UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Cisco Systems, Inc.,
Petitioner

Case IPR2016-_____

U.S. Patent No. 8,432,956

DECLARATION OF DR. SAYFE KIAEI UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,432,956

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I, Sayfe Kiaei, do hereby declare as follows:

I. INTRODUCTION

1. I have been retained as an independent expert witness on behalf of Cisco Systems, Inc. ("Cisco") for the above-captioned Petition for *Inter Partes* Review ("IPR") of U.S. Patent No. 8,432,956 ("the '956 patent"). I am being compensated at my usual and customary rate of $400 per hour for the time I spend in connection with this IPR. My compensation is not affected by the outcome of this IPR.

2. I have been asked to provide my opinions regarding whether claims 1-10 ("the Challenged Claims") of the '956 patent are invalid as they would have been obvious to a person having ordinary skill in the art ("POSITA") at the time of the alleged invention. It is my opinion that all of the limitations of claims 1-10 would have been obvious to a POSITA after reviewing the Milbrandt, Hwang and ANSI T1.413 references, as discussed further below.

3. The '956 patent issued on April 30, 2013, from U.S. Patent Appl. No. 13/476,310, filed May 21, 2012. The '310 Application is a continuation of U.S. Patent Appl. No. 12/779,660, filed on May 13, 2010, which is a continuation U.S. Patent Appl. No. 12/477,742, filed on Jun. 3, 2009, which is a continuation of U.S. Patent Appl. No. 10/619,691, filed July 16, 2003, which is a continuation of U.S. Patent Appl. No. 09/755,173, filed on January 8, 2001. The '956 patent also claims

the benefit of U.S. Provisional Application No. 60/224,308, filed on August 10, 2000, and U.S. Provisional Application No. 60/174,865, filed on January 7, 2000.[1]

4. The face of the '956 patent names David M. Krinsky and Robert Edmund Pizzano, Jr., as the inventors. Further, the face of the '956 patent identifies TQ Delta, LLC as the assignee of the '956 patent.

5. In preparing this Declaration, I have reviewed:

a) the '956 patent, Ex. 1001;

b) the file history of the '956 patent, Ex. 1002;

c) the file histories of the patent applications to which the '956 patent is related, Ex. 1003-1008;

d) the prior art references discussed below: Ex. 1011 (Milbrandt), Ex. 1013 (Hwang), and Ex. 1014 (ANSI T1.413); and

e) selected portions of these references, as discussed below:

- Charles K. Summers, ADSL Standards, Implementation, and Architecture (CRC Press 1999) ("Summers"),

[1] Although it does not appear that the '956 patent claims are entitled to the provisional date of January 7, 2000, this declaration presents prior art and analysis which demonstrates that the Challenged Claims would have been obvious even as of the provisional date.

- Walter Goralski, ADSL and DSL Technologies (McGraw-Hill 1998) ("Goralski"),
- Harry Newton, Newton's Telecom Dictionary, 16th Ed. (2000) ("Newton's"),
- Valerie Illingworth and John Daintith, The Facts on File Dictionary of Computer Science (Market House Books 2001) ("Illingworth"),
- Thomas Starr, John M. Cioffi, Peter J. Silverman, Understanding Digital Subscriber Line Technology, (Prentice Hall 1999) ("Starr"),
- Andrew S. Tanenbaum, Computer Networks (Prentice Hall 1996) ("Tanenbaum"),
- B. P. Lathi, Modern Digital and Analog Communication Systems (Oxford University Press 1998) ("Lathi"), and
- Behzad Razavi, RF Microelectronics (Prentice Hall 1997) ("Razavi").

6. In forming the opinions expressed in this Declaration, I relied upon my education and experience in the relevant field of art, and have considered the viewpoint of a POSITA, as of January 7, 2000. I have also considered:

a) the documents listed above,

b) the additional documents and references cited in the analysis below,

c) the relevant legal standards, including the standard for obviousness provided in and any additional authoritative documents as cited in the body of this declaration, and

d) my knowledge and experience based upon my work in this area as described below.

7. I understand that in an IPR, claims are given their broadest reasonable interpretation in view of the patent specification and the understandings of a POSITA. I further understand that this is not the same claim construction standard as one would use in a District Court proceeding.

II. BACKGROUND AND QUALIFICATIONS

8. My qualifications are set forth in my curriculum vitae, a copy of which is attached as Ex. 1010 to this declaration. As set forth in my curriculum vitae:

9. I earned my B.S. in Computer and Electrical Engineering from Washington State University-Northeastern in 1982, a M.S. in Electrical and

Computer Engineering from Washington State University in 1984, and a PhD. in Electrical and Computer Engineering from Washington State University in 1987.

10. I have been a Professor at Arizona State University (ASU) since 2001. In this capacity, I have served as a Motorola Endowed Professor and Chair in analog and RF integrated circuits. I am also Director of ASU's Center on Global Energy Research and Director of NSF Connection One Research Center with a focus on integrated communication systems.

11. From 2009 to 2012, and concurrent with my position at ASU, I was the Associate Dean of Research at the Ira A. Fulton Schools of Engineering.

12. From 1993 to 2001, I was a senior member of technical staff with the Wireless Technology Center and Broadband Operations at Motorola. In that capacity, I was responsible for the development of RF and transceiver integrated circuits, GPS RF IC and digital subscriber lines (DSL) transceivers.

13. From 1987 to 1993, I served as an Associate Professor at Oregon State University.

14. In addition to the above noted positions, I was the Co-Director of the Industry-University Center for the Design of Analog/Digital ICs (CDADIC). Also, I am an IEEE Fellow, and have been the Chair and on the Technical Program Committee of several IEEE conferences including RFIC, MTT, ISCAS and other international conferences.

15. In total, I have more than thirty years of experience in research, development, design, commercialization, evaluation, and testing, of wireless technologies, products, and systems. My research interests include wireless transceiver design, RF, and mixed-signal IC's in CMOS and SiGe.

16. I have published more than 100 journal and conference papers and have been awarded several U.S. patents.

17. I have organized and chaired international conferences on electrochemical capacitor technology and taught short courses at Electrochemical Society and IEEE meetings.

III. UNDERSTANDING OF PATENT LAW

18. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my opinions. My understanding of the law was provided to me by Cisco's attorneys.

19. I understand that prior art to the '956 patent includes patents and printed publications in the relevant art that predate the priority date of the alleged invention recited in the '956 patent. I have applied the date of January 7, 2000, the filing date of the earliest provisional application in the chain of continuing applications resulting in the '956 patent, as the priority date. I understand,

however, that the '956 patent claims may not be entitled to this earlier date, and that the actual entitled priority date may be later.

20. I understand that a claim is invalid if it would have been obvious. Obviousness of a claim requires that the claim would have been obvious from the perspective of a POSITA at the time the alleged invention was made. I understand that a claim could have been obvious from a single prior art reference or from a combination of two or more prior art references.

21. I understand that an obviousness analysis requires an understanding of the scope and content of the prior art, any differences between the alleged invention and the prior art, and the level of ordinary skill in evaluating the pertinent art.

22. I further understand that certain factors may support or rebut the obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention.

I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

23. I further understand that a claim would have been obvious if it unites old elements with no change to their respective functions, or alters prior art by mere substitution of one element for another known in the field and that combination yields predictable results. Also, I understand that obviousness does not require physical combination/bodily incorporation, but rather consideration of what the combined teachings would have suggested to persons of ordinary skill in the art at the time of the alleged invention.

24. While it may be helpful to identify a reason for this combination, common sense should guide and no rigid requirement of finding a teaching, suggestion, or motivation to combine is required. When a product is available, design incentives and other market forces can prompt variations of it, either in the same field or different one. If a POSITA can implement a predictable variation, obviousness likely bars its patentability. For the same reason, if a technique has been used to improve one device and a POSITA would recognize that it would improve similar devices in the same way, using the technique would have been obvious. I understand that a claim would have been obvious if common sense directs one to combine multiple prior art references or add missing features to reproduce the alleged invention recited in the claims.

25. I am not aware of any allegations by the named inventor of the '956 patent or any assignee of the '956 patent that any secondary considerations tend to rebut the obviousness of any Challenged Claim of the '956 patent.

26. I understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

27. The analysis in this declaration is in accordance with the above-stated legal principles.

IV. THE '956 PATENT

28. The '956 patent relates to a "diagnostic information transmission mode allow[ing] for two modems to exchange diagnostic and/or test information that may not otherwise be exchangeable during normal communication." '956 patent, Abstract. The '956 patent states that "[i]n the diagnostic link mode, the RT [remote terminal] modem sends diagnostic and test information in the form of a collection of information bits to the CO [central office] modem that are, for example, modulated by using one bit per DTM [discrete multi-tone] symbol modulation." *Id.*, 3:50-53. "Other exemplary modulation techniques include Differential Phase Shift Keying (DPSK) on a subset or all the carriers, as specified

in, for example, ITU standard G.994.1, higher order QAM [quadrature amplitude modulated] modulation (>1 bit per carrier), or the like." *Id.* 3:55-59.

29. The '956 patent shows in Table 1, below, "an example of a data message that can be sent by the RT to the CO during the diagnostic link mode." *Id.* 4:31-32.

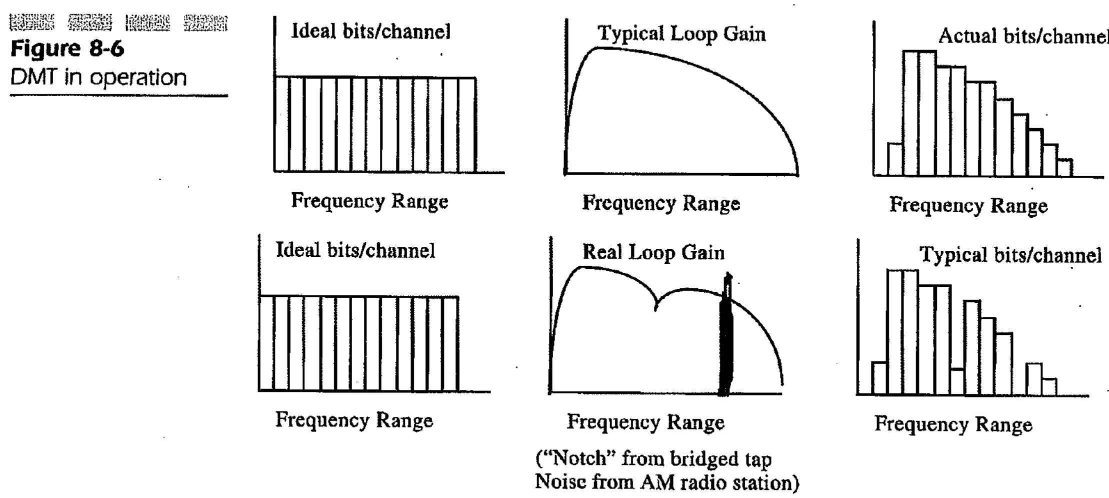
TABLE 1

Exemplary Message Variables
Data Sent in the Diag Link
Train Type
ADSL Standard
Chip Type
Vendor ID
Code Version
Average Reverb Received Signal
Programmable gain amplifier (PGA) Gain - Training
Programmable gain amplifier PGA Gain - Showtime
Filter Present during Idle Channel Calculation
Average Idle Channel Noise
Signal to Noise during Training
Signal to Noise during Showtime
Bits and Gains
Data Rate
Framing Mode
Margin
Reed-Solomon Coding Gain
QAM Usage
Frequency Domain Equalizer (FDQ) Coefficients
Gain Scale
Time domain equalizer (TDQ) Coefficients
Digital Echo Canceller (DEC) Coefficients

'956 patent, 4:7-30.

30. The '956 patent describes communicating digital data using discrete multitone (DMT) signals. Those of skill in the art would have been familiar with DMT, as it had been employed for over five years in various communication systems, including asymmetric digital subscriber line (ADSL) standards such as

ANSI T1.413-1995 and ITU G.992.1. Summers, 26-27; ANSI T1.413, 1-2. DMT divides the available communication bandwidth (range of frequencies) into multiple distinct subchannels (or subcarriers). Goralski, 187. Each subcarrier is tested for its characteristic signal attenuation (or the reciprocal, its signal gain) and for noise. *Id.,* 188. The amount of data encoded into each subchannel is then tailored to the subchannel's characteristics. A subchannel with a strong signal and low noise will have more bits of data encoded into it than another subchannel with a weaker signal or greater noise. These ideas are illustrated in the figure below.



Goralski, Fig. 8-6, 189.

31. As discussed above, the '956 patent purports to provide a diagnostic link mode for transmitting test or diagnostic information from one modem to another modem.

32. Independent claim 1 is representative of the Challenged Claims:

> 1. A transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation comprising:
>
> a transmitter portion capable of transmitting a message, wherein the message comprises one or more data variables that represent the diagnostic information, wherein bits in the message are modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and wherein at least one data variable of the one or more data variables comprises an array representing power level per subchannel information.

V. LEVEL OF ORDINARY SKILL IN THE PERTINENT ART

33. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a POSITA to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art. I understand that one of ordinary skill in the art has ordinary creativity, and is not a robot.

34. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field;

and (4) the prior art solutions to those problems. There are likely a wide range of educational backgrounds in the technology field pertinent to the '956 patent.

35. I am very familiar with the knowledge and capabilities that a POSITA of multicarrier communication systems (such as digital subscriber line (DSL) communications) would have possessed during the late 90s and early 2000s, especially as it pertains to testing lines for their support of multicarrier communications. Specifically, my experience in the industry, with colleagues from academia, and with engineers practicing in the industry during the relevant timeframe allowed me to become personally familiar with the knowledge and capabilities of a person of ordinary skill in the area of multicarrier communications. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art in the field of multicarrier communications during the time period around the priority date of the '956 patent.

36. In my opinion, the level of a POSITA needed to have the capability of understanding multicarrier communications and engineering principles applicable to the '956 patent is (i) a Master's degree in Electrical and/or Computer Engineering, or equivalent training, and (ii) approximately five years of experience working in digital telecommunications. Lack of work experience can be remedied by additional education, and vice versa. Such academic and industry experience would be necessary to appreciate what was obvious and/or anticipated in the

industry and what a POSITA would have thought and understood at the time. For example, an understanding of the '956 patent requires an appreciation of digital communications using discrete multitone (DMT) signals. Such knowledge would be within the level of skill in the art. I believe I possess such experience and knowledge, and am qualified to opine on the '956 patent.

37. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my experience and the understanding of a POSITA generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the field as of January 2000.

VI. BROADEST REASONABLE INTERPRETATION

38. It is my understanding that in order to properly evaluate the '956 patent, the terms of the claims must first be interpreted. It is my understanding that the claims are to be given their broadest reasonable interpretation in light of the specification. It is my further understanding that claim terms are given their ordinary and accustomed meaning as would be understood by a POSITA, unless the inventor, as a lexicographer, has set forth a special meaning for a term.

39. In order to construe the claims, I have reviewed the entirety of the '956 patent along with its prosecution history.

A. "during Showtime"

40. The term "during Showtime" appears in each of claims 9-10.

41. Aside from the claims, the term "during Showtime" appears in the '956 patent specification in only two locations. In the first reference, the specification references "a forward error correction or a CRC error during Showtime, e.g., the normal steady state transmission mode, or the like." '956 patent, 3:35-37. The second reference is to "Signal to Noise during Showtime" in Table 1 as one of the exemplary message variables that may be sent as diagnostic information:

TABLE 1

Exemplary Message Variables
Data Sent in the Diag Link
Train Type
ADSL Standard
Chip Type
Vendor ID
Code Version
Average Reverb Received Signal
Programmable gain amplifier (PGA) Gain - Training
Programmable gain amplifier PGA Gain - Showtime
Filter Present during Idle Channel Calculation
Average Idle Channel Noise
Signal to Noise during Training
Signal to Noise during Showtime
Bits and Gains
Data Rate
Framing Mode
Margin
Reed-Solomon Coding Gain
QAM Usage
Frequency Domain Equalizer (FDQ) Coefficients
Gain Scale
Time domain equalizer (TDQ) Coefficients
Digital Echo Canceller (DEC) Coefficients

’956 patent, 4:7-30.

42. The ’956 specification does not, however, describe how the “Signal to Noise during Showtime” information is measured, nor does it explain what tests are performed to gather information about a signal to noise ratio “during Showtime.”

43. Those of skill in the art would have been familiar with the concept of “Showtime,” which is a term of art in the DSL space used to refer to the mode that follows the completion of initialization and handshake equipment: “Following C-

SEGUE3 the ATU-C has completed initialization and enters state C-SHOWTIME." ANSI T1.413, 108. Showtime is used to describe the mode where the remote and the central office DSL modems can conduct normal communications over the access network. For example, a contemporary reference book on DSL communications states, "The connection is tested in both directions after which each modem notifies its peer that it is ready to enter normal communications, ***known in the standard as 'showtime.'***" Starr, 379. Also, the fact that the term "Showtime" is capitalized would suggest to a person of ordinary skill that the term is being used in accordance with its term of art meaning.

44. Thus, a POSITA would have understood the phrase "during Showtime" to refer to *during normal communications of an ANSI T1.413-compliant device*.

B. "array"

45. The term "array" appears in each of claims 1-10.

46. Aside from the claims, the term "array" appears in the '956 patent specification only once:

> Many variables that represent the type of diagnostic and test information that are used to analyze the condition of the link are sent from the RT modem to the CO modem. These variables can be, for example, ***arrays*** with different lengths depending on, for example, information in the initiate diagnostic mode message.

’956 patent, 4:43-48.

47. Thus, the ’956 patent does not provide an express definition for the term “array,” but instead uses it according to its ordinary meaning.

48. In my opinion, a POSITA would have been familiar with the term “array,” which is commonly used in both the computer and mathematical arts. Contemporary technical dictionaries define array as an “ordered collection of identical structures” (Newton’s, p. 71) or a “collection of data items … [that are] arranged in a particular order or pattern and are all of the same type.” (Facts on File Dictionary of Computer Science, p. 9).

49. Consistent with these dictionary definitions and the usage of the term “array” in the ’956 patent specification, I believe that a POSITA would have understood the broadest reasonable interpretation of “array” to mean *an ordered collection of multiple data items of the same type.*

C. “transceiver”

50. The term “transceiver” appears in the preamble of each of claims 1-10.

51. A POSITA would have been familiar with the term “transceiver” as being a combination of the words “<u>trans</u>mitter” and “re<u>ceiver</u>.” Consistent with this ordinary understanding, the ’956 patent specification states that a “transceiver” is also referred to as a modem and includes a transmitter and a receiver:

> For simplicity of reference, the systems and methods of the invention will hereafter ***refer to the transceivers generically as modems***. One such modem is typically located at a customer premises such as a home or business and is "downstream" from a central office with which it communicates. The other modem is typically located at the central office and is "upstream" from the customer premises. Consistent with industry practice, the modems are often referred to as "ATU-R" ("ADSL transceiver unit, remote," i.e., located at the customer premises) and "ATU-C" ("ADSL transceiver unit, central office" i.e., located at the central office). ***Each modem includes a transmitter section*** for transmitting data and ***a receiver section*** for receiving data, and is of the discrete multitone type, i.e., the modem transmits data over a multiplicity of subchannels of limited bandwidth.

'956 patent, 1:66:2:13. A POSITA would have understood that a modem, which stands for modulator/demodulator, is a transceiver since it modulates and demodulates for the purpose of transmitting and receiving.

52. A contemporary dictionary defines a transceiver as "Any device that transmits and receives." Newton's at 913.

53. Accordingly, I believe that a POSITA would have understood that the broadest reasonable interpretation of "transceiver" is a *device, such as a modem, with a transmitter and a receiver*.

54. I apply these constructions as the broadest reasonable constructions in view of the specification for purposes of this Declaration.

D. Other relevant terms

55. The '956 patent and the prior art – Milbrandt, Hwang, and ANSI T1.413 – describe communication systems that use Discrete Multitone Modulation (DMT). As DMT communication systems evolved, so did the terms that persons of ordinary skill in the art use to describe the system's components and functions. Some of these terms are different, but are used interchangeably by those of ordinary skill in the art, and refer to the same component or function in the communication system. I describe several of these terms below, with reference to the '956 patent and the prior art and Newton's.

56. **"Channel"** A channel is a medium over which data is transmitted. Newton describes a channel as a "path of communication, either electrical or electromagnetic, between two or more points." Newton's, 180. Example channel may be a twisted pair of a telephone wire, a fiber optic cable, or a quad cable. '956 patent, 5:36-39; Hwang, 5:3-5. The '956 patent refers to a broadband communications channel. '956 patent, 1:45-47.

57. A channel may have a defined frequency response, gain, and bandwidth. Newton's, 180. A bandwidth of an analog channel is typically measured in Hertz, which are cycles per second. Newton's, 101.

58. **"Subchannel"** A channel may be divided into multiple sub-channels, where each sub-channel has its own frequency. For example, the broadband communications channel of the '956 patent is formed by multiple carriers, where the carriers "form discrete, non-overlapping communication subchannels of limited bandwidth." '956 patent, 1:46-47.

59. Also, a person of ordinary skill would have recognized that the term "frequency sub-carrier" in the ANSI T1.413 standard (ANSI T1.413, 107) corresponds to Milbrandt's "sub-frequency" (Milbrandt, 12:14-31) and that both of these terms correspond to the "subchannel" in the '956 patent. '956 patent, 1:46-47.

60. **"Carrier"** A carrier is an electrical signal at a continuous frequency that is capable of being modified (also referred to as modulated) to carry information. The modifications can be changes to amplitude, frequency or phase. The modifications or the changes from the carrier's frequency become the carried information. Newton's, 159. A carrier may be another term for a sub-channel when the sub-channel's frequency is modified to carry information.

61. The '956 patent uses terms carrier and sub-channel in the same context. For example, "the carriers form discrete, non-overlapping communication subchannels of limited bandwidth" that collectively form a broadband communication channel. '956 patent, 1:46-47. Similarly, Hwang refers to the

signals being "carried over a distinct carrier frequency channel" where "frequency separation between consecutive carriers is 4.3125 KHz." Hwang, 2:67-3:5.

62. **"Tone"** A tone is a type of a carrier or a carrier signal. A tone refers to an "audio signal consisting of one or more superimposed amplitude modulated frequencies with a distinct cadence and duration." Newton's, 908. Hwang uses the terms "carrier" and "tone" interchangeably. For example, in Hwang, "[t]he frequency separation between consecutive carriers is 4.3125 KHz with a total number of 256 carriers or tones (ANSI)." Hwang, 3:3-5. And, in the "256 tone-carrier DMT coding scheme … tones 8-31 are used as carriers to provide an upstream channel of approximately 100 kHz analog bandwidth." Hwang, 3:5-3:14. The '956 patent also describes a discrete multitone transmission scheme to transmit data, where "the Average Reverb Signal contains the power levels per tone, up to, for example, 256 entries, detected during the ADSL Reverb signal." '956 patent, 4:34-38.

63. **"Frequency"** Frequency is a rate at which electronic signal alternates. As I mentioned above, frequency is measured in Hertz (Hz) and represents a number of cycles per second. A channel can have a particular frequency bandwidth that is divided among multiple sub-channels. The '956 patent describes an "upstream or ATU-C modem transmits data to the downstream or ATU-R modem over a first set of subchannels, which are usually the higher-frequency

subchannels" and "receives data from the downstream or ATU-R modem over a second, usually smaller, set of subchannels, commonly the lower-frequency subchannels." '956 patent, 2:10-16. Hwang describes "[t]he frequency separation between consecutive carriers" or subchanels "is 4.3125 KHz with a total number of 256 carriers or tones (ANSI)." Hwang, 2:66-3:5.

64. **"Symbol"** A symbol is a recognizable electrical state associated with an electrical signal, such as a carrier or a carrier signal. A symbol includes one or more data bits that are carried by a carrier during each cycle. In a binary transmission, a symbol can represent two possible states, e.g., 0 or 1. The '956 patent describes diagnostic and test data that is sent "in the form of a collection of information bits" and is "modulated by using one bit per DTM symbol modulation." '956 patent, 3:47-50. In this "one bit per DMT symbol modulation message encoding scheme, a bit with value 0 is mapped to the REVERB1 signal and a bit with a value of 1 mapped to a SEGUE1 signal." *Id.* 3:57-60. Hwang also describes a symbol that is transmitted using a sub-channel or a carrier, but using multiple bits rather than a single bit. For example, in Hwang "[e]ach tone is QAM to carry up to 15 bits of data on each cycle of the tone waveform (symbol)." Hwang, 3:11-12.

VII. DETAILED INVALIDITY ANALYSIS

65. I have been asked to provide my opinion as to whether the Challenged Claims of the '956 patent would have been obvious in view of the prior art. The discussion below provides a detailed analysis of how the prior art references identified below teach the limitations of the Challenged Claims of the '956 patent. It is my opinion that the Milbrandt, Hwang, and ANSI T1.413 references would have rendered obvious to a POSITA the subject matter of claims 1-10 of the '956 patent.

66. As part of my analysis, I have considered the scope and content of the prior art, and any differences between the alleged invention and the prior art. I took the time of the alleged invention to be the priority date of the earliest provisional application to which the application that issued as the '956 patent claimed priority— January 7, 2000—although it may be that the '956 patent claims are not entitled to this early date. I have also considered the level of ordinary skill in the pertinent art as of that date.

67. I describe in detail below the scope and content of the prior art, as well as any differences between the alleged invention and the prior art, on an element-by-element basis for each Challenged Claim of the '956 patent. At most, there are only minor differences between the identified prior art references and the alleged invention recited in the Challenged Claims of the '956 patent.

68. As described in detail below, the alleged invention of the Challenged Claims would have been obvious in view of the teachings of the identified prior art references as well as the knowledge of a POSITA.

A. Background on Prior Art References

69. Before providing a detailed analysis of how the prior art teaches the limitations of the Challenged Claims, I provide a brief summary of the prior art references.

1. Background on Milbrandt

70. Milbrandt describes technology that allows a digital subscriber line (DSL) service provider to test the telephone lines used to deliver service to its customers. Milbrandt's system collects measurements of "line noise" and other characteristics using devices located at the customers' premises. Ex. 1011, Abstract. The noise measurements and other information are transmitted from the customers' premises to the service provider's central office over the same telephone lines used to provide DSL service. *Id.*, 11:38-53. Milbrandt describes using the collected measurements for various purposes, including determining a transmit power level for the modems providing DSL services and estimating the data rate capacity of the subscriber lines. *Id.*, Abstract, 3:17-24, 10:18-24.

71. Milbrandt further describes how DSL services can provide for high speed data transmission and Internet access. *Id.*, 1:30-39. The communication

components in Milbrandt's network use "ADSL [asymmetric DSL] techniques that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation" to transmit and receive messages. *Id.*, 9:33-34.

2. Background on Hwang

72. Like Milbrandt, Hwang describes "higher-rate digital subscriber line communication schemes capable of utilizing twisted pair wiring from an office or other terminal node of a telephone network to the subscriber premises." Ex. Hwang, 2:23-27. Hwang further describes techniques used with Asymmetric Digital Subscriber Line, or ADSL, communications. Hwang explains that ADSL uses discrete multi-tone (DMT) technology to divide the available frequency range into 256 distinct carriers, or tones. *Id.,* 3:3-5. Within each carrier, data are encoded using quadrature amplitude modulation (QAM) signals. *Id.,* 3:1-3. Hwang explains that these techniques provide "effective high-speed data communications over twisted pair wiring between customer premises and corresponding network-side units, for example located at a central office of the telephone network." *Id.,* 3:15-19.

73. Thus, Hwang describes additional details about the DSL communication techniques referenced in Milbrandt. *See* Milbrandt, 9:31-34.

3. Background on ANSI T1.413-1995

74. I am personally familiar with the ANSI T1.413 reference (1995 version), i.e., Ex. 1014, relied upon in this declaration. Through my experience in the industry, I represented Motorola in DSL Telecommunications standard Working Group T1E1.4. In that capacity, I had the opportunity to review and became familiar with the ANSI T1.413 reference. Based on my personal knowledge and understanding, the ANSI T1.413 reference was made widely available to persons of ordinary skill in the art and to the public during and after 1995. Indeed, I personally received a copy of the ANSI T1.413 reference around 1996.

75. ANSI T1.413 is a standards specification defining the electrical characteristics and signals used in Asymmetric Digital Subscriber Line (ADSL) communications. ANSI T1.413, Abstract. The standard specifies the minimum requirements for equipment implementing ADSL. *Id.*

76. Among the features of ADSL is the encoding to data into discrete multitone (DMT) symbols. *Id.,* 23-34. Within each DMT subchannel, an ADSL transmitter encodes a variable number of bits of data using a constellation encoder. *Id.,* 43-45. Those of skill in the art would have recognized the constellation encoder of ANSI T1.413 as performing quadrature amplitude modulation. Goralski, p. 188.

B. Claims 1-10 are Obvious over Milbrandt, Hwang, and ANSI T1.413

77. It is my opinion that Milbrandt, Hwang, and ANSI T1.413 render claims 1-10 of the '956 patent obvious.

78. Unless otherwise noted, all ***bold italics*** emphasis in any quoted material has been added.

1. Reasons to Combine Milbrandt with Hwang

79. Milbrandt describes communicating via digital subscriber line (DSL) techniques, including Asymmetrical Digital Subscriber Line (ADSL). Milbrandt, 9:31-34. Hwang is similarly directed toward DSL communications to provide data services using a subscriber's existing twisted-pair copper telephone wiring. Hwang, 2:30-36. Hwang further describes the data modulation techniques employed by ADSL modems. As Hwang explains, "ADSL services utilize[] discrete multi-tone (DMT) technology." *Id.,* 2:66-67. Hwang provides additional details, beyond those expressly disclosed in Milbrandt, by explaining that multitone (DMT) symbols are modulated using quadrature amplitude modulation (QAM). Hwang, 2:67-3:3. This modulation technique allows up to 15 bits of data to be transmitted with each symbol. *Id.,* 3:11-12.

80. A POSITA would have found it obvious to combine the teachings of Milbrandt and Hwang because Hwang provides additional details of ADSL

communication technology. Because Milbrandt and Hwang all describe different aspects of the same ADSL communication technology, a POSITA would have found it obvious to refer to all of their teachings in implementing an ADSL communication system for the purpose of obtaining a more complete understanding.

81. Accordingly, it would have been obvious to a POSITA at the time to utilize up to 15 bits for each subchannel, as Hwang teaches, in the communication system of Milbrandt, for the purpose of transmitting more data on each subchannel. Also, it would have been obvious to transmit Milbrandt's message (including the subscriber line information) by modulating bits onto DMT symbols using QAM with up to 15 bits of data for each subchannel, because it would allow for utilization of the communications channel already established, which uses up to 15 bits of data for each subchannel, and allow for transmitting more data on each subchannel. Doing so would have resulted in a system that is overall more efficient and has higher throughput. A person of ordinary skill would have understood that transmitting data at a higher throughput would have practical implications such as improving service for customers and making the system as whole commercially desirable in the marketplace.

82. In short, the combination of Hwang with Milbrandt is nothing more than applying Hwang's known technique (i.e., using up to 15 bits per subchannel)

to the DSL system of Milbrandt that uses DMT/QAM, for the purpose of yielding predictable results (e.g., transmitting data more efficiently, increasing throughput, improving service for customers, and making the system as whole commercially desirable in the marketplace.)

2. Reasons to Combine Milbrandt/Hwang with ANSI T1.413

83. A POSITA would have found it obvious to combine the teachings of Milbrandt and Hwang with the teachings of ANSI T1.413 because Milbrandt and Hwang both describe ADSL communication systems, and ANSI T1.413 defines the ADSL communication standard. Because Milbrandt and Hwang implement the technology standardized by ANSI T1.413, a POSITA would have referred to the ANSI T1.413 document for additional details about how the ADSL communication equipment should function in accordance with the standard.

84. Additionally, Milbrandt specifically describes an embodiment "using ADSL techniques that comply with ANSI Standard T1.413." Milbrandt, 9:33-34. Hwang similarly refer to details of the ADSL standard set by ANSI. Hwang, 3:5. These explicit references in Milbrandt and Hwang would have directed the skilled artisan to combine the teachings of Milbrandt and Hwang with the teachings of ANSI T1.413. Accordingly, a POSITA would have utilized the teachings of ANSI T1.413, in the communication system represented by the combination of Milbrandt

and Hwang for the purpose making its devices and system compliant with the ANSI T1.413—which Milbrandt explicitly references as a desirable feature.

85. For example, with respect to noise information, ANSI T1.413 teaches that the subscriber modem determines and provides a signal to noise ratio (SNR) to the central office modem on demand for the purpose of system testing to thereby improve signal quality and reliability. ANSI T1.413, 103. It would have been obvious to a POSITA to have Milbrandt's subscriber modem to determine and transmit to the central office modem its SNR on demand (as ANSI T1.413 teaches), because it would facilitate system testing improve signal quality and reliability, and allow for Milbrandt's system to comply with the ANSI T1.413 standard.

86. As another example, ANSI T1.413 teaches that the subscriber modem determines a power level per sub-carrier based on a REVERB signal received from the central office modem. ANSI T1.413, 87 and 94-95. It would have been obvious to a POSITA to have Milbrandt's subscriber modem determine its power level based on a REVERB signal (as ANSI T1.413 teaches), because determining the power level per sub-carrier would allow the subscriber modem of Milbrandt to adjust its gains to an appropriate level, allow the subscriber modem to send back upstream to the central office modem the power levels to be used on each DMT

sub-carrier, and make Milbrandt's system compliant with the ANSI T1.413 standard.

87. Making Milbrandt's system compliant with the ANSI T1.413 standard would be desirable because it would allow for interoperability with other devices that are ANSI T1.413 standard compliant, make the overall system more robust since it has been developed through an accredited consensus process represented by the ANSI T1.413 standard, and also make the system as whole commercially desirable in the marketplace.

88. Along with looking to the ANSI T1.413 standard for its specific requirements to be standard compliant, a POSITA would have looked to ANSI T1.413 to gain a better understanding of how communications are performed in general. In one instance, with respect to communications, ANSI T1.413 teaches that the modems transmit in an orderly manner an array indexed by the sub-carrier number *i* to the upstream central office modem (ATU-C). ANSI T1.413, 107 and 110.

89. A POSITA would have recognized and it would have been obvious to transmit information pertaining to sub-carrier frequencies as an array (as ANSI T1.413 teaches), because it would allow for the information to be transmitted in an ordered manner and allow the receiving modem to receive and access the information on a per sub-carrier basis, without the need for additional processing

or reordering of the received information. A skilled artisan would have recognized that such an approach would minimize CPU utilization and provide an overall more efficient and organized communication approach.

90. In short, the combination of ANSI T1.413 with the system represented by the combination of Milbrandt and Hwang is nothing more than applying the ANSI T1.413's known techniques (i.e., using a standardized approach and transmitting data in array format on a per sub-carrier basis) to the DSL system of Milbrandt that seeks to comply to the ANSI T1.413 standard, for the purpose of yielding predictable results (e.g., facilitating system testing, improving signal reliability, allowing for gain adjustments to an appropriate level, allowing the subscriber modem to send back upstream to the central office modem the power levels to be used on each DMT sub-carrier, allowing for interoperability with other devices that are standard compliant, minimizing CPU utilization, providing an overall more efficient and organized communication approach, making the system more robust, and making the system as whole commercially desirable in the marketplace.)

VIII. **CHALLENGES**

91. I believe that the elements of claims 1-10 of the '956 patent are taught by the prior art discussed here. I have included claim charts that map the prior art to claims 1-10 in the pages that follow. These charts support my finding that the

differences between the claims of the '956 patent and the prior art discussed herein are such that the subject matter as a whole would have been obvious at the time of the filing of the '956 patent to a person having ordinary skill in the art to which the subject matter pertains. Reasons to combine are provided above and are also discussed in the charts below. The prior art elements combined as detailed in the below charts yield predictable results. I will now describe on an element-by-element basis how the prior art teaches all elements of claims 1-10.

Claims 1-10 are unpatentable over
Milbrandt, Hwang, and ANSI T1.413

U.S. Patent No. 8,432,956	Claims 1-10 are unpatentable over Milbrandt, Hwang, and ANSI T1.413
[1.0] A transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation comprising:	Milbrandt alone and in combination with Hwang discloses the features recited in the preamble, element [1.0]. As previously construed, a "transceiver" is a device such as a modem. First, Milbrandt teaches that modem 42 (of a subscriber 12) communicates data with via a communication channel (data line 40): "A computer 32 of a subscriber 12 already equipped to receive data service from communication system 10 includes an XDSL ***modem 42 that communicates data using data line 40***." Milbrandt, 4:46-49. Milbrandt also explains that the data line 40 is part of

	subscriber line 16, and thus subscriber line 16 is a "communication channel" that couples the modem 42 to a central office: > Throughout this description, phone line 38 and data line 40 may be referred to specifically, or collectively as part of ***subscriber line 16***. > * * * > Subscriber line 16 couples subscriber 12 to central office 14. Milbrandt, 5:25-27 & 5:39-40. Milbrandt provides further details about how the modem 42 is capable of gathering and transmitting diagnostic information: > "***In the diagnostic mode***, a modem 60 communicates to modem 42 a signal pulse at a known transmit power spectrum density . . . ***Modem 42 at subscriber premises 12*** receives the data signal . . . and ***determines subscriber line information 28, such as attenuation information . . . received signal power spectrum density, S_f***, . . . then extrapolates subscriber line information 28 for all frequencies in the frequency spectrum supported by subscriber line 16 ***and communicates the determined subscriber line information 28 to central office 14*** over any achievable range of sub-frequencies using any suitable communication protocols." Milbrandt, 11:31-51. > "[S]ubscriber line information 28 comprises

	information gathered by modems 60 and 42 operating in a ***diagnostic mode***. In a particular embodiment, information 28 extracted by server 18 comprises the transmit power spectrum density, Q_f, and the ***received power spectrum density, S_f, of a data signal communicated between a modem 60 and a modem 42*** for each channel of the data frequency spectrum supported by a particular subscriber line 16." Milbrandt, 27:25-32. "***Modem 42 measures the received signal power spectrum density, S_f,*** of the received data signal for each downlink channel ***and communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. Consistent with the interpretation of "transceiver" discussed above, Milbrandt's modem 42 is a "transceiver" as claimed. Indeed, it was known and well understood that a modem, such as Milbrandt's modem 42, performs both "modulation" and "demodulation" of data for the purpose of transmitting and receiving messages. Based on the quotes from Milbrandt above, a POSITA would have understood and it would have that the subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f), is diagnostic information transmitted to the central office. This is consistent with the '956 patent which discloses that the diagnostic information can include "received power information" and "power spectral density," which the '956 patent also calls

"Average Reverb Received Signal." '956 patent, 2:42-46; 4:17; 4:38-39; 6:12-14. To a POSITA, the phrase "power spectral density" in the '956 patent has the same meaning as the phrase "power spectrum density" in Milbrandt.

Milbrandt's communications system is illustrated in FIG. 1, reproduced below.

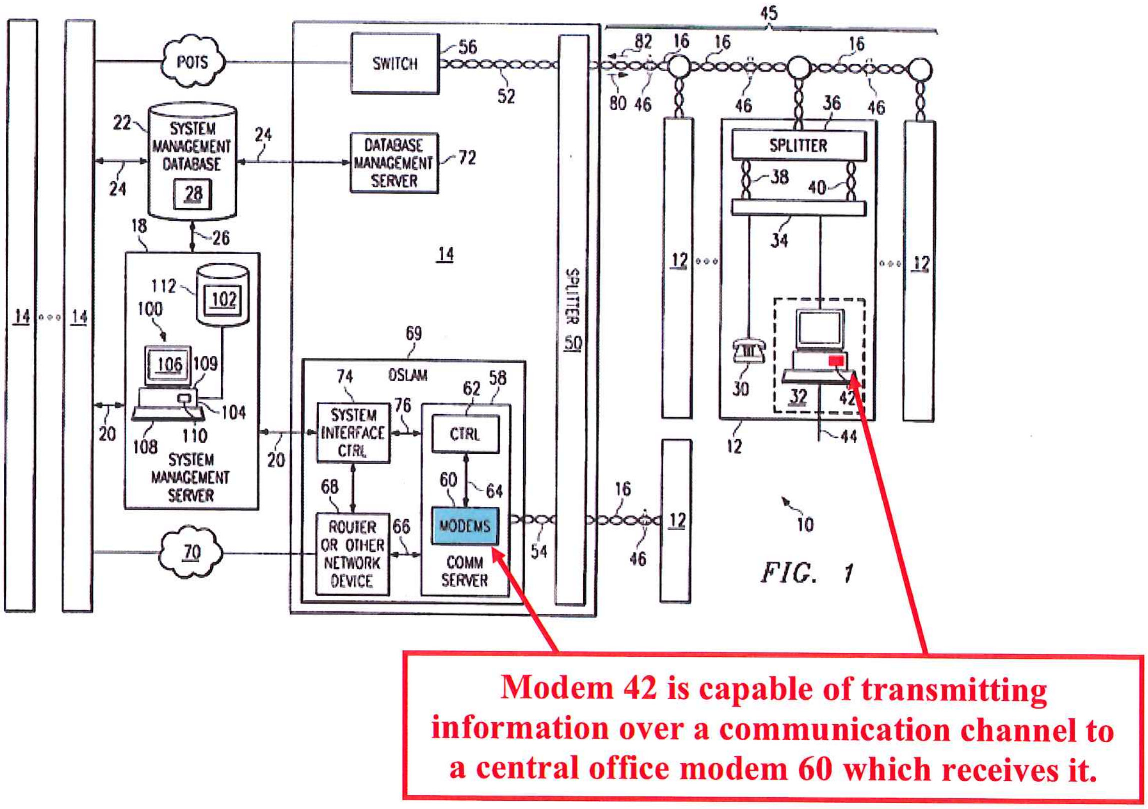


FIG. 1 of Milbrandt (annotated)

<u>Second</u>, Milbrandt further discloses that its transceiver (i.e., modem 42 at the subscriber 12) complies with DMT modulation to transmit data:

> "In one embodiment, subscriber line 16 and components of subscriber 12 and central office 14 support communication using

	> ***ADSL techniques that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation***." Milbrandt, 9:31-34. > "ADSL modems 60 increase the amount of data that the conventional twisted-pair subscriber lines 16 can carry by using ***DMT technology to divide the bandwidth of a subscriber line 16, generally referred to as the frequency spectrum supported by a subscriber line 16, into many individual sub-bands or channel***s." Milbrandt, 10:58-62. Discrete multitone (DMT) modulation is an example of multicarrier modulation. See '956 patent, 1:42-47 & 2:5-13. A POSITA would have understood that ADSL modem 42, which uses discrete multi tone (DMT) modulation to transmit data in each subchannel simultaneously, as taught by Milbrandt, as disclosed by Milbrandt, is performing multi-carrier modulation to transmit the subscriber line information. Thus, a POSITA would understand and it would have been obvious, therefore, that DMT modulation taught by Milbrandt is an example of "multicarrier communication" used by the transceiver (modem 42) to transmit diagnostic information, as claimed. Third, Hwang supplements the teachings of Milbrandt and describes, in its background, a communications system similar to Milbrandt's ADSL communications system for transmitting and receiving data. *See* Hwang, 2:66-67. In this context, Hwang teaches performing multi-carrier

	modulation by way of utilizing DMT technology to transmit information upstream over a communication channel: > "The FDM data transport for ***ADSL services utilizes discrete multi-tone (DMT) technology***. A DMT signal is basically the sum of N independently quadrature amplitude modulated (QAM) signals, each carried over a distinct carrier frequency channel. The frequency separation between consecutive carriers is 4.3125 KHz with a total number of 256 carriers or tones (ANSI). ***An asymmetrical implementation of this 256 tone-carrier DMT coding scheme might use tones 32-255 to provide a downstream channel of approximately 1 MHz analog bandwidth. In such an implementation, tones 8-31 are used as carriers to provide an upstream channel*** of approximately 100 KHz analog bandwidth. Each tone is QAM to carry up to 15 bits of data on each cycle of the tone waveform (symbol). An example of a conventional DMT-based system is illustrated in FIG. 1." Hwang, 2:66-3:14. A POSITA would have understood that "upstream channel" refers to the communication path from a remote device, such as a DSL modem located at a subscriber premises, to a central office modem. Thus, Hwang's tones 8-31, which are used as carriers to provide an upstream channel, discloses a communication channel using multicarrier modulation. Moreover, it is noted that the '956 patent, in the Background section, readily admits that DSL technology communicates by performing multi-carrier modulation:

	"***In DSL technology***, communications over a local subscriber loop between a central office and a subscriber premises is accomplished by modulating the data to be transmitted ***onto a multiplicity of discrete frequency carriers***." '956 patent, 1:42-45. Thus, because Milbrandt alone and in combination with Hwang discloses an ADSL modem 42 that transmits subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f) over communication channels using DMT modulation, the references teach "[a] transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation," as recited in the preamble, element [1.0], of claim 1.
[1.1] a transmitter portion capable of transmitting a message,	Milbrandt teaches the features recited in [1.1]. Milbrandt teaches that modem 42 is capable of transmitting a message: "***Modem 42 comprises any suitable communication device 65 that transmits*** and receives data in communication system 10 using any suitable digital subscriber line technology (xDSL), referred to generally as an XDSL communication." Milbrandt, 4:64-68. The communication device that transmits data is a "transmitter portion capable of transmitting a message." Milbrandt further explains: "***Modem 42*** measures the received signal

	power spectrum density, S_f, of the received data signal for each downlink channel and ***communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. Modem 42 then extrapolates subscriber line information 28 for all frequencies in the frequency spectrum supported by subscriber line 16 and communicates the determined subscriber line information 28 to central office 14 over any achievable range of sub-frequencies ***using any suitable communication protocols***. Milbrandt, 11:45-53. "In one embodiment, subscriber line 16 and ***components of subscriber 12*** and central office 14 support communication using ***ADSL techniques that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation***." Milbrandt, 9:31-34. "To access data services, in particular, a subscriber 12 operates a ***modem 42 . . . exchanges data with a modem 60 of a central office*** 14 using any suitable communication protocol." Milbrandt, 9:54-57. "Similarly, the attenuation information of subscriber line 16 at sub-frequencies supporting the uplink transmission of data

	may be obtained by measuring the power spectrum density, Q_f, of a ***signal transmitted by modem 42***, and the power spectrum density, S_f, of the signal received by modem 60, and performing the appropriate attenuation information modeling techniques as described above." Milbrandt, 12:50-57. A POSITA would have understood and it would have been obvious that Milbrandt's subscriber line information is transmitted in a message using DMT. Also, a POSITA would have understood and it would have been obvious that Milbrandt's modem 42, which transmits messages (including subscriber line information) to the central office, has a transmitter portion (communication device 65) for transmitting the message using DMT. Thus, Milbrandt's disclosure of modem 42, including the modem's communication device that transmits messages using DMT, teaches "a transmitter portion capable of transmitting a message," as recited in element [1.1] of claim 1.
[1.2] wherein the message comprises one or more data variables that represent the diagnostic information,	Milbrandt teaches the features recited in [1.2]. <u>First</u>, Milbrandt teaches that modem 42 (at the subscriber 12) determines subscriber line information by measuring a received signal: "***In the diagnostic mode***, a modem 60 communicates to modem 42 a signal pulse at a known transmit power spectrum density . . . Modem 42 at subscriber premises 12 receives the data signal . . . and ***determines subscriber line information 28, such as attenuation information . . . received signal***

	power spectrum density, S_f.*"** Milbrandt, 11:31-43. It would have been obvious to a POSITA that the values representing Milbrandt's measurements of attenuation and power spectrum density per sub-frequency are "one or more data variables," as claimed. Thus, a POSITA would have understood that the determined subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f) is one or more data variables that represent the diagnostic information. Second, Milbrandt teaches that modem 42 communicates to modem 60 (at the central office) a message including the determined subscriber line information: "Modem 42*** then extrapolates subscriber line information 28 for all frequencies in the frequency spectrum supported by subscriber line 16 and ***communicates the determined subscriber line information 28 to central office 14*** over any achievable range of sub-frequencies using any suitable communication protocols." Milbrandt, 11:45-51. It would have been obvious to a POSITA that modem 42 communicates the determined subscriber line information by transmitting a message including one or more data variables representing the subscriber line information. Thus, communicating subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f) discloses that the message comprises one or more data

	variables that represent the diagnostic information. Thus, Milbrandt disclosing that modem 42 determines diagnostic information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f) and communicates the information to the central office in a message, teaches that "the message comprises one or more data variables that represent the diagnostic information," as recited in element [1.2] of claim 1.
[1.3] wherein bits in the message are modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	The combination of Milbrandt and Hwang teaches the features recited in [1.3]. <u>First</u>, Milbrandt discloses that modem 42 (at the subscriber) supports communication using ADSL techniques that comply with DMT modulation: "In one embodiment, subscriber line 16 and ***components of subscriber 12*** and central office 14 support communication using ***ADSL techniques that comply with . . . discrete multi tone (DMT) modulation***." Milbrandt, 9:31-34. "***DMT technology is very useful for ADSL*** technology where the sub-channels are divided into groups and one group of ***channels is allocated for the uplink transmission of data*** and the other for the downlink transmission of data." Milbrandt, 11:6-10. <u>Second</u>, Milbrandt teaches that modem 60 (at the central office) and modem 42 (at the subscriber) transmit and receive data by modulating the data onto DMT symbols

	using QAM: > "ADSL modems 60 increase the amount of data that the conventional twisted-pair ***subscriber lines 16 can carry by using DMT technology to divide the bandwidth*** of a subscriber line 16, generally referred to as the frequency spectrum supported by a subscriber line 16, into many individual sub-bands or channels. ***Each channel of a subscriber line 16 uses a form of quadrature amplitude modulation (QAM) to transmit data in each channel simultaneously***." Milbrandt, 10:58-65. Thus, it would have been understood and obvious that Milbrandt's modem 42 (at the subscriber) transmits a message (including subscriber line information) whose bits are modulated onto DMT symbols using QAM to modem 60. However, Milbrandt does not describe in detail how many bits are used for the QAM. Third, on the other hand, Hwang teaches that the bits in the message are modulated onto DMT symbols using QAM with more than 1 bit per subchannel: > "The FDM data transport for ***ADSL services utilizes discrete multi-tone (DMT) technology***. ***A DMT signal is basically the sum of N independently quadrature amplitude modulated (QAM) signals, each carried over a distinct carrier frequency channel***. The frequency separation between consecutive carriers is 4.3125 KHz with a total number of 256 carriers or tones (ANSI). An asymmetrical implementation of

	this 256 tone-carrier ***DMT coding scheme*** might use tones 32-255 to provide a downstream channel of approximately 1 MHz analog bandwidth. In such an implementation, ***tones 8-31 are used as carriers to provide an upstream channel of approximately 100 KHz analog bandwidth. Each tone is QAM to carry up to 15 bits of data on each cycle of the tone waveform (symbol).*** An example of a conventional DMT-based system is illustrated in FIG. 1." Hwang, 2:66-3:14. In the above passage, Hwang describes that tones 8-31 (which are subchannels used for upstream communication) carry coded DMT symbols using QAM with up to 15 bits of data per subchannel. Since both Milbrandt and Hwang employ ADSL, DMT and QAM communication techniques, it would have been obvious to a person of ordinary skill in the art to transmit Milbrandt's message (including subscriber line information) by modulating bits in the message onto DMT symbols using QAM with more than 1 bit per subchannel, as taught by Hwang. Thus, the combination of Milbrandt and Hwang teaches that the "bits in the message are modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel," as recited in element [1.3] of claim 1.
[1.4] wherein at least one data variable of the one or more data variables comprises an array representing power level per subchannel information.	The combination of Milbrandt and ANSI T1.413, teaches the features recited in [1.4], because Milbrandt teaches determining and transmitting information representing power level per-frequency and ANSI T1.413 teaches transmitting per-frequency data variables in an array format. <u>First</u>, Milbrandt teaches that modem 42 determines

	frequency domain power spectrum density and attenuation information for sub-frequencies (i.e., frequency sub-channels): "Modem 42 at the subscriber premises 12 receives the data signal that is communicated by modem 60 and ***determines subscriber line information 28, such as attenuation information . . . received signal power spectrum density, S_f,*** or any other information describing the physical or operating characteristics of subscriber line 16 ***at the one or more sub-frequencies*** over which the connection between modem 60 and 42 is established." Milbrandt, 11:38-45. Milbrandt's disclosure of "sub-frequencies," over which the connection between modem 60 and 42 is established, would have been understood to be a "subchannel." It would have been understood by a person of ordinary skill that the power spectrum density per sub-frequency (subchannel) represents the power level of the spectral components within that sub-frequency (subchannel). See, e.g., Lathi, at 126-127 ("the PSD Sg (*w*) ***represents the power*** per unit bandwidth (in hertz) of the spectral components at the frequency *w*.") Razavi at 34 ("The spectral density, $S_x(f)$ . . ***shows how much power the signal carries*** in a unit bandwidth around frequency *f*.") Further, this understanding is demonstrated by ANSI T1.413. ANSI T1.413, 94-95 ("The nominal transmit ***PSD*** for C-REVERB1 is -40 dBm/Hz (i.e., -3.65 dBm ***total transmit power in any 4.3125 KHz sliding window*** over the used passband.") The window is a subchannel and the PSD within that subchannel represents the power level.

	Also, the '956 patent further confirms that the REVERB1 signal of ANSI T1.413 provides the power level per subchannel information. '956 patent, 3:63-64 and 4:38-40. Accordingly, a POSITA would have understood that power spectrum density per sub-frequency, as Milbrandt teaches, is representative of the power level at the sub-frequencies (subchannels) within the spectrum. Further, Milbrandt teaches that the attenuation information is related to the transmit and received power per subchannel (power spectrum density per sub-frequency) by the ratio of the received power per subchannel (S_f) over the transmit power per subchannel (Q_f) shown by the following equation: "[At]tenuation information and may be modeled by the following equation:" $$\|H_f\| = \sqrt{\frac{S_f}{Q_f}}$$ where: H_f = attenuation information for subscriber line 16 at sub-frequency (f); Q_f = power spectrum density of a signal transmitted at sub-frequency(f); and S_f = power spectrum density of the signal received at sub-frequency (f). Milbrandt, 12:14-31. Since the attenuation information is power loss per sub-frequency, and is related to the power spectrum density per sub-frequency by the above noted equation, the attenuation information represents the power

	level per sub-frequency. Therefore, each of Milbrandt's determined power spectrum density per sub-frequency and attenuation information per sub-frequency is information representing the power level per subchannel (sub-frequency). Second, Milbrandt teaches that attenuation information (representative of the power level) is stored as an array (an ordered arrangement with a grid of rows and columns) as a function of frequency: "Line noise grid 370 includes a row 372 for each entry of column 306 of subscriber line grid 300, and a column 374 for each sub-frequency at which the noise is determined for a particular subscriber line 16. Generally, the combination of ***grids 360*** and 370 ***establish the attenuation information*** and noise information ***of subscriber lines 16 as a function of frequency***." Milbrandt, 23:51-57 and FIG. 3; see also *Id.,* 13:5-8. A person of ordinary skill in the art would have recognized Milbrandt's grid as an "array."

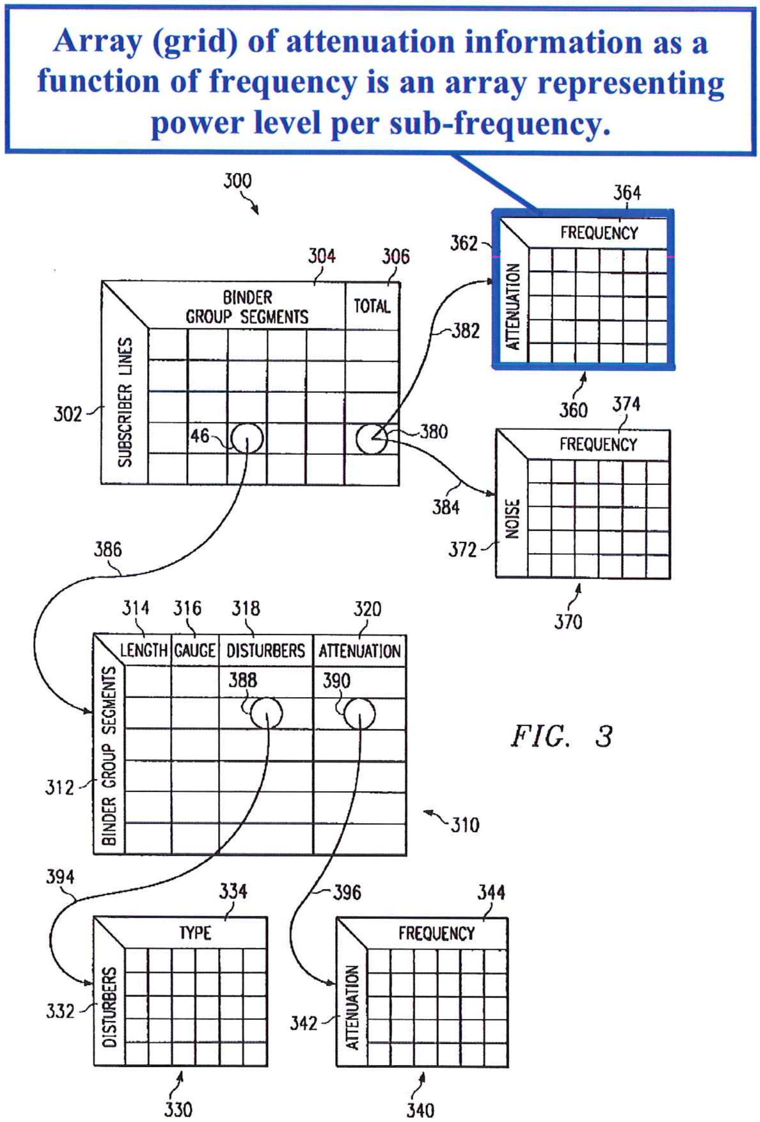


FIG. 3 of Milbrandt (annotated)

<u>Third</u>, Milbrandt teaches that the power spectrum density per sub-frequency and attenuation information per sub-frequency is communicated to the central office modem 60 in a message:

> "***Modem 42*** then extrapolates subscriber line information 28 for all frequencies in the frequency spectrum supported by subscriber

	line 16 and ***communicates the determined subscriber line information 28 [i.e., power spectrum density, S_f, and attenuation information H_f] to central office 14*** over any achievable range of sub-frequencies using any suitable communication protocols." Milbrandt, 11:45-51. "***Modem 42 measures the received signal power spectrum density, S_f, of the received data signal*** for each downlink channel ***and communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. Accordingly, at least one data variable (e.g., power spectrum density per sub-frequency and attenuation information per sub-frequency (which is stored as an array)) of the data that Milbrandt communicates to the home office modem 60 in the message represents the power level per sub-frequency. Milbrandt, however, is silent as to whether the information is transmitted as an array. Fourth, Milbrandt notes that it "support[s] ***communication using ADSL techniques that comply with ANSI Standard T1.413*** such as discrete multi tone (DMT) modulation." Milbrandt, 9:31-34. A POSITA, therefore, would have looked to the ANSI T1.413 standard document to gain a better understanding of how communications are performed. With respect to communications, ANSI T1.413 teaches techniques for transmitting data variables that have a value for a plurality of frequency sub-carriers. Specifically, ANSI T1.413 teaches transmitting each data variable as an ordered sequence of values:

	"*. . .* ***transmit to the ATU-R the bits and gains information, {b1, g1, b2, g2, ... b 255, g31}***, that are to be used on the upstream sub-carriers. b_i indicates the number of bits to be coded by the ATU-R transmitter onto the *i* th upstream carrier." ANSI T1.413, 107. "*. . .* ***transmit to the ATU-C the bits and gains information, {b1, g1, b2, g2, ... b 255, g255}***, to be used on the downstream sub-carriers. b_i indicates the number of bits to be coded by the ATU-C transmitter onto the *i* th downstream sub-carrier g_i indicates the scale factor that shall be applied to the *i* th downstream sub-carrier." ANSI T1.413, 110. A POSITA would have recognized that the term "frequency sub-carrier" in the ANSI T1.413 standard corresponds to Milbrandt's "sub-frequency," and that both of these terms correspond to the claimed "subchannel." It would have been obvious to a POSITA to transmit to the central office modem Milbrandt's power spectrum density per sub-frequency and attenuation information per sub-frequency in an array format (as ANSI T1.413 teaches), because it would provide efficient and ordered communication and because it would allow the central office modem to receive and access the information on a per channel basis, without the need for additional processing or reordering of the received information. Thus, the combination of Milbrandt and ANSI T1.413 teaches that "at least one data variable of the one or more

	data variables comprises an array representing power level per subchannel information," as recited in element [1.4] of claim 1.
[2.0] The transceiver of claim 1,	See [1.0-1.4]
[2.1] wherein the power level per subchannel information is based on a Reverb signal.	The combination of Milbrandt and ANSI T1.413, teaches the features recited in [2.1]. As discussed above at [1.4], Milbrandt teaches that modem 42 measures a signal received from the central office modem 60 and determines the power spectrum density (PSD) at "one or more sub-frequencies over which the connection between modem 60 and 42 is established." Milbrandt, 11:38-45. ANSI T1.413 supplements Milbrandt and teaches that during training the central office modem (ATU-C) transmits to the subscriber modem (ATU-R) a REVERB signal, which is modulated for all sub-carriers: "C-***REVERB1*** . . . The bits shall be used as follows: the first pair of bits (d1 and d2) is used for the dc and Nyquist sub-carriers (the power assigned to them is, of course, zero, so the bits are effectively ignored); ***then the first and second bits of subsequent pairs are used to define the Xi and Yi. for i = 1 to 255***." ANSI T1.413, 94. Based on the above, a POSITA would have understood that the REVERB signal modulates all the sub-carriers (1-255).

	Further, ANSI T1.413 teaches that measuring the REVERB signal to determine PSD per sub-carrier: "... ***measure the aggregate received*** ... ***power on sub-carriers*** ... ***of R-REVERB1, and thereby calculate a downstream PSD***" "***The nominal transmit PSD for C-REVERB1*** is -40 dBm/Hz (i.e., -3.65 dBm total transmit power in any 4.3125 kHz sliding window over the used passband). If, however, the total received upstream ***power measured on sub-carriers 7-18 is greater than 3 dBm, then the PSD for C-REVERB1*** and all subsequent downstream signals shall be as shown in Table 26. " ANSI T1.413, 94-95. It would have been obvious to a person of ordinary skill in the art that ANSI T1.413's power spectrum density on subcarriers (sub-frequency S_f), which is based on the REVERB signal, is representative of "power level per subchannel information." See, e.g., Lathi, 126-127 ("the PSD Sg (*w*) ***represents the power*** per unit bandwidth (in hertz) of the spectral components at the frequency *w*.") Razavi, 34 ("The spectral density, $S_x(f)$ . . ***shows how much power the signal carries*** in a unit bandwidth around frequency *f*.") ANSI T1.413, plainly states that the power levels are determined: "Specifically, each [remote subscriber] receiver communicates to its far-end [central office] transmitter the number of bits and relative ***power levels to be used on each DMT sub-carrier*** . . . ***based on the results***

	> ***obtained through the transceiver training and channel analysis procedures.***" ANSI T1.413, 87. A POSITA would have understood that during training the REVERB signal, which is modulated for all the sub-carriers, is used to determine the power levels on each sub-carrier. Moreover it is noted that the '956 patent evidences that the ANSI T1.413 standard REVERB signal does in fact provide the basis for determining the power level per subchannel. Specifically, as the '956 patent admits, the "***REVERB1 . . . signals are defined in the ITU and ANSI ADSL standards***" and "the ***Average Reverb Signal contains the power levels per tone, up to, for example, 256 entries, detected during the ADSL Reverb signal.***" '956 patent, 3:63-4:40. Further still, ANSI T1.413 teaches that the determination of the power level per sub-carrier allows for the adjustment of gains for each sub-carrier: > "C-REVERB1 is a signal that ***allows the ATU-R receiver to adjust its automatic gain control*** (AGC) to an appropriate level." ANSI T1.413, 94. > "***g_i indicates the scale factor*** that shall be applied to the *i* th downstream sub-carrier." ANSI T1.413, 110. A person of ordinary skill would have determined the power level per subchannel information of Milbrandt based on a received C-REVERB1 signal, as taught by ANSI T1.413, for the purpose of making Milbrandt's system compliant with the ANSI T1.413 standard,

	allowing modem 42 at the subscriber premises to adjust its gains to an appropriate level for each sub-carrier, and allowing the subscriber modem to send back upstream to the central office modem the power levels to be used on each DMT sub-carrier for normal communication. Additionally, ANSI T1.413 describes a second REVERB signal that is used to train a receiver's equalizer: "C-REVERB2 is a signal that allows the ATU-R receiver to perform synchronization and to ***train any receiver equalizer***." ANSI T1.413, p. 95. It would have been obvious to a POSITA that a DSL transceiver (such as Milbrandt's modem 42) receiving the C-REVERB2 signal would measure the power level of each subchannel so that the receiver can properly set the training parameters for the equalizer. This is because the purpose of an equalizer in a multicarrier receiver is to adjust the frequency-dependent gain applied to the received signal so that the signal power level is approximately equal across all received frequencies. In order to adjust the equalizer settings, therefore, the receiving modem would need to measure the relative power level of the received signal as a function of frequency (i.e., subchannel). Thus, it would have been obvious to a POSITA that the power level per subchannel values transmitted by Milbrandt's modem 42 would be based on a Reverb signal as taught by ANSI T1.413.
[3.0] A transceiver capable of receiving diagnostic information over a communication channel using	Milbrandt alone and in combination with Hwang discloses the features recited in the preamble, element [3.0]. As previously construed, a "transceiver" is a device such as a modem.

multicarrier modulation comprising:	First, as analyzed above in element [1.0], Milbrandt describes a subscriber modem 42 that transmits data to a central office modem 60. It would have been obvious to a POSITA that Milbrandt's central office modem 60 receives those data. More specifically, Milbrandt teaches that modem 60 (of the central office 14) receives diagnostic information over a communication channel: "A ***modem 60 comprises any suitable communication device that . . . receives data in communication system 10*** using any suitable communication protocol supported by subscriber lines 16." Milbrandt, 6:47-50. "***In the diagnostic mode***, a modem 60 communicates to modem 42 a signal pulse at a known transmit power spectrum density . . . Modem 42 at subscriber premises 12 receives the data signal . . . and determines ***subscriber line information 28, such as attenuation information . . . received signal power spectrum density, S_f***, . . . then extrapolates subscriber line information 28 for all frequencies in the frequency spectrum supported by subscriber line 16 ***and communicates the determined subscriber line information 28 to central office 14*** over any achievable range of sub-frequencies using any suitable communication protocols." Milbrandt, 11:31-51. "***Modem 42 measures the received signal***

	power spectrum density, S_f, of the received data signal for each downlink channel ***and communicates this and other subscriber line information 28 to modem 60.***" Milbrandt, 11:19-24. Based on the above discussion, a POSITA would have understood that the subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information per sub-frequency H_f) is diagnostic information transmitted by modem 42 in a message using DMT and QAM with more than 1 bit per subchannel and that is received by modem 60 of the central office. This is consistent with the '956 patent which discloses that the diagnostic information can include "transmitted and received power information." '956 patent, 2:26-28. Milbrandt's communications system is illustrated in FIG. 1, reproduced below.

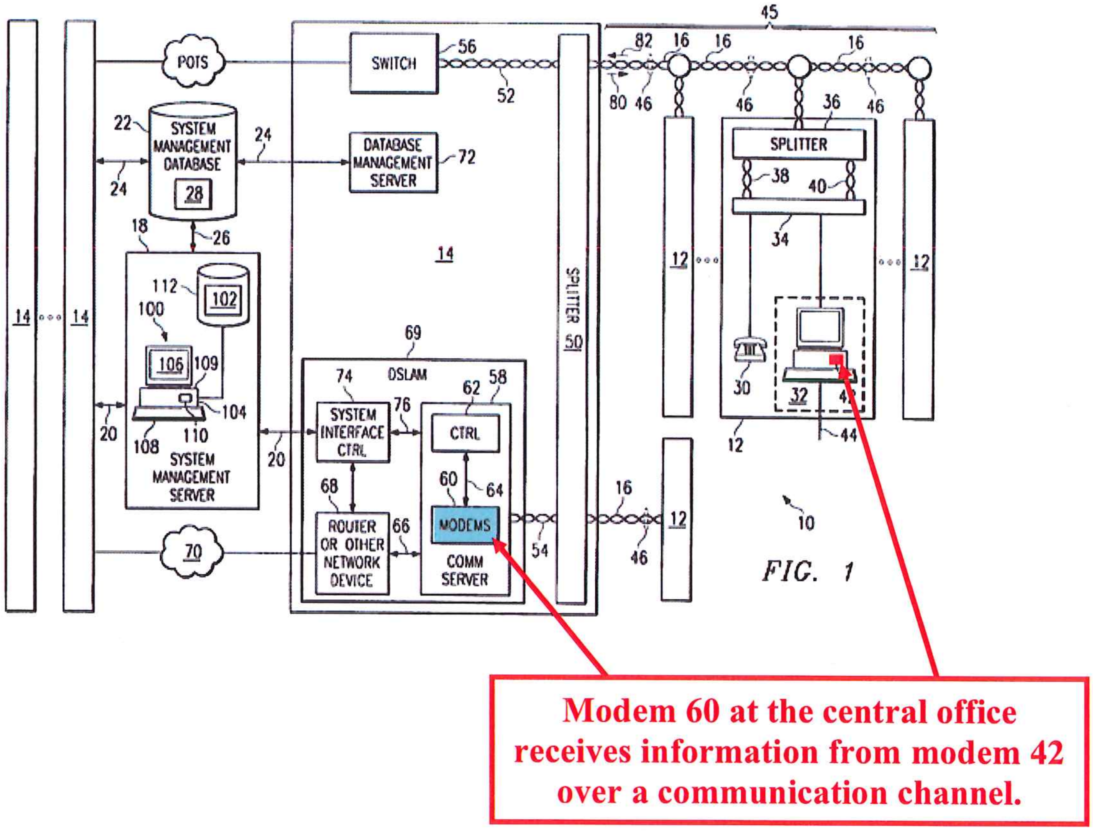


FIG. 1 of Milbrandt (annotated)

<u>Second</u>, Milbrandt further discloses that its transceiver (i.e., modem 60 at the central office 14) communicates over a channel using DMT:

> "In one embodiment, subscriber line 16 and components of subscriber 12 and ***central office 14*** support communication using ***ADSL techniques that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation***."

Milbrandt, 9:31-34.

> "***ADSL modems 60 increase the amount of data that the conventional twisted-pair subscriber lines 16 can carry by using***

	DMT technology to divide the bandwidth of a subscriber line 16, generally referred to as the frequency spectrum supported by a subscriber line 16, into many individual sub-bands or channels." Milbrandt, 10:58-62. Discrete multitone (DMT) modulation is an example of multicarrier modulation. See '956 patent, 1:42-47 & 2:5-13. Thus, a POSITA would have understood that the data received by modem 60 is modulated using multi-carrier modulation, such as DMT. Third, Hwang supplements the teachings of Milbrandt and describes, in its background, a communications system similar to Milbrandt's ADSL communications system for transmitting and receiving data. *See* Hwang, 2:66-67. In this context, Hwang teaches performing multi-carrier modulation by way of utilizing DMT technology for communications: "The FDM data transport for ***ADSL services utilizes discrete multi-tone (DMT) technology***. A DMT signal is basically the sum of N independently quadrature amplitude modulated (QAM) signals, each carried over a distinct carrier frequency channel. The frequency separation between consecutive carriers is 4.3125 KHz with a total number of 256 carriers or tones (ANSI). ***An asymmetrical implementation of this 256 tone-carrier DMT coding scheme might use tones 32-255 to provide a downstream channel of approximately 1 MHz analog bandwidth. In such an implementation, tones 8-31 are used as carriers to provide an upstream channel*** of

	approximately 100 KHz analog bandwidth. Each tone is QAM to carry up to 15 bits of data on each cycle of the tone waveform (symbol). An example of a conventional DMT-based system is illustrated in FIG. 1." Hwang, 2:66-3:14. A POSITA would have understood that upstream channel is used by the subscriber modem to communicate with the central office modem. Hence, tones 8-31 represent data received by Milbrandt's modem 60 at the central office. Accordingly, a POSITA would have understood that tones 8-31 which are used as carriers to provide an upstream channel, discloses a communication channel using multicarrier modulation. Moreover, it is noted that the '956 patent, in the Background section, readily admits that DSL technology communicates by performing multi-carrier modulation: "***In DSL technology***, communications over a local subscriber loop between a central office and a subscriber premises is accomplished by modulating the data to be transmitted ***onto a multiplicity of discrete frequency carriers***." '956 patent, 1:42-45. Accordingly, it would have been obvious to a person of ordinary skill in the art that modem 60 receives the message including the diagnostic information (subscriber line information) transmitted by modem 42 over the communications channel using DMT and QAM. Thus, because Milbrandt alone and in combination with Hwang discloses an ADSL modem that receives subscriber line information (including power spectrum density per sub-frequency S_f and attenuation information

	per sub-frequency H_f) over a communication channel using DMT modulation, the references teach "[a] transceiver capable of receiving diagnostic information over a communication channel using multicarrier modulation," as recited in the preamble, element [3.0], of claim 3.
[3.1] a receiver portion capable of receiving a message,	Milbrandt teaches the features recited in [3.1]. Milbrandt teaches that modem 60 is capable of receiving a message: "A ***modem 60 comprises any suitable communication device that transmits and receives data in communication system 10*** using any suitable communication protocol supported by subscriber lines 16. Modems 60 may be integrated into any suitable chipset that includes the appropriate hardware and memory to support the data scrambling and descrambling, encoding and decoding, interleaving and deinterleaving, data insertion and extraction, filtering, amplifying, and other signal processing techniques employed by the appropriate communication protocols. Modem 60 refers to one or more modems at central office 14 as well as any of the components of the modem chipset." Milbrandt, 6:47-58. The communication device within modem 60 that receives data is a "receiver portion capable of receiving a message." Milbrandt further explains:

	"***Modems 60 may collect information defining the operational characteristics of subscriber lines 16*** while providing data services to subscribers 12. This process of gathering ***subscriber line information*** 28 is referred to as "modem training," and generally occurs during the normal course of operation of system 10." Milbrandt, 10:40-46. "To access data services, in particular, a subscriber 12 operates a modem 42 . . . ***exchanges data with a modem 60 of a central office*** 14 using any suitable communication protocol." Milbrandt, 9:54-57. "Similarly, the attenuation information of subscriber line 16 at sub-frequencies supporting the uplink transmission of data may be obtained by measuring the power spectrum density, Q_f, of a signal transmitted by modem 42, and the power spectrum density, S_f, of ***the signal received by modem 60***, and performing the appropriate attenuation information modeling techniques as described above." Milbrandt, 12:50-57. A POSITA would have understood and it would have been obvious that Milbrandt's subscriber line information collected by modem 60 was received in a message transmitted by modem 42 which was modulated using DMT and QAM with more than one bit per subchannel. Also, a POSITA would have understood and it would have

	been obvious that Milbrandt's modem 60, which receives messages (including subscriber line information) from the subscriber modem 42, has a receiver portion (communication device) for receiving the message. Thus, Milbrandt's disclosure of modem 60 which receives a message teaches "a receiver portion capable of receiving a message," as recited in element [3.1] of claim 3.
[3.2] wherein the message comprises one or more data variables that represent the diagnostic information,	This limitation is the same as [1.2]. The analysis of element [1.2] focused on a "message" transmitted by Milbrandt's subscriber modem 42. It would have been obvious to a POSITA, however, that the same "message" is then received by Milbrandt's central office modem 60. Thus, the analysis of the "message" limitation in element [1.2] is equally applicable to the "message" limitation recited in this element [3.2].
[3.3] wherein bits in the message were modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	As discussed above at [1.3], Milbrandt teaches that the bits in the message transmitted by the subscriber modem 42 were modulated onto DMT symbols using QAM with more than 1 bit per subchannel. Further, as discussed above at [3.1], the central office modem 60 receives the message that was sent by modem 42. *See also* Milbrandt, 9:54-57 and 12:50-57. It would have been understood and it would have been obvious that the bits in the message, received by modem 60 from modem 42, were modulated onto DMT symbols using QAM with more than 1 bit per subchannel. Thus, Milbrandt teaches that "bits in the message were modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel," as recited in element [3.3] of claim 3.
[3.4] wherein at least one data variable of the one or more data	This limitation is the same as [1.4]. The analysis of element [1.4] focused on data transmitted by Milbrandt's subscriber modem 42. It would have been obvious to a

variables comprises an array representing power level per subchannel information.	POSITA, however, that the same data are then received by Milbrandt's central office modem 60. Thus, the analysis of the limitation in element [1.4] is equally applicable to the limitation recited in this element [3.4].
[4.0] The transceiver of claim 3,	See [3.0-3.4]
[4.1] wherein the power level per subchannel information is based on a Reverb signal.	This limitation is the same as [2.1] and is disclosed in the prior art as discussed in that same section above.
[5.0] In a transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation, a method comprising:	As discussed above in [1.0], the prior art discloses a transceiver (Milbrandt's modem 42) capable of transmitting diagnostic information over a communication channel using multicarrier modulation. Further, it is noted that the claim is directed to a one-step method of transmitting and Milbrandt throughout the specification discloses that in the transceiver (modem 42) a method for transmitting is performed. For example, Milbrandt discloses: "Another embodiment of the present invention is a ***method*** for determining the transmit power of a communication device operating on a twisted pair subscriber line. The method includes storing noise information for a first sub scriber line and a second subscriber line." Milbrandt, 2:36-40. "According to the first ***method***, ***if subscriber line 16e receives data services from central***

	office 14, then server 18 determines the attenuation and noise information of subscriber line 16e based upon information collected by modems 60 during training, as described above." Milbrandt, 20:58-62. "***Modem 42 measures the received signal power spectrum density***, S_f, of the received data signal for each downlink channel ***and communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. In view of the above disclosure, it would have been obvious to a POSITA that the modem 42 is performing a one-step method of transmitting. More specifically, a POSITA would have understood Milbrandt's modem 42 to be performing a method in a transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation. Further still, Hwang teaches a method performed in a transceiver capable of transmitting information: "Another aspect of the present invention provides a ***method of transmitting data from a network node***. The ***method includes transmitting a first packet*** comprising bits of data." Hwang, 4:15-17. Hwang further teaches that the information was transmitted over a communication channel using multicarrier modulation, such as DMT. Hwang, 2:66-3:14. Thus, the prior art discloses "[i]n a transceiver capable of

	transmitting diagnostic information over a communication channel using multicarrier modulation, a method," as recited in the preamble, element [5.0], of claim 5.
[5.1] transmitting a message,	Milbrandt teaches the features recited in [5.1]. Milbrandt teaches that modem 42 is transmitting a message: "***Modem 42 comprises any suitable communication device 65 that transmits*** and receives data in communication system 10 using any suitable digital subscriber line technology (xDSL), referred to generally as an XDSL communication." Milbrandt, 4:64-68. "***Modem 42*** measures the received signal power spectrum density, S_f, of the received data signal for each downlink channel and ***communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. "To access data services, in particular, a subscriber 12 operates a ***modem 42*** . . . ***exchanges data with a modem 60 of a central office*** 14 using any suitable communication protocol." Milbrandt, 9:54-57. "Similarly, the attenuation information of subscriber line 16 at sub-frequencies supporting the uplink transmission of data may be obtained by measuring the power

	> spectrum density, Q_f, of a ***signal transmitted by modem 42***, and the power spectrum density, S_f, of the signal received by modem 60, and performing the appropriate attenuation information modeling techniques as described above." Milbrandt, 12:50-57. > "***Modem 42*** at subscriber premises 12 . . . determines ***subscriber line information 28, such as attenuation information, noise information, received signal power spectrum density, S_f, or any other information describing the physical or operating characteristics of subscriber line 16*** at the one or more sub-frequencies . . . and ***communicates the determined subscriber line information 28 to central office 14*** over any achievable range of sub-frequencies using any suitable communication protocols, such as, for example, over a sub-frequency in the voice frequency spectrum using the V.90 communication protocol." Milbrandt, 11:38-53. A POSITA would have understood and it would have been obvious that Milbrandt's subscriber modem 42 communicates the subscriber line information by transmitting a message. Thus, Milbrandt's disclosure of modem 42 transmitting a message teaches "transmitting a message," as recited in element [5.1] of claim 5.
[5.2] wherein the message comprises one or more data	This limitation is the same as [1.2] and is disclosed in the prior art as discussed in that same section above.

variables that represent the diagnostic information,	
[5.3] wherein bits in the message are modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	This limitation is the same as [1.3] and is disclosed in the prior art as discussed in that same section above.
[5.4] wherein at least one data variable of the one or more data variables comprises an array representing power level per subchannel information.	This limitation is the same as [1.4] and is disclosed in the prior art as discussed in that same section above.
[6.0] The method of claim 5,	See [5.0-5.4]
[6.1] wherein the power level per subchannel information is based on a Reverb signal.	This limitation is the same as [2.1] and is disclosed in the prior art as discussed in that same section above.
[7.0] In a transceiver capable of receiving diagnostic information over a communication channel using	As discussed above in [3.0], the prior art discloses a transceiver (Milbrandt's modem 60) capable of receiving diagnostic information over a communication channel using multi carrier modulation. Further, Milbrandt throughout the specification discloses

multicarrier modulation, a method comprising:	that in the transceiver (modem 60) a method for receiving is performed. For example, Milbrandt discloses: "Another embodiment of the present invention is a ***method*** for determining the transmit power of a communication device operating on a twisted pair subscriber line. The method includes storing noise information for a first subscriber line and a second subscriber line." Milbrandt, 2:36-40. "According to the first ***method***, if subscriber line 16e receives data services from central office 14, then server 18 determines the attenuation and noise information of subscriber line 16e based upon ***information collected by modems 60 during training***, as described above." Milbrandt, 20:58-62. In view of the above disclosure, a POSITA would have understood that Milbrandt's modem 60 collects the information by performing a one-step method of receiving. Further still, Hwang teaches a method performed in a transceiver capable of receiving information: "The ***method also includes*** receiving an acknowledgement signal from a destination node when the ***first packet was received without errors***." Hwang, 4:18-20. Hwang further teaches that the information was received over a multicarrier communications channel, i.e., DMT. Hwang, 2:66-3:14. A POSITA would have understood that the transceiver that

	acknowledged that the information was received without errors was capable of receiving the information. Accordingly, Hwang also teaches a method performed in a transceiver capable of receiving information over a communication channel using multi carrier modulation. Thus, the prior art discloses "[i]n a transceiver capable of receiving diagnostic information over a communication channel using multicarrier modulation, a method," as recited in the preamble, element [7.0], of claim 7.
[7.1] receiving a message,	Milbrandt teaches the features recited in [7.1]. Milbrandt teaches that modem 60 receives a message: "A ***modem 60 comprises any suitable communication device that transmits and receives data in communication system 10*** using any suitable communication protocol supported by subscriber lines 16. Modems 60 may be integrated into any suitable chipset that includes the appropriate hardware and memory to support the data scrambling and descrambling, encoding and decoding, interleaving and deinterleaving, data insertion and extraction, filtering, amplifying, and other signal processing techniques employed by the appropriate communication protocols. Modem 60 refers to one or more modems at central office 14 as well as any of the components of the modem chipset." Milbrandt, 6:47-58. "***Modems 60 may collect information defining the operational characteristics of subscriber lines 16*** while providing data

	services to subscribers 12. This process of gathering subscriber line information 28 is referred to as "modem training," and generally occurs during the normal course of operation of system 10." Milbrandt, 10:40-46. "To access data services, in particular, a subscriber 12 operates a modem 42 . . . ***exchanges data with a modem 60 of a central office*** 14 using any suitable communication protocol." Milbrandt, 9:54-57. "Similarly, the attenuation information of subscriber line 16 at sub-frequencies supporting the uplink transmission of data may be obtained by measuring the power spectrum density, Q_f, of a signal transmitted by modem 42, and the power spectrum density, S_f, of ***the signal received by modem 60***, and performing the appropriate attenuation information modeling techniques as described above." Milbrandt, 12:50-57. "Modem 42 measures the received signal power spectrum density, S_f, of the received data signal for each downlink channel and ***communicates this and other subscriber line information 28 to modem 60***." Milbrandt, 11:19-24. "According to the first method, if subscriber

	line 16e receives data services from central office 14, then server 18 determines the attenuation and noise information of subscriber line 16e based upon ***information collected by modems 60 during training***, as described above." Milbrandt, 20:58-62. A POSITA would have understood and it would have been obvious that Milbrandt's subscriber line information collected by modem 60 was received in a message. Thus, Milbrandt's disclosure of modem 60 which receives a message teaches "receiving a message," as recited in element [7.1] of claim 7.
[7.2] wherein the message comprises one or more data variables that represent the diagnostic information,	This limitation is the same as [3.2] and is disclosed in the prior art as discussed in that same section above.
[7.3] wherein bits in the message were modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	This limitation is the same as [3.3] and is disclosed in the prior art as discussed in that same section above.
[7.4] wherein at least one data variable of the one or more data variables comprises an array representing	This limitation is the same as [3.4] and is disclosed in the prior art as discussed in that same section above.

power level per subchannel information.	
[8.0] The method of claim 7,	See [7.0-7.4]
[8.1] wherein the power level per subchannel information is based on a Reverb signal.	This limitation is the same as [2.1] and is disclosed in the prior art as discussed in that same section above.
[9.0] A communications system for DSL service comprising	Milbrandt discloses the features recited in the preamble, element [9.0]. In particular, Milbrandt teaches a communications system for DSL service, including video-on-demand, multi-media, and Internet access: "In accordance with the present invention, a ***system*** for determining the transmit power of a communication device operating on ***digital subscriber lines*** is provided which substantially eliminates or reduces disadvantages and problems associated with previous communication systems." Milbrandt, 2:17-21. "***Digital Subscriber 30 Line technology (DSL)*** uses existing twisted pair telephone lines to transport high ***bandwidth data, such as multimedia, video on demand, and Internet access, to data service subscribers***. DSL technology uses a DSL transceiver unit (e.g. modems, splitters, and other communication 35 equipment) at the central

	office of the data services provider and at the subscriber premises to utilize a greater range of frequencies of the telephone line than traditional telephone services, resulting in high speed data transmission." Milbrandt, 1:29-39. "***ADSL communication is well adapted for applications, such as video-on-demand, multi-media, and Internet access***, that transfers large volumes of information to subscriber 12." Milbrandt, 9:42-45. Milbrandt's communications system 10, which provides DSL services, is illustrated in FIG. 1, reproduced below. It would have been obvious to a POSITA that the communication system 10 is a "communications system for DSL service" as claimed.

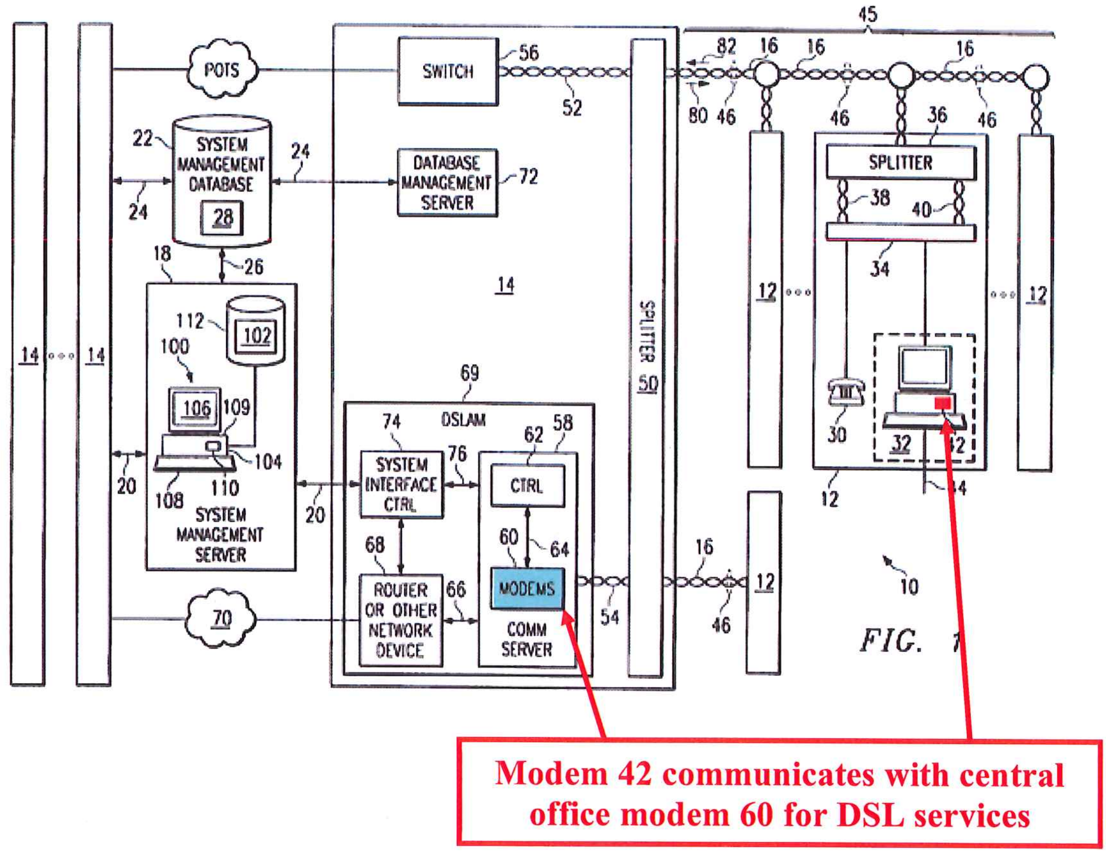


FIG. 1 of Milbrandt (annotated)

[9.0.1] a first DSL transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation and	As discussed above in [1.0], the prior art discloses a transceiver (Milbrandt's modem 42) capable of transmitting diagnostic information over a communication channel using multi carrier modulation. In this context, modem 42 is the "first" transceiver. Further, Milbrandt teaches that modem 42 is a DSL (ADSL) transceiver: "In one embodiment, subscriber line 16 and ***components of subscriber 12 and central office 14 support communication using ADSL techniques*** that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation."

	Milbrandt at 9:31-34. A POSITA would have understood that "ADSL" refers to asymmetric digital subscriber line technology, which is a specific kind of DSL technology. Milbrandt further describes communicating via DSL technology: "In accordance with the present invention, a system for determining the transmit power of a communication device operating on ***digital subscriber lines*** is provided which substantially eliminates or reduces disadvantages and problems associated with previous communication systems." Milbrandt at 2:17-21. Thus, it would have been obvious to a POSITA that Milbrandt's modem 42, located at the subscriber premises 12, is a "first DSL transceiver" as claimed. Therefore, the prior art teaches "first DSL transceiver capable of transmitting diagnostic information over a communication channel using multicarrier modulation," as recited in element [9.0.1] of claim 9.
[9.0.2] a second DSL transceiver capable of receiving the diagnostic information over the communication channel using multicarrier modulation	As discussed above in [3.0], the prior art discloses a transceiver (Milbrandt's modem 60) capable of receiving diagnostic information over a communication channel using multi carrier modulation. In this context, modem 60 is the "second" transceiver that receives the diagnostic information transmitted by modem 42. Further, Milbrandt teaches that modem 60 is a DSL (ADSL) transceiver:

comprising:	"In one embodiment, subscriber line 16 and ***components of subscriber 12 and central office 14 support communication using ADSL techniques*** that comply with ANSI Standard T1.413, such as discrete multi tone (DMT) modulation." Milbrandt at 9:31-34. A POSITA would have understood that "ADSL" refers to asymmetric digital subscriber line technology, which is a specific kind of DSL technology. Milbrandt further describes communicating via DSL technology: "In accordance with the present invention, a system for determining the transmit power of a communication device operating on ***digital subscriber lines*** is provided which substantially eliminates or reduces disadvantages and problems associated with previous communication systems." Milbrandt at 2:17-21. "***ADSL modems 60*** increase the amount of data that the conventional twisted-pair subscriber lines 16 can carry by using DMT technology to divide the bandwidth of a subscriber line 16, generally referred to as the frequency spectrum supported by a subscriber line 16, into many individual sub-bands or channels." Milbrandt at 10:58-62.

	Thus, it would have been obvious to a POSITA that Milbrandt's modem 60, located at the central office 14, is a "second DSL transceiver" as claimed. Therefore, the prior art teaches "a second DSL transceiver capable of receiving the diagnostic information over the communication channel using multicarrier modulation," as recited in element [9.0.2] of claim 9.
[9.1] a transmitter portion of the first transceiver capable of transmitting a message,	As discussed above in [1.1] and [9.0.1], the prior art discloses that a transmitter portion of the first transceiver (Milbrandt's modem 42) is capable of transmitting a message. A POSITA would have understood and it would have been obvious that Milbrandt's modem 42, which transmits messages to the central office, has a transmitter portion capable of transmitting a message. Thus, the prior art teaches "a transmitter portion of the first transceiver capable of transmitting a message," as recited in element [9.1] of claim 9.
[9.2] wherein the message comprises one or more data variables that represent the diagnostic information,	This limitation is the same as [1.2] and is disclosed in the prior art as discussed in that same section above.
[9.3] wherein bits in the message are modulated onto DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	This limitation is the same as [1.3] and is disclosed in the prior art as discussed in that same section above.

[9.4] wherein at least one data variable of the one or more data variables comprises an array representing Signal to Noise ratio per subchannel during Showtime information; and	The combination of Milbrandt and ANSI T1.413discloses the features recited in element [9.4]. As discussed above in the claim construction section, the term "during Showtime information" refers to information obtained during normal DSL operation mode. First, Milbrandt teaches that modem 42 measures and determines frequency domain channel noise information during normal operation: "***The noise information for a particular subscriber line 16 may be determined by measuring noise characteristics of a subscriber line 16 during operation*** or by calculating the noise information using subscriber line information 28 for subscriber line 16. For example, ***a modem 42 of a subscriber 12 may operate as a spectrum analyzer during operation*** to sample a time domain signal communicated by central office 14 using subscriber line 16. Modem 42, operating as a spectrum analyzer, measures the noise variance of the time domain signal over a statistically significant period of time and converts the measured noise variance from the time domain to the frequency domain by performing, for example, a Fast Fourier Transform." Milbrandt, 12:58-13:3. As discussed in the claim construction analysis above, the phrase "during Showtime" refers to the normal communications of an ANSI T1.413-compliant device. Milbrandt states that the devices at the subscriber 12, including modem 42, "comply with ANSI Standard T1.413." Milbrandt, 9:33-34. Thus, it would have been

	obvious to a POSITA that the noise measurements gathered by Milbrandt's modem 42 are obtained "during Showtime" as claimed. Second, Milbrandt teaches that modem 42 communicates the frequency domain channel noise information to the central office modem 60: "If modem 42 is subscribed to receive data services from central office 14, then ***modem 42 may communicate the measured noise information to modems 60 of central office 14*** using any suitable communication protocol and frequencies supported by subscriber lines 16." Milbrandt, 13:11-16. It would have been obvious to a POSITA that the measured noise values and other subscriber line information would be transmitted as "data variables." Third, Milbrandt teaches that frequency domain channel noise information is stored as an array (grid with rows and columns) as a function of frequency: "***Line noise grid*** 370 includes a row 372 for each entry of column 306 of subscriber line grid 300, and a column 374 for each sub-frequency at which the noise is determined for a particular subscriber line 16. Generally, the combination of ***grids 360 and 370 establish the*** attenuation information and ***noise information of subscriber lines 16 as a function of frequency***." Milbrandt, 23:51-57 and FIG. 3; see also *Id.,* 13:5-8.

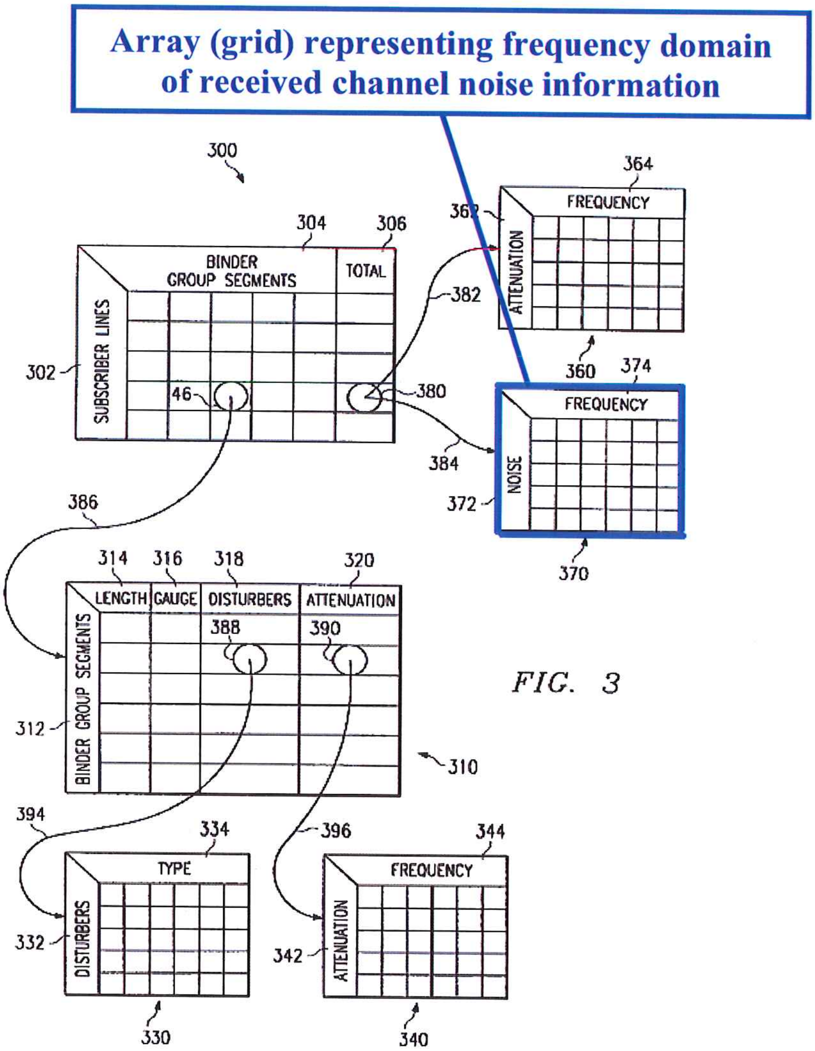


FIG. 3 of Milbrandt (annotated)

Milbrandt also describes calculating a signal-to-noise ratio on a per-subchannel (sub-frequency) basis:

> Using the determined attenuation information and noise information, server 18 ***determines the signal-to-noise ratio*** of a signal communicated by modem 60 or 42 over subscriber line 16 at ***a particular sub-frequency***, according to the following equation:

	$$SNR_f = \frac{(Q_f)(\|H_f\|^2)}{n_f}$$ where: SNR_f=signal to noise ratio of signal; Q_f=transmit power spectrum density at sub-frequency (f); $\|H_f\|$=attenuation information for subscriber line **16** at sub-frequency (f); and n_f=noise information for subscriber line **16** at sub-frequency (f). Milbrandt, 16:34-50. A POSITA would have understood that Milbrandt's reference to a "sub-frequency" has the same meaning as a subchannel. Further, a POSITA would have found it obvious to measure and calculate a signal-to-noise ratio on a per subchannel (sub-frequency) basis. In particular, the discrete multitone (DMT) technology employed in Milbrandt's modems 42 and 60 allows for a variable number of bits to be transmitted on each subchannel. Thus, the number of bits on any particular subchannel can be tailored to match the signal quality of that subchannel. To determine how to spread the bits across the available subchannels (i.e., how many bits to transmit on each available subchannel), it would have been obvious to a POSITA to measure the signal-to-noise ratio on a per subchannel basis. <u>Fourth</u>, although (as discussed above) Milbrandt teaches that the at least one data variable of the one or more data variables that represents the received frequency domain channel noise information is stored as an array, as illustrated in Milbrandt's FIG. 3, and that the noise information is transmitted upstream to the central office, Milbrandt does not expressly state that the noise information is represents a signal to noise ratio, and does not expressly state that the noise information is

	transmitted as an array. Milbrandt, however, notes that it "support[s] ***communication using ADSL techniques that comply with ANSI Standard T1.413*** such as discrete multi tone (DMT) modulation." Milbrandt, 9:31-34. A POSITA, therefore, would have looked to the ANSI T1.413 standard document to gain a better understanding of how the noise information is utilized. With respect to noise information, ANSI T1.413 teaches that the subscriber modem (ATU-R) measured signal to noise ratio is made available from the central office modem (ATU-C) at any time and on demand: > "The attenuation (ATN) and ***signal-to-noise ratio (SNR)*** margin test parameters apply to on-demand test requests; e.g., to check for adequate physical media performance margin at acceptance and after repair verification, or ***at any other time*** following the execution of initialization and training sequence of the ADSL system. ***ATN and SNR, as measured by the receivers at . . . the ATU-R shall be externally accessible from the ATU-C***, but they are not required to be continuously monitored. ***They are made available on-demand*** as defined in 8.1.3." ANSI T1.413, 82-83. Thus, complying with the ANSI T1.413 standard, as suggested by Milbrandt, requires Milbrandt's central office modem 60 receive and make externally accessible the signal-to-noise ratio as measured at Milbrandt's subscriber modem 42. It would have been obvious to a POSITA, therefore, that Milbrandt's subscriber modem 42

	transmits its measured signal-to-noise ratio information to the central office modem 60. Based on the above disclosure, a POSITA would have understood and it would have been obvious that because the signal to noise ratio (SNR) information is determined and provided on demand, it is determined and provided during normal operation (i.e., Showtime). Further, a POSITA would have understood and it would have been obvious that the subscriber modem (ATU-R) transmits the determined SNR to the central office modem (ATU-C), since the central office modem (ATU-C) has to make the SNR of the subscriber modem (ATU-R) available at any time and on demand. Thus, it would have been obvious to a POSITA to have Milbrandt's subscriber modem transmit to the central office modem its determined SNR during Showtime (as ANSI T1.413 teaches), because it would facilitate system testing on demand and allow for Milbrandt's system to comply with the ANSI T1.413 standard, which is a goal of Milbrandt. Fifth, with respect to communications, ANSI T1.413 teaches techniques for transmitting data variables that have a value for a plurality of frequency sub-carriers. Specifically, ANSI T1.413 teaches transmitting each data variable as an ordered sequence of values: "... ***transmit to the ATU-R the bits and gains information, {b1, g1, b2, g2, ... b 255, g31}***, that are to be used on the upstream sub-carriers. b_i indicates the number of bits to be coded by the ATU-R transmitter onto the *i* th upstream carrier." ANSI T1.413, 107. "... ***transmit to the ATU-C the bits and***

	gains information, {b1, g1, b2, g2, ... b 255, g255}, to be used on the downstream sub-carriers. b_i indicates the number of bits to be coded by the ATU-C transmitter onto the *i* th downstream sub-carrier g_i indicates the scale factor that shall be applied to the *i* th downstream sub-carrier." ANSI T1.413, 110. The numeric subscripts (i.e., the values of "*i*") represent indices corresponding to each of the 256 distinct carrier frequencies, or subchannels, that are employed in ADSL communications under the ANSI T1.413 standard. Thus, the ANSI T1.413 standard teaches transmit bit-and-gain value pairs as an ordered sequence of values, i.e., an "array" as that term was construed above. It would have been obvious to a POSITA to transmit to the central office modem Milbrandt's noise information (including the signal to noise ratio) in an array format (as ANSI T1.413 teaches), because it would provide efficient and ordered communication and because it would allow the central office modem to receive and access the information on a per channel basis, without the need for additional processing or reordering of the received information. Thus, the prior art teaches that "at least one data variable of the one or more data variables comprises an array representing Signal to Noise ratio per subchannel during Showtime information," as recited in element [9.4] of claim 9.
[9.5] a receiver portion of the second transceiver capable of receiving the	As discussed above in [3.1] and [9.0.2], the prior art discloses that the second transceiver (Milbrandt's modem 60) has a portion that is capable of receiving a message. *See also* Milbrandt at 9:54-57 and 12:50-57. A POSITA

message,	would have understood and it would have been obvious that Milbrandt's modem 60, which receives messages from modem 42, has a receiver portion for receiving the message sent by modem 42. Thus, the prior art teaches "a receiver portion of the second transceiver capable of receiving the message," as recited in element [9.5] of claim 9.
[9.6] wherein the message comprises the one or more data variables that represent the diagnostic information,	As discussed above at [9.2], the prior art teaches that the subscriber modem 42 transmits a message that comprises one or more data variables that represent the diagnostic information. Further, as discussed above at [7.1] and [9.5], the central office modem 60 receives the message that was sent by modem 42. *See also* Milbrandt, 9:54-57 and 12:50-57. It would have been understood and it would have been obvious that the message, received by modem 60 from modem 42, comprises the one or more data variables that represent the diagnostic information. Thus, the prior art teaches that "the message comprises the one or more data variables that represent the diagnostic information," as recited in element [9.6] of claim 9.
[9.7] wherein the bits in the message were modulated onto the DMT symbols using Quadrature Amplitude Modulation (QAM) with more than 1 bit per subchannel and	As discussed above at [9.3], the prior art teaches that the bits in the message transmitted by the subscriber modem 42 were modulated onto the DMT symbols using QAM with more than 1 bit per subchannel. Further, as discussed above at [7.1] and [9.5], the central office modem 60 receives the message that was sent by modem 42. *See also* Milbrandt, 9:54-57 and 12:50-57. It would have been understood and it would have been obvious that the bits in the message, received by modem 60 from modem 42, were modulated onto the DMT symbols using QAM with more than 1 bit per subchannel. Thus, the prior art teaches that "the bits in the message were modulated onto the DMT symbols using Quadrature

	Amplitude Modulation (QAM) with more than 1 bit per subchannel," as recited in element [9.7] of claim 9.
[9.8] wherein the at least one data variable of the one or more data variables comprises the array representing Signal to Noise ratio per subchannel during Showtime information.	As discussed above at [9.4], the prior art teaches that at least one data variable of the one or more data variables of the message transmitted by the subscriber modem 42 comprises an array representing Signal to Noise ratio per subchannel during Showtime information. Further, as discussed above at [7.1] and [9.5], the central office modem 60 receives the message that was sent by modem 42. *See also* Milbrandt, 9:54-57 and 12:50-57. It would have been understood and it would have been obvious that the message, received by modem 60 from modem 42, included the at least one data variable of the one or more data variables which comprises the array representing Signal to Noise ratio per subchannel during Showtime information. Thus, the prior art teaches that "the at least one data variable of the one or more data variables comprises the array representing Signal to Noise ratio per subchannel during Showtime information," as recited in element [9.8] of claim 9.
[10.0] The media of claim 9,	See [9.0- 9.10]
[10.1] wherein the DSL service is for internet access.	Milbrandt teaches the features recited in [10.1]. Milbrandt teaches that the DSL service is for internet access: ***"Digital Subscriber Line technology (DSL) uses existing twisted pair telephone lines to . . . [provide] Internet access, to data service subscribers***. DSL technology uses a DSL transceiver unit (e.g. modems, splitters, and other

	communication equipment) at the central office of the data services provider and at the subscriber premises to utilize a greater range of frequencies of the telephone line than traditional telephone services, resulting in high speed data transmission." Milbrandt, 1:30-39. "***Modem 42 also supports*** Ethernet; fast Ethernet; V-series data protocols such as V.32bis, V.32terbo, V.34, V.42, V.42bis, and V.90; data frame relay; Asynchronous Transfer Mode (ATM); switched multi-mega-bit data service (SMDS); high level data link control (HDLC); serial line ***Internet protocol*** (SLIP); point-to-point protocol (PPP); transmission control protocol/***Internet protocol*** (TCP/***IP***); or any other appropriate protocol, collectively referred to as digital communication protocols." Milbrandt, 5:1-9; see also FIG. 1. "***A communication network 70, such as a global communication network like the Internet***, is coupled to network device 68." Milbrandt, 7:18-21. "***ADSL communication is well adapted for*** applications, such as video-on-demand, multi-media, and ***Internet access***, that transfers large volumes of information to subscriber 12."

	Milbrandt, 9:42-45. Thus, it would have been obvious to employ the DSL service provided by Milbrandt's communication system "for internet access," as recited in element [10.1] of claim 10.

IX. CONCLUSION

92. I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both. See 18 U.S.C. § 1001.

Date: April 29, 2016

Respectfully submitted,

Dr. Sayfe Kiaei