because of the different wavelengths, “signals transmitted over coaxial cables at high frequencies are known to be [more] chaotic.” Ex. 2001, ¶ 70. However, that shows, if anything, that the need for multicarrier modulation is at least as apparent in coaxial cable networks as in telephone line networks. It does not demonstrate why a POSITA would consider the two types of networks as different fields.

22. Therefore, it is my opinion that both the ’518 patent and Mirfakhraei are within the same field of endeavor.

B. Mirfakhraei Is Reasonably Pertinent to the Problems that the ’518 Patent Addresses

23. It is my opinion that both the ’518 patent and Mirfakhraei address the same problem—improving communication efficiency in the face of channel impairments. And they do so with the same solution—bit-loaded multicarrier modulation. Ex. 1001, 4:37-46; Ex. 1007, ¶5. Mr. Garrett argues that the ’518 patent

presents a solution uniquely tailored to the coaxial environment, because its channel impairments arise from branched topologies and splitters—features absent in Mirfakhraei’s network. Ex. 2001, ¶¶73-76. However, a POSITA would understand that bit-loaded multicarrier modulation reduces the impact of channel impairments regardless of the cause of such impairments (e.g., whether the cause is splitters or something else).

24. The ’518 patent does not address those channel impairments by eliminating or reducing any particular causes of the impairments. For example, the ’518 patent does not modify existing splitters or network topologies. Rather, the ’518 patent merely allocates more bits to less impaired subchannels, precisely what is taught by Mirfakhraei. Ex. 1001, 8:9-12; Ex. 1007, ¶¶5-8. Therefore, a POSITA, seeking to address channel impairments in a coaxial cable LAN, would look to Mirfakhraei for the solution because Mirfakhraei addresses the same problem.

III. A POSITA WOULD HAVE COMBINED AFSHARY AND MIRFAKHRAEI

A. A POSITA Would Have Ample Motivation to Combine Afshary and Mirfakhraei

25. As stated in my first Declaration, a POSITA would have ample motivation to combine Afshary and Mirfakhraei to achieve higher transmission efficiency, because Afshary discloses a network that is known to have various channel impairments and Mirfakhraei’s bit-loaded multicarrier modulation

addresses channel impairments. Ex. 1002, ¶¶127-128, 139, 145-147. Mr. Garrett cites Afshary's statement, "cables themselves are a very clear, clean medium," and takes the statement out of context, attempting to show that Afshary's network does not suffer from channel impairments. Ex. 2001, ¶127 (citing Ex. 1006, ¶ 24). However, Afshary's statement is about the cables "themselves." Afshary's cable network includes much more than cables. Ex. 1006, ¶¶42. For example, Afshary's cable network includes splitters, which are known to cause various channel impairments. *See Id.*; *see also, e.g.*, Ex. 1018, p. 305 ("Taps, amplifiers, and splitters can all cause signals to be reflected at their insertion points. In particular, splitters in subscriber homes are known to have poor isolation characteristics"); Ex. 1010, pp. 374-375 (describing channel impairments including "impulse noise, radio frequency ingress, and **spectral variability**," "passband ripple, spectral nulls, impulse noise, and radio-frequency interference," and "problems caused by changes in the channel frequency response.").

26. It is my opinion that a POSITA would understand that Mirfakhraei's bit-loaded multicarrier modulation has general applicability across different types of networks and addresses different types of channel impairments, including reflections, attenuations, and interference-which can cause the communications channel to exhibit frequency dependent attenuation. Ex. 1010; Ex. 1018. As stated above (¶6), bit-loaded multicarrier modulation benefits a transmission network that

communicates over a channel that experiences frequency dependent attenuation by breaking a frequency selective range of frequencies into smaller sub-channels such that each experience “nearly-flat frequency responses” (Ex. 1010, p. 375), assigning more bits to sub-channels that are more reliable, and assigning fewer bits to sub-channels that are less reliable, so that the data rate is optimized for each individual sub-channel without sacrificing the network robustness. Ex. 1007, ¶¶4, 17-18, 23-24; Ex. 1010, p. 375. Bit-loaded multi-carrier modulation therefore enables robust and reliable communications while not constraining the number of bits per sub-channel, and its techniques are applicable to any communications channel that is subject to frequency selective attenuation, regardless of the sources causing the channel to experience frequency dependent attenuation.

27. Therefore, a POSITA would understand that bit-loaded multicarrier modulation, as taught by Mirfakhraei, would benefit Afshary in addressing Afshary’s channel impairments in a similar way as it addresses channel impairments in telephone lines.

28. Mr. Garrett alleges that “Mr. Bertonis fails to identify a single instance of bit-loading on a coaxial network in any reference in this proceeding.” Ex. 2001, ¶119. However, that is clearly incorrect. As I explained in paragraph 127 of my first Declaration, the use of bit-loaded multicarrier modulation was known in the prior art. Ex. 1002, ¶127; Ex. 1010, p. 379 (“DMT can [] be used effectively in multipoint-

to-point environments,” on “cable or HFC networks.”); Ex. 1018, pp. 306-307 (noting the benefits of multi-carrier modulation in a CATV network, including addressing attenuation and making tolerable “severe and unpredictable interference.”). Mr. Garrett admits that he did not consider these references in providing his Declaration. Ex. 1032, 35:6-36:9.

B. Afshary is Ready for Improvement with Mirfakhraei’s Bit-Loaded Multicarrier Modulation

29. PO alleges that FSK, BPSK, and QPSK are all “single carrier modulation schemes,” supposedly reflecting Afshary’s thoughtful choice of single carrier modulation. POR, pp. 32-33. This is inaccurate. As explained in my first Declaration, FSK, BPSK, and QPSK represent different types/orders of modulation dictating how (and how many) bits are represented within a symbol of *a specific carrier*. Each could be applied to either single carrier modulation (if one carrier is used in a transmission) or multi-carrier modulation (if multiple carriers are used in a transmission). Ex. 1002 ¶¶ 29-44, 49; Ex. 1024, pages 161-192. In other words, FSK, BPSK, and QPSK differ in how bits are represented within a symbol of a specific carrier and are not related to the number of subcarriers used in a transmission. *Id.* For example, BPSK is a lower order modulation scheme (1 bit in each symbol) compared with QPSK (also known as “4-QAM”), which includes 2 bits in each symbol. *Id.* Above QPSK are successively higher orders of QAM that include more bits in each symbol (e.g., 16-QAM, 32-QAM, and 64-QAM). Ex. 1002,

¶¶45-47. When a single carrier modulation is used, only one modulation scheme is used. When multicarrier modulation is used, a respective modulation scheme is selected for each specific subcarrier. Ex. 1002, ¶51. Bit-loading specifies different orders of modulation schemes for different sub-channels, based on factors such as channel capacity (e.g., SNR) and the desired data transmission rate. Ex. 1007, ¶6.

30. It is my opinion that the different modulation schemes described by Afshary suggest a readiness for use with bit-loaded multicarrier modulation, which indeed uses different modulation schemes. Ex. 1007, ¶6.

31. Mr. Garrett stated that Afshary's system uses lower-order modulation schemes such as BPSK to "buil[d] in margin of safety," so that the transmission could tolerate channel impairments better than higher-order modulation schemes like 256-QAM. Ex. 1032, 71:25-72:8. That precisely shows that Afshary is ready for improvement by multicarrier modulation, because Afshary's use of lower-orders of modulation reflects the limitations of its single-carrier scheme and impedes Afshary's desire to achieve high-speed data transmission. Ex. 1006, ¶¶4-6. A POSITA would understand that, with Mirfakhraei's bit-loaded multicarrier modulation, higher data transmission speed could be achieved without sacrificing reliability. *See* Ex. 1010, p. 375 ("DMT can maximize the bit rate supported on any channel ... As a result, the aggregate bit rate on the channel is generally higher than it would be using a single-carrier technique."); Ex. 1018, p. 312 ("Furthermore,

DMT can easily adapt to a variety of channel degradations, optimizing the system bit rate for a given channel and complexity.”).

C. Mirfakhraei’s Multi-Carrier Modulation Is Not Redundant to Afshary’s Network

32. I disagree with Mr. Garrett’s opinion that the use of Afshary’s filters, error correction protocols, and/or cable shield removes the motivation to use Mirfakhraei to further improve the transmission efficiency of Afshary’s network. Ex. 2001, ¶¶122, 123, 129.

33. A POSITA would understand that a communication system typically employs multiple mechanisms to achieve transmission robustness and/or efficiency, and therefore the existence of one mechanism does not necessarily make another one redundant. For example, Mirfakhraei describes the use of multi-carrier modulation in combination with various filters to address channel impairments and also error detection and correction codes. *See, e.g.*, Ex. 1007 ¶17 (“encoder 112 may interleave the data and append cyclic redundancy codes or error detection and correction codes to the data,” ¶24 (“TEQ 180 filters incoming samples to ...reduce distortion across the broadband signal”); *id.* (“[a] frequency domain equalizer [] filters the frequency components to [] reduce channel distortion”). The use of multiple mechanisms is also evidenced by Afshary (describing the use of both filters and error correction protocols) and the ’518 patent (describing the use of “power loading, adaptive power control, and frequency coordination ... in combination to implement a network that

overcomes the problem of multipath and high attenuation.”). Ex. 1006, ¶¶36-37, 42; Ex. 1001, 4:42-47.

34. Further, a POSITA would understand that neither the filters nor error correction protocols disclosed in Afshary are an absolute solution to channel impairments. Afshary describes “[f]ilters within Baseband section 90 filters out [the] reflected signals” that are caused by “low pass filter 18.” Ex. 1006, ¶42. Afshary does not state the filters filter out all reflected signals from the entire network nor do I believe these filters would be capable of doing so. Mirfakhraei’s multicarrier modulation provides another approach to mitigate channel impairments that can be used in conjunction with any of these other techniques. Mr. Garrett provides no reasonable explanation as to why a POSITA would treat Mirfakhraei’s bit loading as redundant while all other references mentioned above employ multiple mechanisms to achieve system robustness.

35. Therefore, it is my opinion that Mirfakhraei’s multi-carrier modulation is not redundant in view of Afshary’s use of other mechanisms to improve the reliability of network communications.

D. Mirfakhraei’s Multi-Carrier Modulation Does Not Frustrate Afshary’s Goal of Cost-Saving

36. A POSITA would understand that a tradeoff typically exists between performance and cost/complexity. A communication system with a higher transmission rate or greater robustness typically requires more expensive or complex

components, and the choice of specific components is often based on the system's need. Even assuming, *arguendo*, that replacing Afshary's single carrier modulation with Mirfakhraei's multicarrier modulation would add cost/complexity, such cost/complexity comes with the benefit of a more efficient and robust system. Ex. 1007, ¶¶4, 17-18, 23-24; Ex. 1010, p. 375. A POSITA would use Mirfakhraei's multicarrier modulator in exchange for these benefits as desired.

37. In addition, while Afshary identifies cost efficiency as one goal, Afshary describes other objectives, such as providing a quick and secure transmission of high bandwidth data. Ex. 1006, ¶27 ("A significant advantage of this invention is ...to quickly distribute digital video and other types of high-bandwidth data"); *Id.*, ¶6 (describing "a need to transmit data ... in ... quick, and secure fashion"). Mirfakhraei's modulator benefits Afshary's system by supporting the goal of transmitting data more quickly and therefore does not frustrate Afshary's goal.

38. Indeed, a POSITA would understand that Afshary's use of a low-cost adapter and lower-order modulation schemes is based on the low-performance requirement in a private home. Ex. 1006, ¶43 ("The cable LAN has been described in reference to use in a private home, but may be used for any enterprise that has cabling equal to or superior than that found in a typical private home."). A POSITA would also understand that achieving a higher performance system (e.g., in settings

beyond a private home) would require a higher-cost adapter capable of multicarrier modulation and/or a higher order of modulation. *Id.*

39. The discussion above assumes that multicarrier modulation is more complex than single carrier modulation, as alleged by Mr. Garrett. Ex. 2001, ¶¶89-91. However, there is no evidence the overall cost and complexity of multicarrier modulation are higher, as the difference between sequential and parallel processing, as described by Mr. Garrett, is only one contributing factor. Evidence shows that the “computational complexity of [a] multicarrier system [can be] significantly less than that of [a] single-carrier system,” especially in networks that suffer from interference and/or reflections, because single carrier modulation systems require more complex equalization techniques to achieve equivalent throughput. Ex. 1018, pp. 305-306. Again, I note that Mr. Garrett did consider Ex. 1018, much less its comparative analysis between single carrier modulation and multi-carrier modulation. Ex. 1032, 35:6-36:9. Given that Afshary’s network suffers from various types of channel impairments, a POSITA would not conclude that multicarrier modulation is necessarily more complex overall.

IV. A POSITA WOULD HAVE KNOWN HOW TO IMPLEMENT THE COMBINATION OF AFSHARY AND MIRFAKHRAEI

A. Applying Mirfakhraei's Teachings to Afshary Would Yield an Operable System for the Same Reasons the Alleged Invention of the '518 Patent is Operable

40. I disagree with Mr. Garrett's argument that applying Mirfakhraei to Afshary would result in an inoperable system. Ex. 2001, ¶¶92-110. Mr. Garrett raised various issues regarding why a POSITA would not be able to implement Mirfakhraei's teaching in Afshary, which I address below.

41. Before addressing the individual arguments in detail, it is important to note that the network architectures in Afshary and the '518 patent are essentially identical, and the bit-loaded multicarrier modulation techniques in Mirfakhraei and the '518 patent are also essentially the same. Neither PO nor Mr. Garrett disputes that. Below is a side-by-side comparison of the '518 patent Figure 2 (left) and Afshary Figure 1 (right). Afshary's Figure 1 depicts the network in an inverted orientation relative to Figure 2 of the '518 patent, but the architectures are virtually identical.

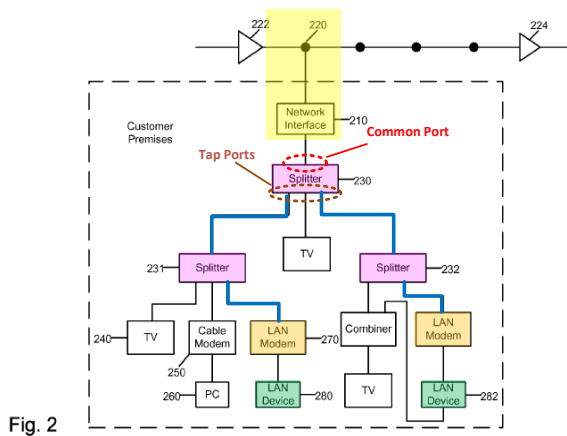


Fig. 2

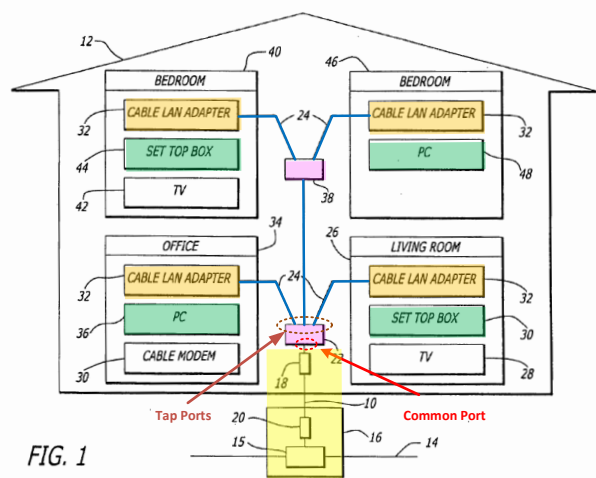


FIG. 1

Figure 2 of '518 patent (left, annotated); Figure 1 of Afshary (right, annotated)

42. As shown in Figure 2 of the '518 patent, when LAN device 280 communicates with LAN device 282, the data signal from the LAN modem connected to LAN device 280 traverses splitter 231 (e.g., entering through its tap port and exiting through its common port), passes through the cable between splitter 231 and 230, traverses splitter 230 (entering through one of its tap port and exiting through another), passing through the cable between splitter 230 and 232, and then goes through splitter 232 (entering through its common port and exiting through its tap port) to reach the LAN modem connected to LAN device 282. Similarly, in Afshary, when PC 48 communicates with PC 36, the data signal from cable LAN adapter 32 traverses splitter 38 (entering through its tap port and exiting through its common port), passing through the cable between splitter 38 and splitter 22, and traverses splitter 22 (entering through one of its tap port and exiting through another) to reach cable LAN adapter 32 connected to PC 36 via multiple segments of cable

wiring. Thus, in both the '518 patent's network and Afshary's network, communication between two devices traverses multiple coaxial cable segments and splitters.

43. Therefore, if Afshary's system were incompatible with a bit-loaded multicarrier modulation scheme, then the network in the '518 patent would equally be inoperable. Yet, the '518 patent does not describe how to overcome the purported difficulties raised by Mr. Garrett, which indicates that the '518 patent assumes a POSITA would have the knowledge to implement the bit-loaded multicarrier modulation in its coaxial cable LAN, and hence Afshary's coaxial cable LAN, without issue.

44. Mr. Garrett contends that because Afshary's network consists of multiple points connected to each other via cables and splitters, a POSITA would not be able to use Mirfakhraei's handshake messages (for channel probing) to determine specific channel characteristics between two endpoints as a handshake message would necessarily be sent to and responded by all devices in Afshary's network, and the handshake transmitter would not be able to distinguish where each response originates from. Ex. 2001, ¶¶101-110. However, Mirfakhraei's handshake messages operate in essentially the same manner as the probing messages in the '518 patent—and Mr. Garrett does not argue otherwise. Just as the '518 patent itself trusts that a POSITA would be able to implement probing messages in its LAN (e.g., it

does not explain any specific approaches to facilitate probing messages within its multi-point network to avoid the issue raised by Mr. Garrett), there is no reason to believe that a POSITA would be unable to implement Mirfakhraei's handshake messages in Afshary.

45. Similarly, Mr. Garrett argues that the combination of Afshary and Mirfakhraei would be inoperable due to the alleged absence of a controller. Ex. 2001, ¶98. However, the '518 patent itself does not explicitly disclose a controller within its LAN device or explain how a controller would manage multicarrier modulation. The only references by the '518 patent to a "controller" pertains to a "central controller" or a "controller node" in the network. Ex. 1001, 6:48-52; 11:43-46. The '518 patent does not disclose any controller within a network device, which indicates that the '518 patent trusts a POSITA would have the knowledge to implement one as needed. As another example, Mr. Garrett contends that Afshary's TDMA protocol would be incompatible with Mirfakhraei's handshake protocol or the combined system would require an alternative synchronization mechanism. Ex. 2001, ¶98. This argument is unfounded because the '518 patent itself assumes a POSITA would be able to implement both an existing TDMA protocol and the signal probing mechanism with no issue. Ex. 1001, 6:11-24 (stating that "the present invention can use a time division duplex (TDD) protocol [and] time division multiple access (TDMA)" without imposing any specific limitation on how TDMA and bit loading

are coordinated). I also note that none of the '518 patent claims requires a controller, a TDMA protocol, or any synchronization mechanism.

46. Because of the essentially identical network architectures of Afshary and the '518 patent, the same types of channel impairments arise in each network and therefore none of the channel impairments in the network of the '518 patent are unique or unknown in the art. Mr. Garrett explains that channel impairments in the '518 patent result from splitters, variations in signal paths between different device pairs, and imperfect connection points, all of which contribute to reflections, signal attenuation, and inter-symbol interference ("ISI"). Ex. 2001, ¶¶47-49. However, Afshary's network suffers equally from those impairments due to the presence of splitters, signal path variations, and imperfect connection points. See also my paragraphs 5-10 above discussing evidence from prior art references regarding channel impairments in coaxial cable networks.

B. Mirfakhraei's Bit Loading Scheme Is Compatible with Afshary's Multi-Point Network Topology

47. Mr. Garrett fabricates a nonexistent problem by alleging that, because Afshary has a multipoint network topology, a POSITA would not be able to use Mirfakhraei's handshake messages (for channel probing) to determine specific channel characteristics between two endpoints, as a handshake message would necessarily be sent to and responded by all devices in Afshary's network, and the handshake transmitter would not be able to distinguish where each response

originates, with the sub-optimal result that the bit-loading would be “based on the SNR profile to the worst-case end-point.”) Ex. 2001, ¶104. I note that during his deposition, Mr. Garrett admitted that the problem is based on the assumption of a **broadcast** transmission and would not arise in a non-broadcast scenario. Ex. 1032, 67:17-68:5. Mr. Garrett further admitted that Afshary’s network is not limited to broadcast. *Id.*, 62:14-16. I agree that Afshary is not so limited. Later on, Mr. Garrett confusingly and conflictingly alleges that this same problem would arise in a case where “a handshake signal [is sent] to every single client in the system, even when transmitting the same data.” Ex. 2001, ¶ 108; *see also, id.* ¶¶ 109-110. In his deposition, Mr. Garrett testified that here he was addressing a **non**-broadcast scenario. Ex. 1032, 68:18-69:14.

48. Regardless, it is my opinion that a POSITA would readily address this alleged issue of determining “where the return signals originated” (Ex. 2001, ¶ 108) using fundamental principles of how devices communicate with each other in a LAN—namely by including addresses in the messages to identify the sender and the recipient(s). For example, a message transmitted over a LAN typically includes a source identifier to identify the sending device and a destination identifier to identify the intended recipient(s). In a LAN, when the message reaches a LAN device, the LAN device determines whether it is the intended recipient, discarding messages not addressed to it and receiving (e.g., decoding) only those for which it is the intended

recipient. *See* Ex. 1034, 12-14, 150-151, 168-170, 184-186; Ex. 1033, 7-10, 275-282 (particularly 280-282); Ex. 1031, 252-263.

49. Afshary explicitly describes that a signal from a first adapter is transmitted to a “**designated** second adapter.” (Emphasis added). Ex. 1006, ¶41. Mr. Garrett’s further acknowledges that Afshary’s network “transmits packets with defined headers and preambles to ensure signal transmissions can be reliably received and decoded,” which is consistent with the known use addressing techniques by LANs. Ex. 2001, ¶123. Therefore, a POSITA would have known that a message in Afshary would be transmitted by a first adapter to a designated second adapter using addressing techniques.

50. A POSITA would also have known that, in the combined system, a handshake message taught in Mirfakhraei would be transmitted in the same way as any other message. The intended recipient of the handshake message (the designated second adapter) would receive the handshake message and other adapters would discard it, based on the destination address in the message. Similarly, the first adapter would be capable of determining where a response originated from, based on the source address in the response. Mr. Garrett provides no reasons, nor do I believe there are any reasons, as to why Mirfakhraei’s handshake messages would not be handled like routine communication messages between adapters in Afshary or the combined Afshary-Mirfakhraei system.

51. Thus, the bit-loading profile in the combined system would be tailored to the specific channel characteristic for each signal path (between a specific pair of LAN devices). Mr. Garrett’s argument that the bit-loading “would lead to the use of the SNR for the entire in-home coaxial environment rather than specific channel characteristics between each endpoint” is unfounded. Ex. 2001, ¶110.

C. A POSITA Would Have Known How to Implement Mirfakhraei’s “Multi-Carrier Modulator and Multi-Carrier Demodulator” in Afshary’s Adapter

52. It is my opinion that a POSITA would have understood how to modify Afshary’s adapter to incorporate Mirfakhraei’s teaching, and all the issues Mr. Garrett raises concerning “integrating Mirfakhraei’s multi-carrier modulator and demodulator and into Afshary’s single carrier system” would be readily addressed using knowledge well within the skillset of a POSITA.

53. Mr. Garrett assumes, without any justification, that in the combined system, Mirfakhraei’s handshake protocol would substitute for Afshary’s TDMA and then erroneously concludes that a synchronization mechanism would therefore be missing. Ex. 2001, ¶98. The assumption is completely unfounded because a POSITA would have understood that Mirfakhraei’s handshake process is indeed not a substitute for TDMA but instead would operate within the TDMA scheme already used by Afshary. It was well known to a POSITA that TDMA is simply a way to regulate access to the shared coaxial cable medium, by allocating time slots among

different users sharing a common frequency channel to avoid simultaneous transmission. Ex. 1006, ¶34; Ex. 1001, 6:11-24, 9:42-49; Ex. 1032, 46:13-47:17, 48:4-49:16. TDMA would be applied to all communications within Afshary's network, and there is no reason (nor does Mr. Garrett attempt to provide one) why Mirfakhraei's handshake signals would not be transmitted in accordance with the TDMA scheme in the combined system. Specifically, a POSITA would have understood that the handshake process as taught in Mirfakhraei does not require a dedicated connection. Even assuming, *arguendo*, that Mirfakhraei uses a dedicated connection, it was due to the deployment of twisted pair telephone lines, not due to the use of the handshake messages. Therefore, incorporating Mirfakhraei's handshake process into Afshary, the handshake process, in the combined system, would be implemented in the shared medium network as in Afshary, and operate with (not be substituted for) Afshary's TDMA scheme.

54. Since the combined system would use Afshary's TDMA, there is no additional or alternative synchronization mechanism required. During my deposition, I was asked whether Afshary describes a synchronization mechanism without any specific context. Ex. 2002, 87:1-92:18. In the context of Mr. Garrett's arguments regarding TDMA, I understand that PO and Mr. Garrett were using "synchronization" to refer to an arbitration mechanism for coordinating devices that share a common medium and avoiding simultaneous transmissions. Ex. 2001, ¶98.

However, without this context (as was the case during the deposition), “synchronization” is a broad term that can refer to different concepts. For example, Afshary describes using “a time division multiple access (TDMA) scheme that supports both isochronous and asynchronous data.” Ex. 1006, ¶34. Here, “asynchronous” does not refer to the absence of an arbitration mechanism (e.g., it is not the opposite of “synchronization” as discussed above), but rather to a distinct concept.

55. A POSITA would have known how to use a controller to manage Mirfakhraei’s handshake messages within the combination. As I stated in my first Declaration, the illustration figure provided (Ex.1002, p. 80) was merely intended to “visualize how Afshary’s cable LAN adapter would incorporate the functionality of Mirfakhraei’s multi-carrier modulator ... and the functionality of Mirfakhraei’s multi-carrier demodulator.” Ex. 1002, ¶143. There is no reasonable basis to understand that the illustrative figure suggests I intended to exclude the functioning of a controller in the combined system. In the combined system, the controller can be implemented in various approaches, by modifying the existing controller in Afshary’s adapter, integrating a controller from Mirfakhraei, or utilizing a new controller replacing both Afshary’s and Mirfakhraei’s controller. Any of these approaches were well in the skills of a POSITA.

56. Mr. Garrett also alleges that various “additional improvements” are required to modify Afshary with Mirfakhraei’s teaching, such as adding buffers and controls. Ex. 2001, ¶ 99. However, such modifications fall well within the skillset of a POSITA, and a POSITA would have a reasonable expectation of success in incorporating Mirfakhraei’s techniques into Afshary’s adapter – a point that Mr. Garrett does not dispute.

D. A POSITA Would Understand How to Implement Mirfakhraei’s Multi-carrier Signals over Afshary’s Operating Frequency Band

57. It is my opinion that a POSITA would understand that, in the combined system, Mirfakhraei’s multi-carrier signals would be transmitted over Afshary’s operating frequency range, despite that Mirfakhraei describes embodiments with a different operating frequency.

58. As explained in my first Declaration and depicted in Figure 3 of Afshary, Afshary’s RF & Mixed Signal section 100 includes components to translate modulated data from its Baseband section 90 to a 1300 MHz center frequency (red) while occupying a bandwidth of 5 MHz (dark blue). Ex. 1002, ¶123; Ex. 1006, ¶¶25, 38-39. Afshary explains that by doing so, Afshary’s cable LAN avoids lower frequencies used by existing services. Ex. 1002, ¶ 123; Ex. 1006, Abstract, ¶¶2, 7, 12, 24-25, 39, Figs. 1, 3. A POSITA incorporating Mirfakhraei’s multi-carrier signaling would, as far as bandwidth is concerned, simply follow what Afshary already teaches—up-conversion of baseband signals to a desired operating

frequency that avoids occupied lower frequencies. Ex. 1006, Abstract, ¶¶2, 7, 12, 24-25, 39, Figs. 1, 3.

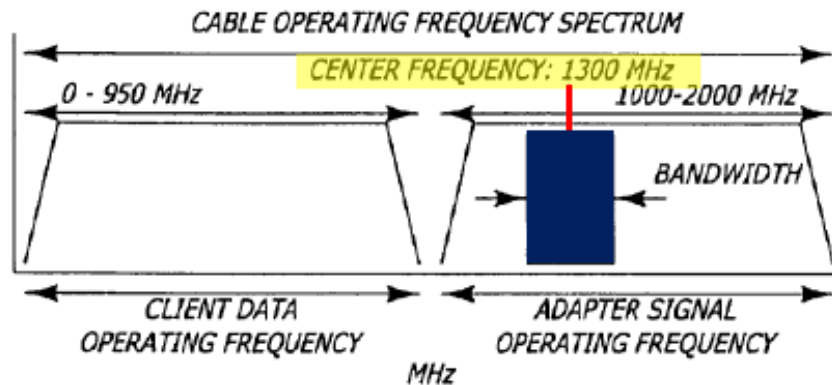


FIG. 3

Ex. 1006, Fig. 3 (annotated); Ex. 1002, p. 66

59. A POSITA would have understood that Mirfakhraei implements its signaling over a lower frequency range simply because Mirfakhraei describes an embodiment using twisted-pair as a communication medium and there is nothing limiting the multicarrier modulation, as taught by Mirfakhraei, to the lower frequency range. Mr. Garrett explains that different frequency bands lead to different levels of SNR. Ex. 2001, ¶115. However, a POSITA would understand how to implement Mirfakhraei's teaching by allocating appropriate numbers of bits to each subchannel based on their respective SNRs, regardless of whether the SNR variations stem from different operating frequency bands or other factors.

60. Mr. Garrett's arguments regarding the obviousness of claim 3 (Ex. 2001, ¶¶134-140) is likewise flawed because, as I explained, a POSITA would have

the skills to modify Afshary's RF & Mixed Signal section 100 to up-convert a signal to any suitable frequency, including a frequency above the one used by the cable television service, as required by claim 3. Ex. 1001, claim 3; Ex. 1006, Abstract, ¶¶ 2, 7, 12, 24-25, 39, Figs. 1, 3.

61. Mr. Garrett alleges that "Mirfakhraei's ... disclosure states modulation schemes over 'high[er] frequencies are difficult to accurately transmit' data. Ex. 1007 (Mirfakhraei), [0002])." Ex. 2001, ¶139. However, that is a mischaracterization of Mirfakhraei. Paragraph [0002] of Mirfakhraei discloses the difficulties of accurate transmission in higher frequencies over twisted telephone lines, and does not disclose that such difficulties are due to multicarrier modulation. *See* Ex. 1007, ¶2 ("A typical modem currently transmits data using ... a single carrier frequency. ... With such modems, the carrier frequency ... limit the maximum data transmission rate. Generally, a higher frequency carrier signal permits a higher data transmission rate, but high frequencies are difficult to accurately transmit using systems such as conventional telephone lines. ... Accordingly, the maximum data rate of a conventional modem architecture is limited."). A POSITA would understand that, in the combined system, signals would be transmitted over coaxial cable as taught by Afshary, not over telephone lines as taught by Mirfakhraei – therefore, a POSITA would understand the transmitting in higher frequencies would not cause the difficulties as alleged by Mr. Garrett.

V. MY QUALIFICATION TO OPINE FROM THE PERSPECTIVE OF A POSITA

62. While I do not agree with PO's proposed definition of a POSITA, which additionally requires "at least two years of experience with coaxial cables," (POR, 10), I am fully qualified to opine on the knowledge of a POSITA under both our definition (as I explained in my first Declaration, Ex. 1002, ¶¶4-15) and PO's definition. As indicated in my CV, I've had extensive experience in coaxial cable networks throughout my career. Ex. 1002, A1-A3. One of my early industry experiences involving coaxial cable began in 1976 at Blonder-Tongue Laboratories, where I was responsible for developing modulators and set-top boxes for cable TV systems. Ex. 1002, A3. Later in my career, I conducted various engineering and consulting projects related to DOCSIS standards, for example, during my time at Adbs Corporation (between 1984-2000) and Advanced Radio Cells Incorporated (ARCi) (later Arcwave Inc.) from 2000 to 2008. Ex. 1002, Appendix A; *id.* ¶¶12-13. I also published an academic paper titled "High Speed Wireless Internet over Unlicensed Radio Bands - An Innovative Approach," which discusses the application of DOCSIS. Ex. 1002, Appendix A; *id.* ¶¶12-13.

63. As I stated in my first Declaration, I also have extensive industrial experience in developing multicarrier modulators and demodulators. Ex. 1002, ¶¶13-14. For example, a WiMAX product I developed at Azurecomm was configured for OFDMA signals. *Id.* PO alleges that I had "no professional knowledge of multi-

carrier modulation schemes.” POR, p. 50. That takes my answers during my deposition clearly out of context. During the deposition, PO only asked about my “**first exposure** to ...DMT,” and after I provided an example of a professional exposure and a hobby-related exposure, PO continued to ask solely about the latter, without asking about my professional experience or anything later in my career (i.e., following my “first exposure”). Ex. 2002, 42:11-47:3. PO’s characterization is misleading and does not accurately reflect my actual experience, which is outlined in my CV and my first Declaration. Ex. 1002, ¶¶13-14; Appendix, A1-A3.

64. Finally, the fact that products I developed at ArcWave were sold to Comcast does not influence my opinion in the slightest. The sale was 20 years ago (around 2004), and the product was widely sold to essentially every major cable operator in the country, with Comcast being just one among many customers. Ex. 2002, 26:17-30:4. In addition, I was only responsible for the engineering work at that time, and was not involved in the sales or marketing of the products.

CONCLUSION

65. 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: 3-12-2025


James G. Bertonis