IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC.,	§	
Plaintiff,	§	
v.	§	Civil Action No.: 2:24-cv-29
AT&T INC., AT&T CORP., AT&T COMMUNICATIONS LLC, AT&T MOBILITY LLC, AT&T MOBILITY II LLC and AT&T SERVICES INC.	§	JURY TRIAL DEMANDED
Defendants.	§	

PLAINTIFF ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC.'S COMPLAINT FOR PATENT INFRINGEMENT

Adaptive Spectrum and Signal Alignment, Inc. ("ASSIA" or "Plaintiff"), brings this action for unauthorized patent infringement of U.S. Patent Nos. 7,428,669; 7,593,458; 7,991,122; and 9,954,631 (*see* Exhibits A-D) under 35 U.S.C. § 271 against Defendants AT&T Inc., AT&T Corp., AT&T Communications LLC, AT&T Mobility LLC, AT&T Mobility II LLC and AT&T Services Inc. (collectively, "AT&T" or "Defendants") and alleges as follows:

THE PARTIES

1. Plaintiff Adaptive Spectrum and Signal Alignment, Inc. is a California corporation with its principal place of business located at 303 Twin Dolphin Drive, Suite 600, Redwood City, California 94065.

2. Defendant AT&T Inc. ("AT&T Inc.") is a Delaware corporation having a principal place of business at 208 South Akard Street, Dallas, Texas 75202. AT&T Inc. may be served through its registered agent, CT Corporation System, 1999 Bryan St., Suite 900, Dallas, TX 75201.

3. Defendant AT&T Corp. ("AT&T Corp.") is a New York corporation having a principal place of business at One AT&T Way, Bedminster, New Jersey 07921. AT&T Corp. may be served through its registered agent for service, CT Corporation System, 1999 Bryan St., Ste. 900, Dallas, Texas 75201. AT&T Corp. is a wholly owned subsidiary of AT&T Inc.

4. Defendant AT&T Communications LLC ("AT&T Communications") is a Delaware corporation having a principal place of business at 208 South Akard Street, Dallas, Texas 75202. AT&T Communications may be served through its registered agent for service, The Corporation Trust Company, 1209 Orange Street, Wilmington, Delaware 19801. AT&T Communications is a wholly owned subsidiary of AT&T Inc.

5. Defendant AT&T Mobility LLC ("AT&T Mobility") is a Delaware corporation having a principal place of business at 1025 Lenox Park Boulevard NE, Atlanta, Georgia 30319. AT&T Mobility may be served through its registered agent for service, The Corporation Trust Company, 1209 Orange Street, Wilmington, Delaware 19801. AT&T Mobility is a subsidiary of and owned by AT&T Inc.

6. Defendant AT&T Mobility II LLC ("AT&T Mobility II") is a Delaware corporation having a principal place of business at 1025 Lenox Park Boulevard NE, Atlanta, Georgia 30319. AT&T Mobility II may be served through its registered agent for service, The Corporation Trust Company, 1209 Orange Street, Wilmington, Delaware 19801. AT&T Mobility II is a subsidiary of and owned by AT&T Inc.

7. Defendant AT&T Services Inc. ("AT&T Services") is a Delaware corporation having a principal place of business at 208 South Akard Street, Dallas, Texas 75202. AT&T Services may be served through its registered agent for service, The Corporation Trust Company,

1209 Orange Street, Wilmington, Delaware 19801. AT&T Services is a subsidiary of and owned by AT&T Inc.

JURISDICTION AND VENUE

8. This action arises under the Patent Act, 35 U.S.C. § 1 *et seq*.

9. Subject matter jurisdiction is proper in this Court under 28 U.S.C. §§ 1331 and 1338(a).

10. Venue in this District is proper under 28 U.S.C. § 1391(c)(3) and 28 U.S.C. § 1400(b).

11. This Court has general personal jurisdiction over AT&T Inc., AT&T Communications, and AT&T Services because, as indicated above, AT&T Inc., AT&T Communications, and AT&T Services each have their principal place of business located within the State of Texas.

12. This Court has specific personal jurisdiction over AT&T Inc., AT&T Communications, AT&T Services, AT&T Corp., AT&T Mobility LLC, and AT&T Mobility II because AT&T Inc., AT&T Communications, AT&T Services, AT&T Corp., AT&T Mobility LLC, and AT&T Mobility II each have committed acts of patent infringement and has induced and contributed to acts of patent infringement by others in the District, the State of Texas, and elsewhere in the United States. AT&T Inc., AT&T Communications, AT&T Services, AT&T Corp., AT&T Mobility LLC, and AT&T Mobility II directly and through their subsidiaries or intermediaries, have committed and continue to commit acts of infringement in this District by, among other things, designing, developing, manufacturing, importing, offering to sell, and selling products that infringe the Asserted Patents. Moreover, AT&T Corp. is registered to do business in the state of Texas.

13. AT&T Inc. operates and maintains a regular and established place of business in this district at 2900 W Plano Pkwy, Plano, Texas 75075.[1] On information and belief, each AT&T entity, including AT&T Corp. (conducting business under AT&T Business Solutions),[2] AT&T Communications, AT&T Services, AT&T Mobility, and AT&T Mobility II collaborate with, operate from, and design, test, use, and sell telecommunications services through this AT&T Foundry location in Plano, Texas.

14. Each AT&T entity has a regular and established physical presence in the district, including but not limited to, ownership of or control over property, inventory, or infrastructure. For example, AT&T operates and maintains retail stores within this federal judicial district including those located at 1712 E Grand Ave, Marshall, Texas 75670, 109 W Loop 281, Longview, Texas 75605, 1214 North US Highway 259, Suite 102, Kilgore, Texas 75662, 4757 South Broadway Avenue, Tyler, Texas 75703; 2028 Southeast Loop #323, Tyler, Texas 75701; 8922 South Broadway Avenue, Tyler, Texas 75703 (among many others).[3]

15. Of AT&T's nearly 5,500 locations in the United States, AT&T owns and operates 593 locations in the State of Texas making up approximately 11% of its entire U.S. presence, making Texas the state with the highest number of AT&T locations.[4]

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[1] *See* https://about.att.com/story/2018/plano_foundry.html.

[2] *See* https://www.sec.gov/Archives/edgar/data/732717/000073271718000009/ex21.htm.

[3] *See* https://www.att.com/stores/texas.

[4] *See* https://www.scrapehero.com/location-reports/AT%20&%20T-USA/#:~:text=How%20many%20AT%20%26%20T%20locations,T%20locations%20in%20the%20US.

16. On information and belief, each AT&T entity maintains corporate offices in this District, specifically at 3400 West Plano Parkway, Plano, Texas 75075.[5]

17. At the above-listed stores, foundry, and offices, each AT&T entity maintains a regular and established place of business where one or more employee(s) and/or agent(s) of AT&T are routinely physically present for the purpose of conducting AT&T's business at said locations on behalf of or otherwise at the direction of AT&T. Upon information and belief, each Defendant entity conducts operations at one or more of these locations.

18. Each AT&T entity has committed acts of infringement in this judicial district and maintains regular and established places of business in this district.

19. Each AT&T entity's presence in this District is directly related to the infringing activities at issue in this litigation. Specifically, Defendants design, develop, manufacture, sell, and offer for sale infringing products in this District. Defendants' website shows numerous job openings in Plano for technical and sales positions,[6] including openings for positions related to the sales and implementation of products related to AT&T Fiber and Broadband.

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[5] *See* https://www.waze.com/live-map/directions/us/tx/plano/atandt-corporate-offices?to=place.ChIJ5VvjR2EjTIYRqsBPIexdBvw.

[6] https://www.att.jobs/search-jobs/Plano%2C%20TX/117/4/6252001-4736286-4682500-4719457/33x01984/-96x69889/50/2 (listing job openings in Plano, Frisco, etc.).

THE ASSERTED PATENTS

20. ASSIA owns all rights, title, and interest to U.S. Patent Nos. 7,428,669; 7,593,458; 7,991,122; and 9,954,631 (collectively, the "Asserted Patents").

I. The '669 Patent

21. On September 23, 2008, the United States Patent and Trademark Office duly and legally issued United States Patent No. 7,428,669 ("the '669 patent"), entitled "Adaptive FEC Codeword Management." A copy of the '669 patent is attached to this Complaint as Exhibit A.

22. The '669 patent issued from U.S. Patent Application 10/795,593, which was assigned from inventor, John M. Cioffi, to ASSIA on November 18, 2004.

23. The '669 patent is valid and enforceable.

II. The '458 Patent

24. On September 22, 2009, the United States Patent and Trademark Office duly and legally issued United States Patent No. 7,593,458 ("the '458 patent"), entitled "FEXT Determination System." A copy of the '458 patent is attached to this Complaint as Exhibit B.

25. The '458 patent issued from U.S. Patent Application 11/122,356, which was assigned from inventor, John M. Cioffi, to ASSIA on May 5, 2005. The now-issued '458 patent was assigned from ASSIA to ASSIA SPE, LLC on September 19, 2016, and then assigned from ASSIA SPE, LLC to ASSIA on January 18, 2024.

26. The '458 patent is valid and enforceable.

III. The '122 Patent

27. On August 2, 2011, the United States Patent and Trademark Office duly and legally issued United States Patent No. 7,991,122 ("the '122 patent"), entitled "DSL System Training,". A copy of the '122 patent is attached to this Complaint as Exhibit C.

28. The '122 patent issued from U.S. Patent Application 11/345,215, which was

assigned from inventors, John M. Cioffi, Wonjong Rhee, Bin Lee, and Georgios Ginis, to ASSIA on February 17, 2006. The now-issued '122 patent was assigned from ASSIA to ASSIA SPE, LLC on September 19, 2016, and then assigned from ASSIA SPE, LLC to ASSIA on January 18, 2024.

29. The '122 patent is valid and enforceable.

IV. <u>The '631 Patent</u>

30. On April 24, 2018, the United States Patent and Trademark Office duly and legally issued United States Patent No. 9,954,631("the '631 patent"), entitled Management System and Methods of Managing Time-Division Duplex (TDD) Transmission Over Copper." A copy of the ''631 patent is attached to this Complaint as Exhibit D.

31. The '631 patent issued from U.S. Patent Application 14/417,544, which was assigned by inventors, Kenneth Kerpez, George Ginis, Marc Goldburg, and Ardavan Maleki Tehrani, to ASSIA by April 14, 2015, which was later assigned by ASSIA to ASSIA SPE, LLC on September 19, 2016, and then assigned from ASSIA SPE, LLC to ASSIA on January 18, 2024.

32. The '631 patent is valid and enforceable.

33. ASSIA owns all rights, title, and interest in and to each of the '669, '458, '122,'631 patents (the "Asserted Patents") and possess all rights of recovery.

<u>FACTUAL ALLEGATIONS</u>

34. The inventions described in the asserted claims of the Asserted Patents (the "Accused Functionality") relate to various improvements in DSL and other wireline technology, including the utilization of existing DSL systems and telephone copper wire lines, which have been incorporated into systems practicing various ITU industry standards including the ITU-T ADSL2 (G.992.3), VDSL2 (G.993.2), G.vector (G.993.5), G.inp (G.998.4), G.ploam (G.997.1),

G.fast (G.9701), G.mgfast (G.9711), and G.hn (G.9960, G.9961) standards (collectively the "DSL Standards").[7]

35. The DSL Standards are used in telecommunications networks not only for traditional DSL internet connections but also to provide internet connections that are marketed as broadband or fiber internet connections. For example, the DSL Standards are used in a situation where an internet connection, marketed or sold as a "fiber" line, uses a fiber connection up until the "last-mile" of the connection where the connection transitions to a copper wire or phone line connection into the interior of a residential or business building.

36. AT&T offers equipment and networks that comply with and implement the Accused Functionality of one or more of the DSL Standards (collectively the "Accused Instrumentalities").[8] These Accused Instrumentalities include, but are not limited to, AT&T's home gateways, customer premises equipment and DSLAMs that implement one or more of the DSL Standards including at least BGW320, BGW210, NVG599, NVG589, NVG510, PACE5268, PACE5168, PACE5031, 2Wire 3801, 2Wire 3800, 2Wire i38, 2Wire 3600, and 2Wire 2701 products, and network services including at least AT&T Internet, AT&T Broadband, AT&T DSL, AT&T Fiber and AT&T Business Internet, AT&T Business Broadband, AT&T Business DSL, AT&T Business Fiber, and AT&T U-Verse. The Accused Instrumentalities include AT&T services and products that may in the future implement the DSL Standards.

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[7] G.vector, G.inp, and G.ploam standards provide additional functionality and are designed to be utilized by equipment, systems, and networks employing ADSL2, VDSL2, and/or G.fast standards. For example, G.vector and G.inp enable VDSL systems to achieve speeds up to and exceeding 100Mbps.

[8] *See* https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095; *see, e.g.,* NVG599 Manual, https://manualzz.com/download/24825294.

37. As further described below, the technologies claimed in the Asserted Patents have been incorporated into systems practicing the DSL Standards, of which AT&T implements one or more of in its Accused Instrumentalities. In particular, AT&T and/or its customers and end users practice one or more claims from each of the Asserted Patents in order to implement the DSL Standards in the Accused Instrumentalities. Thus, AT&T's implementation(s) of the DSL Standards necessarily infringes one or more claims of the Asserted Patents.

38. AT&T does not have any rights to use the Asserted Patents as alleged in this Complaint.

39. ASSIA has complied with 35 U.S.C. § 287.

40. ASSIA's patents are publicly available from the United States Patent Office and other online resources such as Google Patents.

41. In addition, one or more of the patents-in-suit were cited during the prosecution of patents assigned to AT&T affiliated companies.[9]

42. To the extent necessary, ASSIA provided AT&T with actual notice of its infringement prior to the filing of this lawsuit at least as early as October 23, 2023.

ALLEGATIONS OF PATENT INFRINGEMENT

43. Plaintiff incorporates the allegations of all of the foregoing paragraphs as if fully restated herein.

44. As set forth below, AT&T's Accused Instrumentalities incorporate technology protected by patents owned by ASSIA. ASSIA respectfully seeks relief from this Court for AT&T's infringement.

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[9] *See, e.g.,* U.S. Patent Nos. 7,656,814; 7,937,640; 8,159,942; 8,369,485; 8,660,138; 10,158,454.

45. AT&T has directly infringed, and continues to directly infringe, the Asserted Patents under 35 U.S.C. § 271(a) by making, using, selling and/or offering to sell, in this District and elsewhere in the United States, and/or importing into this District and elsewhere in the United States, one or more of the Accused Instrumentalities.

46. AT&T makes, sells, offers for sale, uses, designs, develops, tests, and manufactures the Accused Instrumentalities in the United States.

47. AT&T makes, sells, offers for sale, uses, and imports Accused Instrumentalities that infringe the Asserted Patents to its customers, subsidiaries, distributors, retailers, and/or end users in the United States.

48. For example, AT&T owns and operates nearly 5,500 retail locations[10] in the United States that sell and offer for sale of the Accused Instrumentalities sold throughout the United States.

49. By way of another example, AT&T sells and offers for sale the Accused Instrumentalities throughout the United States via its online website[11] and over the phone.[12]

50. AT&T also makes, manufactures, develops, designs, maintains, sells, offers for sale and operates wireline Internet lines and services outfitted to infringe the Asserted Patents across the United States under names such as: AT&T Internet, AT&T Broadband, AT&T DSL, AT&T

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[10] *See* https://www.scrapehero.com/location-reports/AT%20&%20T-USA/#:~:text=How%20many%20AT%20%26%20T%20locations,T%20locations%20in%20the%20US.

[11] *See, e.g.*, https://www.business.att.com/products/att-dedicated-internet.html; https://www.att.com/internet/.

[12] *See, e.g.*, https://www.att.com/support/smallbusiness/internet/ ("Give us a call . . . Ordering & billing 888.944.0447").

Fiber and AT&T Business Internet, AT&T Business Broadband, AT&T Business DSL, AT&T Business Fiber, and AT&T U-Verse.[13]

51. AT&T owns and operates the official AT&T websites that offer for sale Accused Instrumentalities that infringe the Asserted Patents in the United States.[14]

52. AT&T advertises that the Accused Instrumentalities can provide speeds ranging from less than 1Mpbs to over 100Mbps using the DSL Standards.[15]

53. In addition or in the alternative, AT&T has indirectly infringed the Asserted Patents under 35 U.S.C. § 271(b) by inducing infringement by others, such as its subsidiaries and end-user customers, by, for example, implementing the infringing features in its wired broadband lines, encouraging its users to use those lines within the United States, requiring its users to use those wired broadband lines in order to obtain AT&T's broadband services at a customer's desired performance level, and/or instructing, dictating, or training its customers to use the infringing features.

54. For example, AT&T's advertising, sales, design, development, and/or technical materials related to operation of the Accused Instrumentalities contained and continue to contain instructions, directions, suggestions, and/or invitations that invite, entice, lead on, influence, encourage, prevail on, move by persuasion, and/or cause its subsidiaries and customers to directly infringe at least one claim of each of the Patents-in-Suit, either literally or under the doctrine of equivalents.

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[13] *See* https://www.attsavings.com/availability; https://www.business.att.com/products/att-dedicated-internet.html; https://www.att.com/internet.

[14] *See* https://www.att.com/.

[15] https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095.

55. AT&T advertises on its website to customers and other end users its wireline network services that utilize the DSL Standards. These advertisements are meant to entice sales and the use of the Accused Instrumentalities, and further describer to a customer or end user the benefits of using the Accused Instrumentalities.[16]

56. AT&T further advertises and provides its customers and end users with manuals describing the Accused Instrumentalities including how to use and operate the Accused Instrumentalities.

57. AT&T took the above actions intending to cause infringing acts by others.

58. ASSIA sought to avoid litigation with AT&T by engaging in licensing negotiations with AT&T.

59. ASSIA sent a letter to AT&T on October 23, 2023 informing AT&T of ASSIA's relevant patent portfolio, including the standard essential and implementation patents related to the DSL Standards used in AT&T's Accused Instrumentalities to initiate licensing discussions.

60. In particular, ASSIA explained that it holds patents that are essential to and/or beneficial for use with DSL-related standards such as ITU-T ADSL2 (G.992.3), VDSL2 (G.993.2), G.vector (G.993.5), G.inp (G.998.4), G.ploam (G.997.1), G.fast (G.9701), G.mgfast (G.9711), and G.hn (G.9960, G.9961) standards.

61. ASSIA further explained that it sought to engage in open and amicable licensing discussions, which would likely necessitate the exchange of confidential information from both sides. To that end, ASSIA proposed an attached non-disclosure and standstill agreement to facilitate productive discussions.

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[16] *See* https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095.

62. Although AT&T initially declined to respond to ASSIA's letter, ASSIA continued to follow up with AT&T.

63. AT&T ultimately responded acknowledging ASSIA's initial notice letter but stating that it would not enter into a non-disclosure and standstill agreement with ASSIA and asserted that ASSIA should contact AT&T's suppliers.

64. The following week, ASSIA responded that AT&T is ultimately responsible for its own infringement as AT&T is the party who configures its equipment and uses the relevant standards. Nonetheless, ASSIA explained that AT&T and ASSIA could exchange relevant information with AT&T's suppliers to facilitate good faith negotiations further noting ASSIA's originally proposed mutual non-disclosure agreement expressly allowed AT&T to communicate confidential information to third parties provided it identifies those parties in advance. ASSIA again requested that AT&T enter into a non-disclosure and standstill agreement to facilitate those negotiations.

65. Despite ASSIA's multiple attempts to negotiate a license to the patents-in-suit, AT&T refused to engage in any good faith licensing negotiations with ASSIA. AT&T continues using, selling and offering for sale the AT&T Accused Instrumentalities equipped with infringing technology. AT&T had actual knowledge of ASSIA's Asserted Patents, their standard essentiality, and its likely infringement through the use of standard-compliant Accused Instrumentalities using ASSIA's Asserted Patents, and/or deliberately took action to avoid learning these facts.

66. Therefore, AT&T received actual notice of its infringement of the Asserted Patents at least as early as October 23, 2023. To the extent AT&T nonetheless contends ASSIA did not provide actual notice of AT&T's infringement prior to filing this lawsuit (it did), AT&T, at a bare minimum, has actual notice of its infringement by the filing of this Complaint and, certainly,

AT&T was or is now aware of the Asserted Patents or has willfully blinded itself as to the existence of the Asserted Patents and the Accused Instrumentalities' infringement thereof.

67. Further, AT&T has made, used, sold, offered to sell, imported and/or encouraged the making, using, selling, offering to sell, or importing of AT&T's Accused Instrumentalities despite knowing of an objectively high likelihood that its actions constituted infringement of the Asserted Patents at all times relevant to this suit. Alternatively, AT&T subjectively believed there was a high probability that others would infringe the Asserted Patents but took deliberate steps to avoid confirming that it was actively inducing infringement by others.

68. AT&T's infringement of the Asserted Patents has been willful and egregious.

69. AT&T's acts of infringement have caused damage to ASSIA, and ASSIA is entitled to recover damages incurred by ASSIA as a result of AT&T's wrongful acts.

70. In the interest of providing detailed averments of infringement, ASSIA has identified below at least one claim per patent to demonstrate infringement. However, the selection of claims and identified standards should not be considered limiting, and additional claims of the Asserted Patents and accused functionality that are infringed by AT&T will be disclosed in compliance with the Court's rules related to infringement contentions.

COUNT I
(Defendants' Infringement of the '669 Patent)

71. ASSIA incorporates the allegations of all of the foregoing paragraphs as if fully restated herein.

72. The '669 patent, entitled "Adaptive FEC Codeword Management," issued on September 23, 2008, to inventor John M. Cioffi.

73. ASSIA owns all rights, title, and interest in the ’669 patent, and holds all substantial rights pertinent to this suit, including the right to sue and recover for all past, current, and future infringement.

74. The ’669 patent is valid and enforceable and directed to patentable subject matter.

75. AT&T infringes one or more claims of the ’669 patent by making, using, selling, and/or offering to sell, in this District and elsewhere in the United States, and/or importing into this District and elsewhere in the United States, one or more of the Accused Instrumentalities. In particular, AT&T infringes by installing, configuring, servicing, and/or operating wired broadband lines employing the G.inp standard.

76. ASSIA provides the following explanation of infringement with regard to an exemplary claim compared to exemplary functionality.

77. Claim 14 of the ’669 patent recites: “A method of adjusting Forward Error Correcting (FEC) coding in a Digital Subscriber Line (DSL) modem in which data is transmitted between a transmitter and a receiver on a channel.”

78. AT&T performs this method. In particular, in operating the Accused Instrumentalities, AT&T operates multiple wired broadband lines in compliance with the G.inp standard.[17] This standard provides for changes to FEC coding in DSL lines. For example, through the use of OLR request of Type 6, as indicated below:[18]

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[17] *See* https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095. AT&T’s advertising references use of the VDSL2 standard. G.inp provides improvements to VDSL2 to provide, e.g., higher speed service such as 100+ mbps service. https://versatek.com/how-g-inp-will-optimize-copper-lines-to-reach-100mbps/#:~:text=inp%20increases%20stability%2C%20reduces%20latency,high%20demand%20for%20faster%20broadband; https://www.fiercetelecom.com/telecom/alcatel-lucent-says-vdsl2-vectoring-isn-t-enough-to-deliver-100-mbps-over-existing-copper. AT&T employs G.inp-compliant devices. *see, e.g.,* NVG599 Manual, https://manualzz.com/download/24825294.

[18] G.inp at C.3.2.

C.3.2 On-line reconfiguration (OLR) commands and responses

ITU-T G.998.4 defines two new OLR commands for ITU-T G.993.2. These OLR commands shall replace the OLR Request type 3 (SRA) and OLR Request type 4 (SOS) when retransmission is enabled. They are designated in [ITU-T G.993.2] as OLR Request types 5 and 6 respectively and are fully defined below in Table C.11. In addition, two new OLR responses are defined, corresponding to OLR Request types 5 and 6. These messages are defined in Table C.12.

When SRA and retransmission are simultaneously enabled, the modems shall use OLR Request type 5 to initiate an SRA request and OLR response type 5 to reject an SRA request. When SOS and retransmission are simultaneously enabled, the modems shall use OLR Request type 6 to initiate an SOS request and OLR response type 6 to reject an SOS request.

The first byte of the eoc messages defined in Table C.11 and Table C.12 is the value of the OLR command type, as defined in clause 11.2.3.2 of [ITU-T G.993.2]. The eoc protocol is identical to the one specified in clause 11.2.3 of [ITU-T G.993.2].

In every OLR request of type 5, the new framer settings shall be selected such that all configuration constraints are met as well as the maximum number of bytes reserved for the upstream and downstream transmitter retransmission queue as selected during initialization.

In every OLR request of type 6, the new framer settings shall be selected such that all configuration constraints, except those defined for SOS in [ITU-T G.993.2], are met as well as the maximum number of bytes reserved for the upstream and downstream transmitter retransmission queues as selected during initialization.

Table C.11 – OLR commands sent by the initiating VTUName

	Length (octets)	Octet number	Content	Support
Request type 5 (SRA/ ITU-T G.998.4)	14+4 N_f ($N_f \leq 128$)	2	08_{16}	Optional
		3-4	two octets containing the new value for L_l	
		5	one octet containing the new value for B_{l0}	
		6	one octet containing the new value for M_l	
		7	one octet containing the new value for R_l	
		8	one octet containing the new value for Q	
		9	one octet containing the new value for V	
		10	one octet containing the new value for Q_{tx}	
		11	one octet containing the new value for lb	
		12 – 13	2 octets for the number of sub-carriers N_f to be modified	
		14 – 13+4 N_f	4 N_f octets describing the sub-carrier parameter field for each sub-carrier	
		14+4 N_f	1 octet for Segment Code (SC)	
Request type 6 (SOS/ ITU-T G.998.4)	N_{TG}/2+12	2	09_{16}	Optional
		3	Message ID	
		4 to N_{TG}/2+3	$\Delta b(2)$ $\Delta b(1)$	
			$\Delta b(4)$ $\Delta b(3)$	
			…	
			$\Delta b(N_{TG})$ $\Delta b(N_{TG} - 1)$	
		N_{TG}/2+4 to N_{TG}/2+5	two octets containing the new value for L_l	
		N_{TG}/2+6	one octet containing the new value for B_{l0}	
		N_{TG}/2+7	one octet containing the new value for M_l	
		N_{TG}/2+8	one octet containing the new value for R_l	
		N_{TG}/2+9	one octet containing the new value for Q	
		N_{TG}/2+10	one octet containing the new value for V	

Table C.12 – OLR responses sent by the responding VTU

Name	Length (octets)	Octet number	Content	Support
Reject type 5 Request	3	2	85_{16} (Note)	Optional
		3	1 octet for reason code (Table 11-7)	
Reject type 6 Request	3	2	86_{16} (Note)	Optional
		3	1 octet for reason code (Table 11-7)	
NOTE – All other values for octet number 2 are reserved by ITU-T.				

79. In addition or in the alternative, in operating the Accused Instrumentalities, AT&T operates multiple wired lines in compliance with the G.hn standard. This standard provides for changes to FEC coding in DSL lines. For example, through the selection of FEC encoding parameters, as indicated below:[19]

Table 7-56 – FEC encoding parameters

	Code rate, *R*	Information block size, *K*	Puncturing pattern, pp	Mother code matrix	FEC codeword size, N_{FEC}
For header	1/2	$PHY_H = 168$	$\mathbf{pp}_{16}^{(0)}$	$(1/2)_H$	336
For payload	1/2	960	$\mathbf{pp}_{16}^{(0)}$	$(1/2)_S$	1920
	1/2	4320	$\mathbf{pp}_{16}^{(0)}$	$(1/2)_L$	8640
	2/3	960	$\mathbf{pp}_{16}^{(0)}$	$(2/3)_S$	1440
	2/3	4320	$\mathbf{pp}_{16}^{(0)}$	$(2/3)_L$	6480
	5/6	960	$\mathbf{pp}_{16}^{(0)}$	$(5/6)_S$	1152
	5/6	4320	$\mathbf{pp}_{16}^{(0)}$	$(5/6)_L$	5184
	16/18	960	$\mathbf{pp}_{1152}^{(72)}$	$(5/6)_S$	1080
	16/18	4320	$\mathbf{pp}_{5184}^{(324)}$	$(5/6)_L$	4860
	20/21	960	$\mathbf{pp}_{1152}^{(144)}$	$(5/6)_S$	1008
	20/21	4320	$\mathbf{pp}_{5184}^{(648)}$	$(5/6)_L$	4536

[19] G.hn at Table 7-56.

80. This table shows that FEC encoding for the payload at the PMA sublayer of a G.9960 transceiver allows for multiple encoding parameters. For a given information block size, the puncturing pattern and the mother code matrix produce a corresponding FEC codeword size. Thus, it provides for adjusting FEC coding in DSL lines.

81. Claim 14 of the '669 patent recites: "(a) selecting a Codeword Composition Ratio (CCR) representing a relation between payload and parity bytes in an FEC coding scheme."

82. AT&T performs this step, e.g., by selecting parameters B, R, and M, as described below:[20]

Table 9-8 – Framing parameters for latency path *p*

Parameter	Definition
Primary framing parameters	
B_{pn}	The number of octets from bearer channel #*n* per MDF. The range of values is from 0 to 254. When G_p/T_p is not an integer, the number of octets from the bearer channel #0 varies between B_{p0} and $B_{p0}+1$.
R_p	The number of redundancy octets in the RS codeword.
M_p	The number of MDFs in an RS codeword. Only values of 1, 2, 4, 8 and 16 shall be supported.
T_p	The number of MDFs in an OH subframe; $T_p = k \times M_p$, where *k* is an integer. The value of T_p shall not exceed 64.
G_p	The total number of overhead octets in an OH subframe; $1 \le G_p \le 32$.
F_p	Number of OH frames in the OH superframe. $1 \le F_p \le 255$.
L_p	The number of bits from latency path *p* transmitted in each data symbol.
Derived framing parameters	
N_{FECp}	The RS codeword size: $N_{FECp} = M_p \times \left[\text{ceiling}\left(\frac{G_p}{T_p}\right) + B_{p0} + B_{p1}\right] + R_p$ bytes

83. As another example, AT&T performs this step by selecting a code rate R as described in Table 7-56 G.hn.

[20] G.inp at 9.4.

84. Claim 14 of the ’669 patent recites: “(b) transmitting a control signal for transmitting data from the DSL modem via the channel the control signal specifying the CCR and the FEC coding scheme.”

85. AT&T performs this step, e.g., by communicating this information in the OLR messages that are sent by the modem, which are defined in Table C.11 and which are acknowledged by the other modem via the OLR Reponses shown in Table C.12 :

Table C.11 – OLR commands sent by the initiating VTUName

	Length (octets)	Octet number	Content		Support
Request type 5 (SRA/ ITU-T G.998.4)	14+4 N_f (N_f ≤128)	2	08_{16}		Optional
		3-4	two octets containing the new value for L_I		
		5	one octet containing the new value for B_{I0}		
		6	one octet containing the new value for M_I		
		7	one octet containing the new value for R_I		
		8	one octet containing the new value for Q		
		9	one octet containing the new value for V		
		10	one octet containing the new value for Q_{tx}		
		11	one octet containing the new value for lb		
		12 – 13	2 octets for the number of sub-carriers N_f to be modified		
		14 – 13+4 N_f	4 N_f octets describing the sub-carrier parameter field for each sub-carrier		
		14+4 N_f	1 octet for Segment Code (SC)		
Request type 6 (SOS/ ITU-T G.998.4)	N_{TG}/2+12	2	09_{16}		Optional
		3	Message ID		
		4 to N_{TG}/2+3	$\Delta b(2)$	$\Delta b(1)$	
			$\Delta b(4)$	$\Delta b(3)$	
			…		
			$\Delta b(N_{TG})$	$\Delta b(N_{TG}-1)$	
		N_{TG}/2+4 to N_{TG}/2+5	two octets containing the new value for L_I		
		N_{TG}/2+6	one octet containing the new value for B_{I0}		
		N_{TG}/2+7	one octet containing the new value for M_I		
		N_{TG}/2+8	one octet containing the new value for R_I		
		N_{TG}/2+9	one octet containing the new value for Q		
		N_{TG}/2+10	one octet containing the new value for V		

Table C.12 – OLR responses sent by the responding VTU

Name	Length (octets)	Octet number	Content	Support
Reject type 5 Request	3	2	85_{16} (Note)	Optional
		3	1 octet for reason code (Table 11-7)	
Reject type 6 Request	3	2	86_{16} (Note)	Optional
		3	1 octet for reason code (Table 11-7)	
NOTE – All other values for octet number 2 are reserved by ITU-T.				

86. As another example, AT&T performs this step by communicating FEC encoding information in MSG communications as shown in Table 7-11 of G.hn:[21]

Table 7-11 – MSG PHY-frame type specific fields

Field	Octet	Bits	Description	Reference
MSG_DUR	0 and 1	[15:0]	Duration for MSG frame	Clause 7.1.2.3.2.2.1
BLKSZ	2	[1:0]	Block size of FEC codeword for MSG frame payload	Clause 7.1.2.3.2.2.2
FEC_RATE		[4:2]	FEC coding rate for MSG frame payload	Clause 7.1.2.3.2.2.3
REP		[7:5]	Number of repetitions used for encoding the MSG frame payload	Clause 7.1.2.3.2.2.4
FCF	3	[2:0]	FEC concatenation factor	Clause 7.1.2.3.2.2.5
SI		[6:3]	Scrambler initialization	Clause 7.1.2.3.2.2.6
MDET		[7]	Master is detected	Clause 7.1.2.3.2.2.7
BAT_ID	4	[4:0]	Bit allocation table identifier	Clause 7.1.2.3.2.2.8
OFB_ID/GRP_ID		[7:5]	OFB identifier/subcarrier grouping identifier	Clause 7.1.2.3.2.2.9
GI_ID	5	[2:0]	Guard interval identifier	Clause 7.1.2.3.2.2.10
APSD_MAX-M		[7:3]	APSD_MAX-M of an MSG frame	Clause 7.1.2.3.2.2.11
CONNECTION_ID	6	[7:0]	Connection identifier	Clause 7.1.2.3.2.2.12
RPRQ	7	[1:0]	Reply required	Clause 7.1.2.3.2.2.13
BRSTCnt		[3:2]	Burst frame count	Clause 7.1.2.3.2.2.14
BEF		[4]	Burst end flag	Clause 7.1.2.3.2.2.15
AIFG_IND		[5]	AIFG indication	Clause 7.1.2.3.2.2.16

[21] G.hn at Table 7-11.

87. Claim 14 of the '669 patent recites "(c) repeatedly acquiring Measured transmission Error Values (MEVs) representing impulse noise events detected on the channel, the MEVs acquired after training and initializations on the DSL modem; (d) analyzing the acquired MEVs relative to a Target transmission Error Value (TEV); and (e) adjusting the CCR when the MEV differs sufficiently from the TEV."

88. AT&T performs these steps, e.g., by measuring SOS triggering criteria, comparing those measurements to the required thresholds, and by then sending an SOS request when required containing new primary framing parameters, as indicated below:[22]

13.4.3.2 Standard SOS triggering criteria

If the following conditions hold:

- the standard SOS triggering criteria are enabled (through SOS-TIME ≠ 0);
- the percentage of tones in the MEDLEY SET that are persistently degraded throughout the time window SOS-TIME exceeds SOS-NTONES; and
- the count of normalized CRC anomalies throughout the same time window SOS-TIME exceeds SOS-CRC.

then the VTU:

- shall send either an SOS request or an SRA request if the number of degraded tones is ≤ 128 and the message length of the SRA request has a duration less than 100 ms; or
- shall send an SOS request if the number of degraded tones > 128 or if the message length of the SRA request has a duration more than 100 ms.

These SRA requests are not required to respect either RA-TIME or RA-SNRM.

The time between the moment that the SOS trigger conditions have become valid, and the SOS request or SRA request sent by the VTU appears at the U-interface, shall be less than 128 ms if there is no other outstanding OLR request.

89. As another example, AT&T performs these steps by measuring line conditions, and in response, adjusting the FEC_RATE defined in G.hn. For example, G.hn, describes

[22] G.993.2 at 13.4.3.2.

measurement of line conditions, and while the BLKSZ may not be adjusted to account for changing conditions, the FEC_RATE can, as indicated below:[23]

Table 8-93 – Format of the MMPL of the CE_ParamUpdate.req message

Field	Octet	Bits	Description
VALID_BAT_ID	2 to 4	[23:0]	This field contains a bitmap indicating which runtime BATs are valid (including the New BAT ID) for this node (SID) when receiving from the destination node (DID). Each bit is associated with one runtime BAT. The LSB of the VALID_BAT_ID shall be set to one if runtime BAT 8 is valid. The MSB of the VALID_BAT_ID shall be set to one if runtime BAT 31 is valid.
NUM_TX_ AVAIL_BATS	5	[4:0]	This field contains the number of runtime BATs, assuming *G* =1, that this node (SID) can support when transmitting to the destination node (DID). Valid values are from 0 to 24.
APSD_MAX_EXT		[5]	This field is the value of APSD_MAX_EXT in the PHY-frame header associated with the new BAT. This field shall be formatted as shown in clause 7.1.2.3.2.2.25 of [ITU-T G.9960]. (Note 10)
Reserved		[7:6]	Reserved by ITU-T (Note 1)
New block size	6	[1:0]	This field indicates the proposed BLKSZ associated with the new BAT. It shall be formatted as shown in Table 7-7 of [ITU-T G.9960] (Note 2).
New FEC rate		[4:2]	This field indicates the proposed FEC_RATE associated with the new BAT. It shall be formatted as shown in Table 7-12 of [ITU-T G.9960] (Note 3).
New GI		[7:5]	This field indicates the proposed GI_ID associated with the new BAT. It shall be formatted as shown in Table 7-14 of

NOTE 2 – The transmitter shall use the proposed block size or larger block size for a new connection. Once the block size is selected for a connection, it shall not be changed throughout the lifetime of the connection (clause 8.1.3.2).

90. AT&T owns or controls the equipment, which is used to access AT&T's networks, that is on its customers' premises. The performance of the claimed steps by this equipment is thus attributable to AT&T.

91. In addition or in the alternative, to the extent that AT&T argues that its customers perform claimed steps of the '669 patent claims, AT&T directs or controls its customers'

[23] G.hn at Table 8-93, 8.6.2, 8.11

performance of those steps, conditions the benefits of its Internet service on the performance of those steps, and/or has the power, right, and ability to stop the performance of those steps but declines to do so and instead profits from their performance. AT&T controls access to its networks, and limits the equipment customers may use to access the network. While customers may, e.g., turn a modem on or off, doing so will nonetheless cause the modem to interface with AT&T's network using the DSL Standards as controlled by AT&T. AT&T thus conditions its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T similarly conditions its customers' receipt of the benefit of the accused technologies' compatibility and capabilities on its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T also has the power, right, and ability to stop the performance of these steps by customers at least by AT&T's control and limitations over its networks and the equipment accessing them. AT&T does not stop this performance and instead profits from customers' usage of its networks in ways that would cause the performance of these steps. Thus, the performance of the claimed method steps is attributable to AT&T.

92. AT&T directly infringes, literally and/or under the doctrine of equivalents, the '669 patent under 35 U.S.C. § 271(a).

93. In addition or in the alternative, when AT&T provides G.inp-compliant equipment to its customers, they perform the method described above and thus directly infringe the '669 patent under 35 U.S.C. § 271(a).

94. In addition or in the alternative, AT&T has indirectly infringed the Asserted Patents under 35 U.S.C. § 271(b) by inducing infringement by others, such as its subsidiaries and end-user customers, by, for example, implementing the infringing features in its G.inp-compliant wired

broadband lines, encouraging its users to use those lines within the United States, requiring its users to use those wired broadband lines in order to obtain AT&T's broadband services at a customer's desired performance level, and/or instructing, dictating, or training its customers to use the infringing features.

95. Similarly, AT&T's advertising, sales, design, development, and/or technical materials related to operation of the Accused Instrumentalities contained and continue to contain instructions, directions, suggestions, and/or invitations that invite, entice, lead on, influence, encourage, prevail on, move by persuasion, and/or cause its subsidiaries and customers to directly infringe at least one claim of the '669 patent, either literally or under the doctrine of equivalents.

96. AT&T took the above actions intending to cause infringing acts by others, and/or it willfully blinded itself as to the existence of the Asserted Patent and the Accused Instrumentalities' infringement thereof.

97. AT&T's acts of infringement have caused damage to ASSIA. ASSIA is entitled to recover from AT&T the damages sustained by ASSIA as a result of AT&T's wrongful acts in an amount subject to proof at trial.

COUNT II
(Defendants' Infringement of the '458 Patent)

98. ASSIA incorporates the allegations of all of the foregoing paragraphs as if fully restated herein.

99. The '458 patent, entitled "FEXT Determination System," issued on September 22, 2009, to inventor John M. Cioffi.

100. ASSIA owns all rights, title, and interest in the '458 patent, and holds all substantial rights pertinent to this suit, including the right to sue and recover for all past, current, and future infringement.

101. The ’458 patent is valid and enforceable and directed to patentable subject matter.

102. AT&T infringes one or more claims of the ’458 patent by making, using, selling, and/or offering to sell, in this District and elsewhere in the United States, and/or importing into this District and elsewhere in the United States, one or more of the Accused Instrumentalities. In particular, AT&T infringes by installing, configuring, servicing, and/or operating its wired broadband lines employing the G.vector and G.fast standards.

103. ASSIA provides the following explanation of infringement with regard to an exemplary claim compared to exemplary functionality.

104. Claim 1 of the ’458 patent recites: 1. A method of evaluating operational characteristics of a multi-line, vectored Digital Subscriber Line (DSL) system having a plurality of crosstalking lines in a common communication channel (channel).

105. AT&T performs this method. In particular, in operating the Accused Instrumentalities, AT&T operates multiple wired broadband lines in compliance with the G.vector and/or G.fast Standards.[24] The G.fast standard, e.g., explains how to evaluate operational characteristics for employing vectoring, as shown below:[25]

---

[24] *See* https://about.att.com/story/att_g_fast_on_sale_now_to_apartment_and_condominium_properties.html; https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095. AT&T’s advertising references use of the VDSL2 and G.fast standards. G.vector provides improvements to VDSL2 to provide, e.g., higher speed service such as 100 mbps service. https://www.fiercetelecom.com/telecom/tdc-denmark-trials-alcatel-lucent-s-vdsl2-vectoring-technology; https://versatek.com/how-g-inp-will-optimize-copper-lines-to-reach-100mbps/#:~:text=inp%20increases%20stability%2C%20reduces%20latency,high%20demand%20for%20faster%20broadband; https://www.fiercetelecom.com/telecom/alcatel-lucent-says-vdsl2-vectoring-isn-t-enough-to-deliver-100-mbps-over-existing-copper. AT&T employs G.vector-compliant devices. *see, e.g.,* NVG599 Manual, https://manualzz.com/download/24825294.

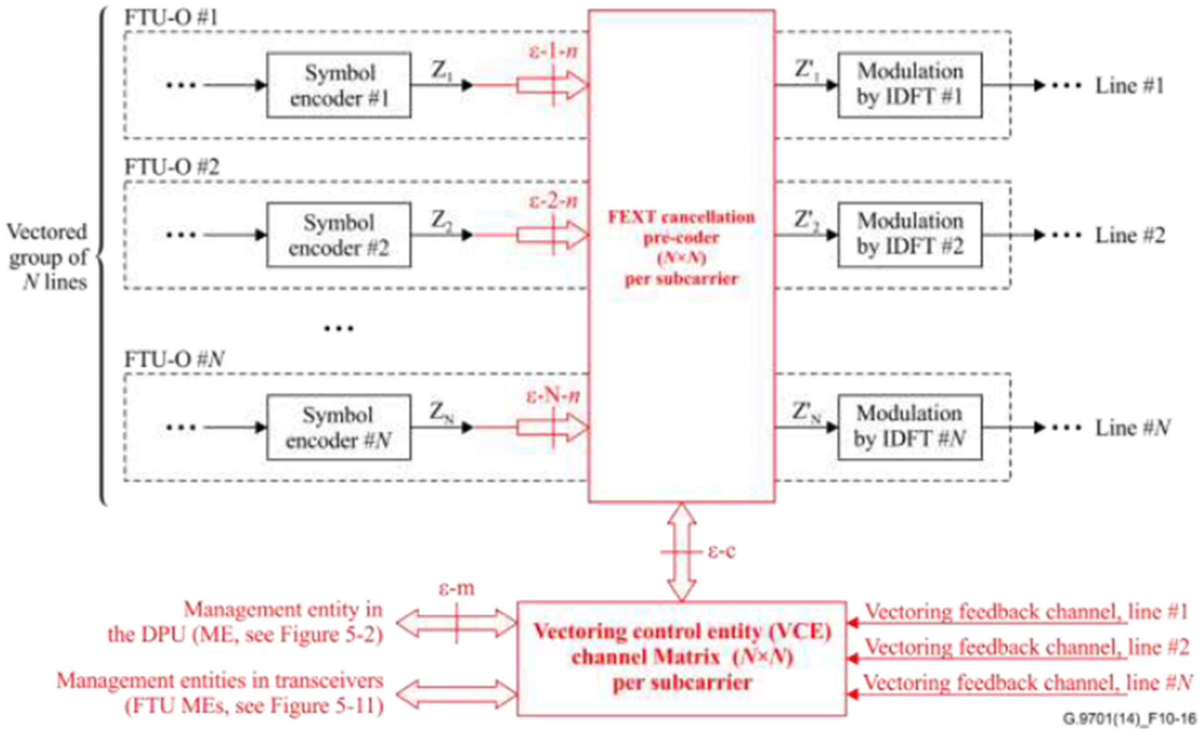
[25] G.fast at 10.3.

10.3 Precoder (downstream vectoring)

10.3.1 Overview

Figure 10-16 provides an overview of the functional model for the inclusion of downstream FEXT cancellation precoding at the DPU for all lines in the vectored group, as a generalization of Figure 10-1 from a signal processing perspective. The model shows an array of the downstream symbol encoders (which represent the data, sync, pilot or initialization symbol encoders shown in Figure 10-1) and the modulation by the IDFT functional blocks of the FTU-Os, with the FEXT cancellation precoder inserted between the symbol encoders and the modulation by the IDFT blocks.

The VCE of the vectored group learns and manages the channel matrix per vectored subcarrier, which reflects the channel characteristics of the managed group of lines. In the functional model in Figure 10-16, the channel matrix for each vectored subcarrier is of size $N \times N$ where N is the number of lines in the vectored group.



NOTE – Symbol encoder represents the data, sync, pilot or initialization symbol encoder shown in Figure 10-1.

Figure 10-16 – Vectored group functional model of PMD sub-layer using $N \times N$ precoder for downstream vectoring

106. The G.vector standard, e.g., also explains how to evaluate operational characteristics for employing vectoring, as shown below:[26]

> **6.1 General**
>
> Figure 6-1 shows the functional model for the inclusion of downstream FEXT cancellation pre-coding at the AN for all lines in the vectored group, as a generalization of Figure 5-2 from a signal processing perspective. The model shows only the portion of an array of the downstream symbol encoders (which represent the data, sync or initialization symbol encoders shown in Figure 5-2) and the modulation by the inverse discrete Fourier transform (IDFT) functional blocks of the VTU-Os, with the FEXT cancellation pre-coder inserted between the symbol encoders and the modulation by the IDFT blocks.
>
> The VCE of the vectored group learns and manages the channel matrix per vectored subcarrier, which reflects the channel characteristics of the managed group of lines. In the functional model in Figure 6-1, the channel matrix for each vectored subcarrier is of size $N \times N$ where N is the number of lines in the vectored group.
>
> From the channel matrix, a FEXT pre-coder matrix may be derived and used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 6-1, this is shown by a matrix of FEXT cancellation pre-coders per vectored subcarrier of size $N \times N$. This FEXT cancellation pre-coding matrix may be "sparse" (see Note). Knowing the transmit symbols on each disturbing channel, the pre-coder pre-compensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced.
>
> NOTE – In typical cases, several of the pre-coder coefficients may be set to 0 for implementation reasons, or because the crosstalk coefficients are negligibly small.
>
> The channel matrix and the resulting FEXT cancellation pre-coder matrix are assumed to be entirely managed inside the AN. An information exchange between the VTU-O and VTU-R is required in each vectored line to learn, track, and maintain the channel matrix and associated FEXT cancellation pre-coder matrix (see backchannel definition in clause 7 and initialization in clause 10). The actual algorithms for processing this information to obtain the channel matrix and to generate the FEXT cancellation pre-coder are vendor discretionary. Depending on the implementation, it may be possible for the VCE to directly determine the FEXT cancellation pre-coder matrix and only have an implicit learning of the channel matrix.

---

[26] G.vector at 6.1.

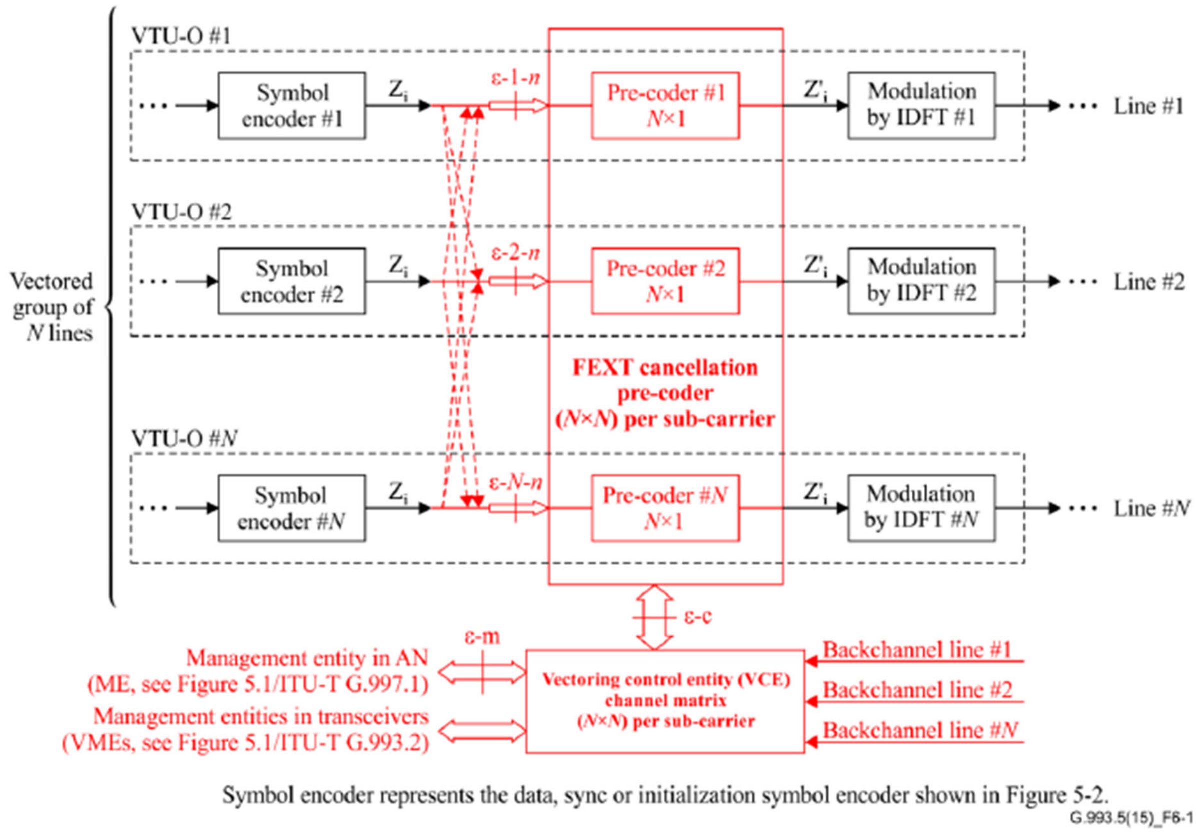


Figure 6-1 – Vectored group functional model of PMD sub-layer using *N*×*N* pre-coder for downstream vectoring

107. Claim 1 of the ’458 patent recites: “exciting the plurality of crosstalking lines in the channel with a known sequence of input symbols applied to the crosstalking lines; acquiring output data from a primary line among the plurality of lines in the channel, the output data comprising the known sequence of input symbols after having been affected by crosstalk coupling among the plurality of crosstalking lines in the channel.”

108. AT&T performs these steps, e.g., by transmitting known sync symbols from an FTU-O to an FTU-R, and measuring the difference between expected and received symbols, as explained below in the G.fast standard:[27]

[27] G.fast at 10.3.2.

10.3.2 Vectoring feedback channel

10.3.2.1 Definition of normalized error sample

The FTU-R converts the received time domain signal into frequency domain samples, resulting in a complex value z for each of the received subcarriers. The subsequent constellation de-mapper associates each of these complex values z with a particular constellation point, represented by a value *C*. Figure 10-17 shows the computation of a normalized error sample *E* for a particular subcarrier in a particular sync symbol. The normalized error sample represents the error between the received complex data sample z normalized to the 4-QAM constellation and the corresponding expected constellation point *C*, referred to the input of the quadrant descrambler. This expected constellation point corresponds to the constellation point obtained after the quadrant scrambler and before the constellation point scaling in the generation of the sync symbol at the FTU-O (see clauses 10.2.2.2 and 10.2.1.5).

For each of the subcarriers, the complex normalized error sample E is defined as $E = Z - C$, where *E* is the complex error defined as $E = e\_x + j \times e\_y$ with real component e_x and imaginary component e_y, and z is the received normalized data sample defined as $Z = z\_x + j \times z\_y$ with real component z_x and imaginary component z_y, and C is the expected constellation point associated with the received data sample *Z*, defined as $C = c\_x + j \times c\_y$ with real component c_x and imaginary component c_y (with $c\_x = -1, 0, +1$ and $c\_y = -1, 0, +1$). The gain stage of the receiver shall be independent of the expected value of *C*.

NOTE – The FTU-R can identify the expected constellation point *C* for each subcarrier by the element value of the probe sequence modulating the sync symbol, communicated to FTU-R during the initialization (see clause 12.3.3.2.1) or by the probe sequence update command (see clause 11.2.2.15) during the showtime.

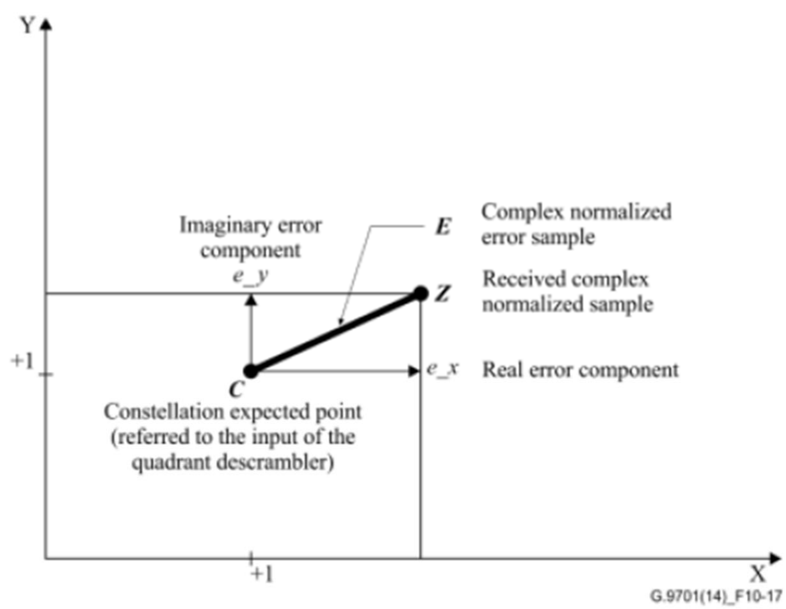


Figure 10-17 – Definition of the normalized error sample *E*

The real and imaginary components of each normalized error sample E shall be clipped and quantized to integer values for the clipped error sample components q_x and q_y respectively, as follows:

$$q\_x = \max\left(-2^{B\_\max}, \min\left(\left\lfloor e\_x \times 2^{N\_\max - 1} \right\rfloor, 2^{B\_\max} - 1\right)\right)$$
$$q\_y = \max\left(-2^{B\_\max}, \min\left(\left\lfloor e\_y \times 2^{N\_\max - 1} \right\rfloor, 2^{B\_\max} - 1\right)\right)$$

where $Q = q\_x + j \times q\_y$ represents the clipped error sample and *N_max* represents the FTU-R's maximum quantization depth of normalized error samples and shall be set to 12, and *B_max* represents the upper bound of the bit index for reporting clipped error sample components q_x and q_y (*B_max* < *N_max* + 6, with *B_max* configured by the VCE, see Tables 10-9 and 10-10). The parameter *B_max* is configured by the VCE.

The values of both clipped error sample components q_x and q_y shall be represented using the two's complement representation of (*B_max*+1) bits. The format of the clipped error sample for reporting over the vectoring feedback channel shall be as defined in clause 10.3.2.3. The particular subcarriers on which clipped error samples shall be reported during the initialization and the showtime shall be configured as described in clause 12.3.3.2.6 and Table 11-40.

109. AT&T also performs these steps, e.g., by transmitting known sync symbols from an VTU-O to an VTU-R, and measuring the difference between expected and received symbols, as explained below in the G.vector standard:[28]

7.2.1 Definition of normalized error sample

The VTU-R converts the received time domain signal into frequency domain samples, resulting in a complex value Z for each of the received subcarriers. The subsequent constellation de-mapper associates each of these complex values Z with a constellation point, represented by a value $\hat{C}$. Figure 7-3 shows the computation of a normalized error sample E for a particular subcarrier in a

[28] G.vector at 7.2.1.

particular sync symbol. The normalized error sample represents the error between the received complex data sample Z normalized to the 4-quadrature amplitude modulation (QAM) constellation point and the corresponding decision constellation point $\hat{C}$ associated with the received sync symbol in a VTU-R and referred to the input of the constellation descrambler. For illustration, in Figure 7-3, the received normalized complex data sample Z is shown to occur within the constellation boundary of the decision constellation point $\hat{C} = (+1, +1)$.

For each of the subcarriers, the complex normalized error sample E is defined as $E = Z - \hat{C}$, where E is the complex error defined as $E = e\_x + j \times e\_y$ with real component e_x and imaginary component e_y, and Z is the received normalized data sample defined as $Z = z\_x + j \times z\_y$ with real component z_x and imaginary component z_y, and $\hat{C}$ is the decision constellation point associated with the received data sample Z, defined as $\hat{C} = \hat{c}\_x + j \times \hat{c}\_y$ with real component $\hat{c}\_x$ and imaginary component $\hat{c}\_y$ (with $\hat{c}\_x = \pm 1$ and $\hat{c}\_y = \pm 1$).

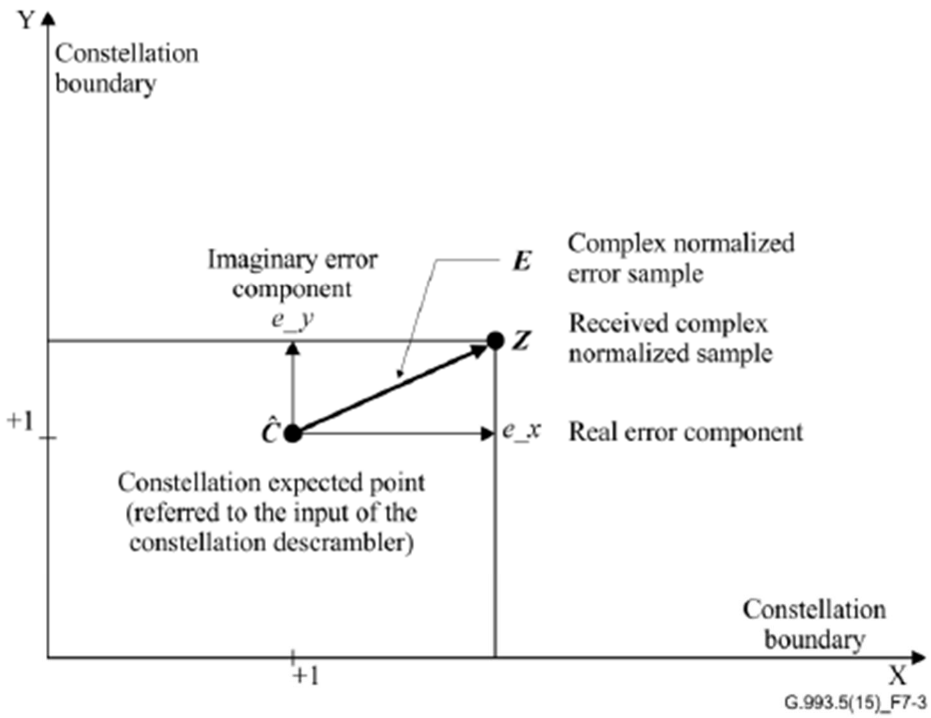


Figure 7-3 – Definition of the normalized error sample *E*

> The real and imaginary components of each normalized error sample E are clipped and quantized to integer values for the clipped error sample components q_x and q_y respectively, as follows:
>
> $$q\_x = \max\left(-2^{B\_\max}, \min\left(\left\lfloor e\_x \times 2^{N\_\max - 1} \right\rfloor, 2^{B\_\max} - 1\right)\right)$$
> $$q\_y = \max\left(-2^{B\_\max}, \min\left(\left\lfloor e\_y \times 2^{N\_\max - 1} \right\rfloor, 2^{B\_\max} - 1\right)\right)$$
>
> where $Q = q\_x + j \times q\_y$ represents the clipped error sample and *N_max* represents the VTU-R's maximum quantization depth of normalized error samples and shall be set to 12, and *B_max* represents the upper bound of the bit index for reporting clipped error sample components q_x and q_y (*B_max* < *N_max*, with *B_max* configured by the VCE, see Tables 7-1 and 7-2).
>
> The values of both clipped error sample components q_x and q_y shall be represented using the two's-complement representation of *B_max*+1 bits. The format of the clipped error sample for reporting over the backchannel is defined in clause 7.2.2. The particular subcarriers on which clipped error samples shall be reported during initialization and Showtime shall be configured as described in clauses 10.4.2.1, and in clause 8.1, respectively.

110. Claim 1 of the '458 patent recites: "ordering the crosstalking lines based on a comparison between the known sequence of input symbols used to excite the crosstalking lines and the output data acquired from the primary line."

111. AT&T performs this step. After an OTU-R obtains measured error samples, it provides that information as vectoring feedback to the OUT-O. This information is then provided to the VCE to determine precoding for FEXT cancellation in the FTU-O. The lines are ordered based on this measured information to prioritize the lines whose crosstalk will be cancelled. See below, from G.fast:[29]

[29] G.fast at 10.3.1.

10.3 Precoder (downstream vectoring)

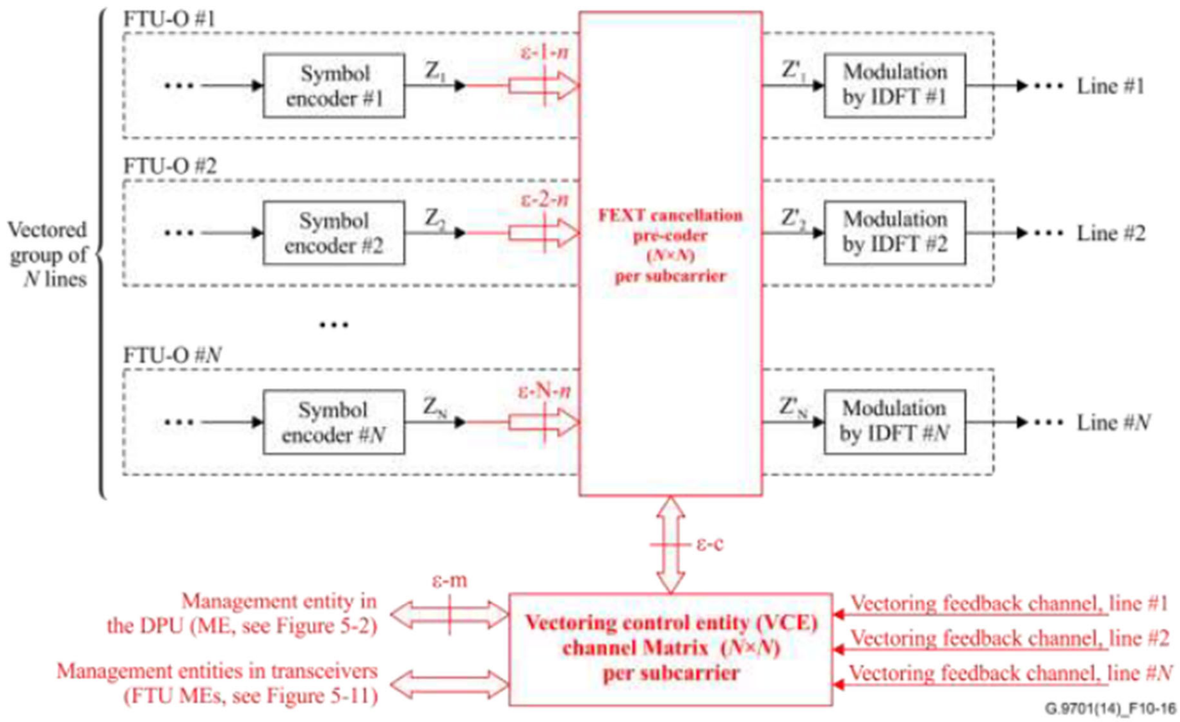
10.3.1 Overview

Figure 10-16 provides an overview of the functional model for the inclusion of downstream FEXT cancellation precoding at the DPU for all lines in the vectored group, as a generalization of Figure 10-1 from a signal processing perspective. The model shows an array of the downstream symbol encoders (which represent the data, sync, pilot or initialization symbol encoders shown in Figure 10-1) and the modulation by the IDFT functional blocks of the FTU-Os, with the FEXT cancellation precoder inserted between the symbol encoders and the modulation by the IDFT blocks.

The VCE of the vectored group learns and manages the channel matrix per vectored subcarrier, which reflects the channel characteristics of the managed group of lines. In the functional model in Figure 10-16, the channel matrix for each vectored subcarrier is of size $N \times N$ where N is the number of lines in the vectored group.

From the channel matrix, a VCE derives a FEXT precoder matrix, which is used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 10-16, this is shown by a matrix of FEXT cancellation precoders per vectored subcarrier of size $N \times N$. Knowing the transmit symbols on each disturbing channel, the precoder precompensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced. As a part of the channel matrix or separately, the VCE shall set the precoder such that the precoder output signals (Z' values shown in Figure 10-16) shall not lead at the U reference point to violation of the PSD limit corresponding with the tss_i (see clause 10.2.1.5.3).

The channel matrix and the resulting FEXT cancellation precoder matrix are assumed to be entirely managed inside the DPU. An information exchange between the FTU-O and FTU-R is required in each vectored line to learn, track and maintain the channel matrix and associated FEXT cancellation precoder matrix (see vectoring feedback channel definition in clause 10.3.2 and initialization in clause 12.3). The actual algorithms for processing this information to obtain the channel matrix and to generate the FEXT cancellation precoder are vendor discretionary. Depending on the implementation, it may be possible for the VCE to directly determine the FEXT cancellation precoder matrix and only have an implicit learning of the channel matrix.



NOTE – Symbol encoder represents the data, sync, pilot or initialization symbol encoder shown in Figure 10-1.

Figure 10-16 – Vectored group functional model of PMD sub-layer using *N*×*N* precoder for downstream vectoring

112. See also below, from G.vector:[30]

6.1 General

Figure 6-1 shows the functional model for the inclusion of downstream FEXT cancellation pre-coding at the AN for all lines in the vectored group, as a generalization of Figure 5-2 from a signal processing perspective. The model shows only the portion of an array of the downstream symbol encoders (which represent the data, sync or initialization symbol encoders shown in Figure 5-2) and the modulation by the inverse discrete Fourier transform (IDFT) functional blocks of the VTU-Os, with the FEXT cancellation pre-coder inserted between the symbol encoders and the modulation by the IDFT blocks.

[30] G.vector at 6.1.

The VCE of the vectored group learns and manages the channel matrix per vectored subcarrier, which reflects the channel characteristics of the managed group of lines. In the functional model in Figure 6-1, the channel matrix for each vectored subcarrier is of size $N \times N$ where N is the number of lines in the vectored group.

From the channel matrix, a FEXT pre-coder matrix may be derived and used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 6-1, this is shown by a matrix of FEXT cancellation pre-coders per vectored subcarrier of size $N \times N$. This FEXT cancellation pre-coding matrix may be "sparse" (see Note). Knowing the transmit symbols on each disturbing channel, the pre-coder pre-compensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced.

NOTE – In typical cases, several of the pre-coder coefficients may be set to 0 for implementation reasons, or because the crosstalk coefficients are negligibly small.

The channel matrix and the resulting FEXT cancellation pre-coder matrix are assumed to be entirely managed inside the AN. An information exchange between the VTU-O and VTU-R is required in each vectored line to learn, track, and maintain the channel matrix and associated FEXT cancellation pre-coder matrix (see backchannel definition in clause 7 and initialization in clause 10). The actual algorithms for processing this information to obtain the channel matrix and to generate the FEXT cancellation pre-coder are vendor discretionary. Depending on the implementation, it may be possible for the VCE to directly determine the FEXT cancellation pre-coder matrix and only have an implicit learning of the channel matrix.

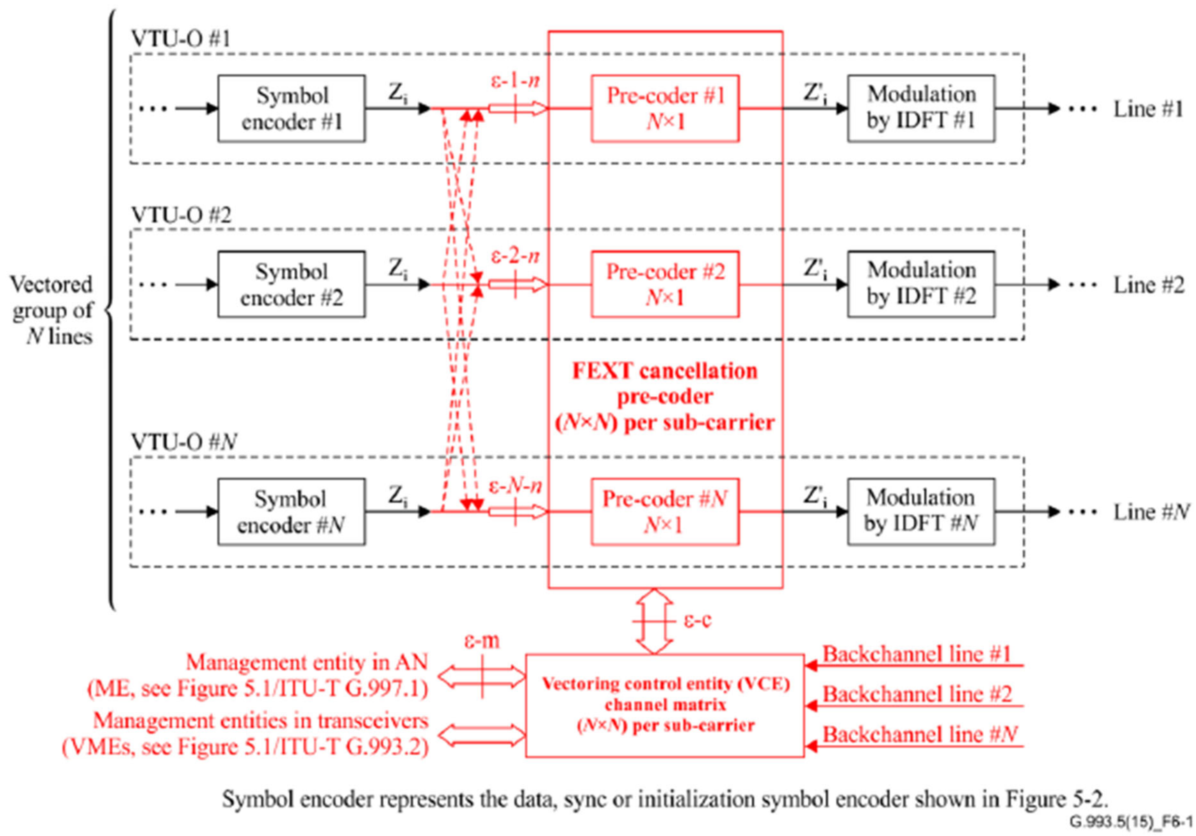


Figure 6-1 – Vectored group functional model of PMD sub-layer using $N \times N$ pre-coder for downstream vectoring

113. Configuration parameters provided to the VCE allow it to prioritize lines for vectoring:[31]

> **11.1.3 Target NDR/target ETR**
>
> Both the target net data rate (target NDR) configuration parameter and the target expected throughput (target ETR) configuration parameter shall be defined for each line in a group of vectored lines. These configuration parameters assist a VCE to decide on allocating vectored AN resources among the lines in a vectored group for FEXT cancellation. Because of limited resources, the vectored AN may be unable to mitigate all the FEXT sources into every single line in the vectored group. Therefore, The VCE may choose to limit the number of crosstalk sources to cancel for each vectored line.

114. Claim 1 of the '458 patent recites: "generating a data quantity representative of the crosstalk coupling between the primary line and each of the crosstalking lines based on the ordering of the crosstalking lines."

115. AT&T performs this step, e.g., by calculating the FEXT precoder matrix described below in G.fast:[32]

> From the channel matrix, a VCE derives a FEXT precoder matrix, which is used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 10-16, this is shown by a matrix of FEXT cancellation precoders per vectored subcarrier of size $N \times N$. Knowing the transmit symbols on each disturbing channel, the precoder precompensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced. As a part of the channel matrix or separately, the VCE shall set the precoder such that the precoder output signals (Z' values shown in Figure 10-16) shall not lead at the U reference point to violation of the PSD limit corresponding with the tss_i (see clause 10.2.1.5.3).

116. And as also described in G.vector:[33]

---

[31] G.vector at 11.1.3.

[32] G.fast at 10.3.1.

[33] G.vector at 6.1.

> From the channel matrix, a FEXT pre-coder matrix may be derived and used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 6-1, this is shown by a matrix of FEXT cancellation pre-coders per vectored subcarrier of size $N \times N$. This FEXT cancellation pre-coding matrix may be "sparse" (see Note). Knowing the transmit symbols on each disturbing channel, the pre-coder pre-compensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced.
>
> NOTE – In typical cases, several of the pre-coder coefficients may be set to 0 for implementation reasons, or because the crosstalk coefficients are negligibly small.

117. Claim 1 of the '458 patent recites: "sending instructions to one or more modems communicatively interfaced with the plurality of crosstalking lines in the channel based on the data quantity generated."

118. AT&T performs this step, e.g., when the VCE sends instructions to the OUT-R for performing FEXT cancellation based on the precoder matrix, as described below in G.fast:[34]

> From the channel matrix, a VCE derives a FEXT precoder matrix, which is used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 10-16, this is shown by a matrix of FEXT cancellation precoders per vectored subcarrier of size $N \times N$. Knowing the transmit symbols on each disturbing channel, the precoder precompensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced. As a part of the channel matrix or separately, the VCE shall set the precoder such that the precoder output signals (Z' values shown in Figure 10-16) shall not lead at the U reference point to violation of the PSD limit corresponding with the tss_i (see clause 10.2.1.5.3).
>
> [. . .]
>
> An FTU-O shall support FEXT cancellation precoding, as shown in Figure 10-1 and Figure 10-16.

119. And as explained below in G.vector:[35]

> From the channel matrix, a FEXT pre-coder matrix may be derived and used to compensate the FEXT from each line in the vectored group. In the functional model in Figure 6-1, this is shown by a matrix of FEXT cancellation pre-coders per vectored subcarrier of size $N \times N$. This FEXT cancellation pre-coding matrix may be "sparse" (see Note). Knowing the transmit symbols on each disturbing channel, the pre-coder pre-compensates the actual transmit symbol such that at the far-end receiver input, the crosstalk is significantly reduced.
>
> NOTE – In typical cases, several of the pre-coder coefficients may be set to 0 for implementation reasons, or because the crosstalk coefficients are negligibly small.
>
> [. . .]

---

[34] G.fast at 10.3.1.

[35] G.vector at 6.1.

The VTU-O shall support downstream vectoring (see clause 6.2) and may support upstream vectoring (see clause 6.3).

120. AT&T owns or controls the equipment, which is used to access AT&T's networks, that is on its customers' premises. The performance of the claimed steps by this equipment is thus attributable to AT&T.

121. In addition or in the alternative, to the extent that AT&T argues that its customers perform claimed steps of the '458 patent claims, AT&T directs or controls its customers' performance of those steps, conditions the benefits of its Internet service on the performance of those steps, and/or has the power, right, and ability to stop the performance of those steps but declines to do so and instead profits from their performance. AT&T controls access to its networks, and limits the equipment customers may use to access the network. While customers may, e.g., turn a modem on or off, doing so will nonetheless cause the modem to interface with AT&T's network using the DSL Standards as controlled by AT&T. AT&T thus conditions its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T similarly conditions its customers' receipt of the benefit of the accused technologies' compatibility and capabilities on its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T also has the power, right, and ability to stop the performance of these steps by customers at least by AT&T's control and limitations over its networks and the equipment accessing them. AT&T does not stop this performance and instead profits from customers' usage of its networks in ways that would cause the performance of these steps. Thus, the performance of the claimed method steps is attributable to AT&T.

122. AT&T directly infringes, literally and/or under the doctrine of equivalents, the '458 patent under 35 U.S.C. § 271(a).

123. In addition or in the alternative, when AT&T provides G.vector and/or G.fast-compliant equipment to its customers, they perform the method described above and thus directly infringe the ’458 patent under 35 U.S.C. § 271(a).

124. In addition or in the alternative, AT&T has indirectly infringed the Asserted Patents under 35 U.S.C. § 271(b) by inducing infringement by others, such as its subsidiaries and end-user customers, by, for example, implementing the infringing features in its G.vector and G.fast-compliant wired broadband lines, encouraging its users to use those lines within the United States, requiring its users to use those wired broadband lines in order to obtain AT&T’s broadband services at a customer’s desired performance level, and/or instructing, dictating, or training its customers to use the infringing features.

125. Similarly, AT&T’s advertising, sales, design, development, and/or technical materials related to operation of the Accused Instrumentalities contained and continue to contain instructions, directions, suggestions, and/or invitations that invite, entice, lead on, influence, encourage, prevail on, move by persuasion, and/or cause its subsidiaries and customers to directly infringe at least one claim of the ’458 patent, either literally or under the doctrine of equivalents.

126. AT&T took the above actions intending to cause infringing acts by others, and/or it willfully blinded itself as to the existence of the Asserted Patent and the Accused Instrumentalities’ infringement thereof.

127. AT&T’s acts of infringement have caused damage to ASSIA. ASSIA is entitled to recover from AT&T the damages sustained by ASSIA as a result of AT&T’s wrongful acts in an amount subject to proof at trial.

COUNT III
(Defendants' Infringement of the '122 Patent)

128. ASSIA incorporates the allegations of all of the foregoing paragraphs as if fully restated herein.

129. The '122 patent, entitled "DSL System Training," issued on August 2, 2011 to inventors John M. Cioffi, Wonjong Rhee, Bin Lee and Georgios Ginis.

130. ASSIA owns all rights, title, and interest in the '122 patent, and holds all substantial rights pertinent to this suit, including the right to sue and recover for all past, current, and future infringement.

131. The '122 patent is valid and enforceable and directed to patentable subject matter.

132. AT&T infringes one or more claims of the '122 patent by making, using, selling, and/or offering to sell, in this District and elsewhere in the United States, and/or importing into this District and elsewhere in the United States, one or more of the Accused Instrumentalities. In particular, AT&T infringes by installing, configuring, servicing, and/or operating wired broadband lines employing the G.vector and G.fast standards.[36]

133. ASSIA provides the following explanation of infringement with regard to an exemplary claim compared to exemplary functionality.

---

[36] *See* https://about.att.com/story/att_g_fast_on_sale_now_to_apartment_and_condominium_properties.html; https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095. AT&T's advertising references use of the VDSL2 and G.fast standards. G.vector provides improvements to VDSL2 to provide, e.g., higher speed service such as 100 mbps service. https://www.fiercetelecom.com/telecom/tdc-denmark-trials-alcatel-lucent-s-vdsl2-vectoring-technology; https://versatek.com/how-g-inp-will-optimize-copper-lines-to-reach-100mbps/#:~:text=inp%20increases%20stability%2C%20reduces%20latency,high%20demand%20for%20faster%20broadband; https://www.fiercetelecom.com/telecom/alcatel-lucent-says-vdsl2-vectoring-isn-t-enough-to-deliver-100-mbps-over-existing-copper. AT&T employs G.vector-compliant devices. *see, e.g.,* NVG599 Manual, https://manualzz.com/download/24825294.

134. Claim 14 of the '122 patent recites: "a controller comprising: a data collection unit configured to collect operational data from a new DSL line set and an already-operating DSL line set."

135. AT&T makes, uses, sells, offers to sell, and/or imports into the United States such a controller. For example, the Accused Instrumentalities comprise VCE configured to collect operational data from a new DSL line set and an already-operating DSL line set during the channel discovery phase as described in G.fast. Downstream transmitters transmit O-P-VECTOR 1, O-P-VECTOR 1-1, O-P-VECTOR 2, and O-P-VECTOR 2-1, while upstream transmitters transmit R-P-VECTOR- 1, R-P-VECTOR 1-1, R-P-VECTOR 1-2, and R-P-VECTOR 2, as shown below:[37]

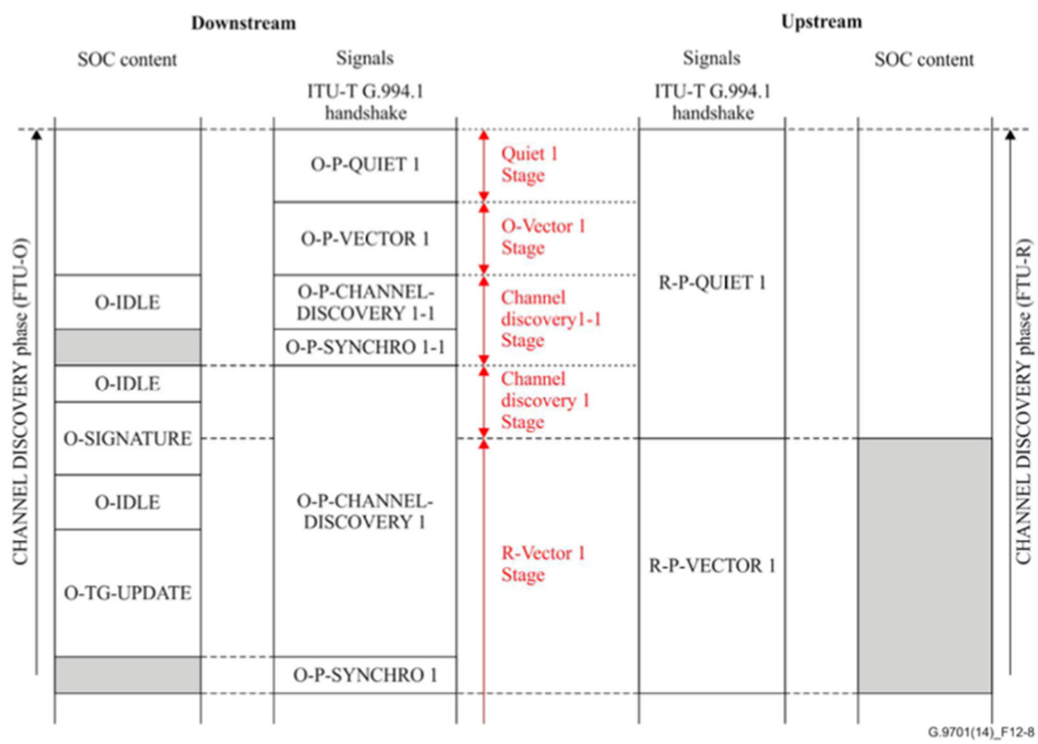


Figure 12-8 – The details of early stages of the channel discovery phase

[37] G.fast at 12.2.3, 12.3.3, figs. 12-8, 12-9.

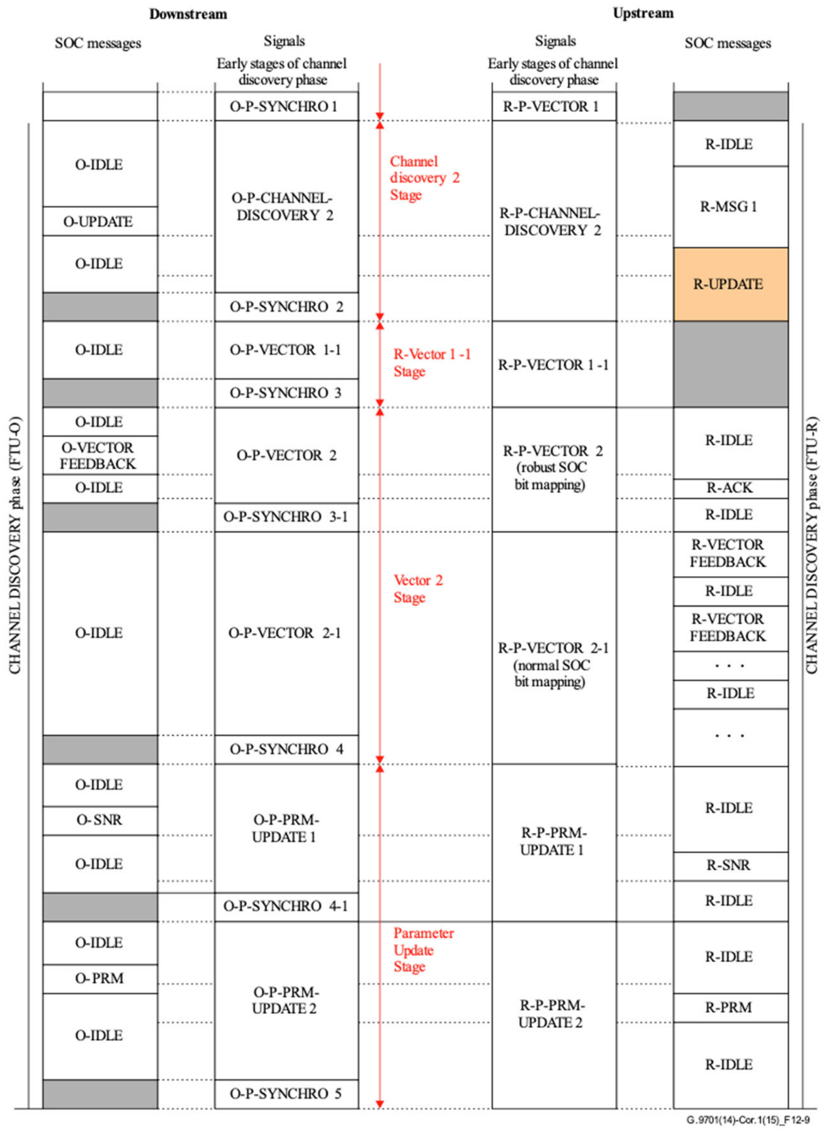


Figure 12-9 – The details of the later stages of the channel discovery phase

136. During this process, the VCE collects operational data comprises timing information, modulated sync symbols, and VF samples, as explained below in G.fast:[38]

[38] G.fast at 10.2, 10.3, 10.8.

10.8 Alignment of transmissions in vectored group

The superframes transmitted by all FTU-Os of a vectored group shall be aligned in time so that the downstream sync symbols are aligned in time at the U-O reference points of the vectored lines. All other symbols of the superframe (data symbols) transmitted by all FTU-Os of a vectored group shall also be aligned in time between themselves at the U-O reference points of the vectored lines. The misalignment shall be evaluated as the time difference between reference samples of the aligned symbols of the vectored lines (see clause 8.4.1, Figure 8-12) and is vendor discretionary.

To avoid performance degradation in a vectored group, the misalignment should be significantly smaller than the assigned value of the cyclic extension (CE).

The FTU-O shall facilitate that the upstream symbols transmitted by all FTU-Rs of a vectored group be aligned between themselves at the U-O reference point by adjusting the value of T_{g1}' during the initialization, as described in clause 12.3.3.1.

To facilitate alignment in time, symbols in all lines of a vectored group shall be assigned the same cyclic extension, in both upstream and downstream. Also, the TDD frame parameters M_F, M_{us} and M_{ds} shall be the same in all lines of the vectored group. The CE length used for all lines in a vectored group should be appropriate for the line with the largest propagation delay.

10.2.2.1 Sync symbol encoder

Sync symbols shall be able to carry a probe sequence during initialization and showtime. Each element in the probe sequence shall be from the finite set {−1, 0, 1}. The length and content of a probe sequence are determined by the VCE. They may be different for upstream and downstream. They are communicated to the FTU-R during initialization, and may be updated by request of the VCE during showtime.

10.3.2.3 Reporting of vectoring feedback (VF) samples

The FTU-R shall send vectoring feedback (VF) samples (either clipped error samples as defined in clause 10.3.2.1 or DFT output samples as defined in clause 10.3.2.2) to the FTU-O through the vectoring feedback channel established between the FTU-O and the FTU-R in each line of the vectored group, as defined in Table 11-43 (vectoring feedback responses) in clause 11.2.2.14 for showtime or in clause 12.3.3.2.8 (R-VECTOR-FEEDBACK message) during initialization. The FTU-O conveys the received VF samples to the VCE of the vectored group.

137. The Accused Instrumentalities also comprise VCE configured to collect operational data from a new DSL line set and an already-operating DSL line set during initialization as described in G.vector. Downstream transmitters transmit O-P-VECTOR 1, O-P-VECTOR 1-1, O-P-VECTOR 2, and O-P-VECTOR 2-1, while upstream transmitters transmit R-P-VECTOR- 1, R-P-VECTOR 1-1, R-P-VECTOR 1-2, and R-P-VECTOR 2, as shown below:[39]

[39] G.vector at 10.1, Fig. 10-1.

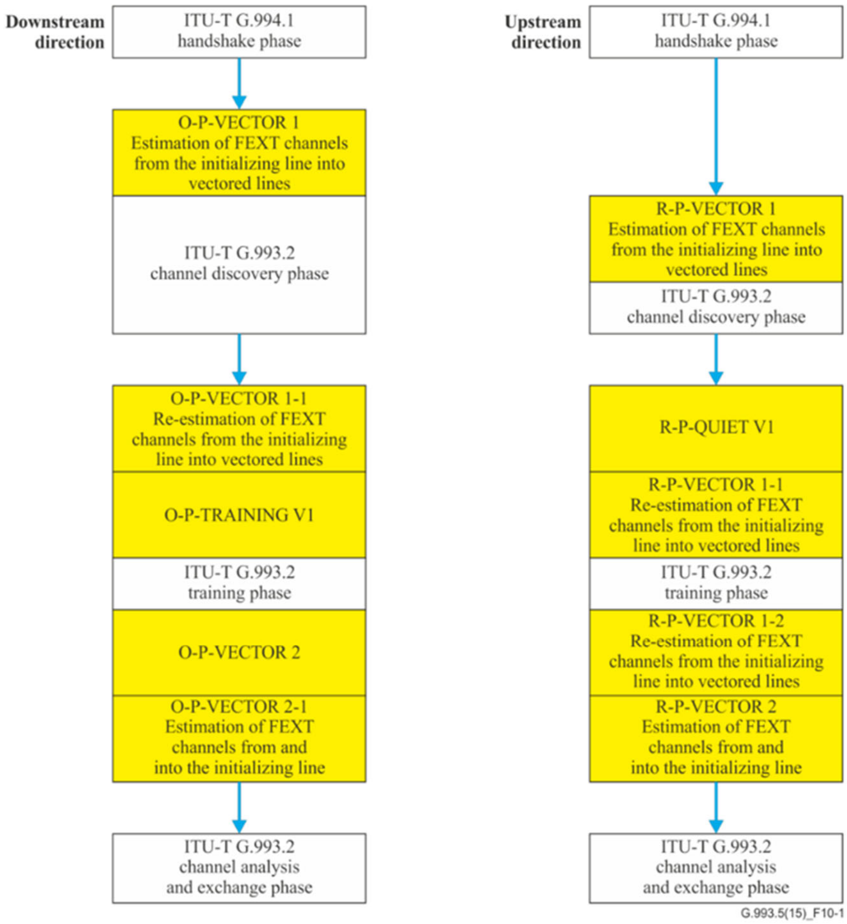


Figure 10-1 – ITU-T G.993.5 initialization overview

138. During this process, the VCE collects operational data comprises timing information, modulated sync symbols, and error samples, as explained below in G.vector:[40]

[40] G.vector at 10.1, 7.3.

7.3.1 Symbol alignment

Under VCE control, all VTU-Rs in the vectored group shall use the same subcarrier spacing and symbol rate.

NOTE – The VCE may control the alignment of symbols from different lines of the vectored group at the U-O2 reference point (defined in Figure 5-4 of [ITU-T G.993.2]) by adjusting the timing advance (TA) of these lines during initialization (see clause 10).

7.3.2 Sync symbol position

The VTU-R shall have the capability to transmit sync symbols as defined in clause 10.2 of [ITU-T G.993.2]. The VTU-R shall transmit sync symbols at time positions assigned by the VCE and communicated to the VTU-R during initialization. The time position of upstream sync symbols is defined by an offset between upstream and downstream sync symbol positions.

The offset between the upstream and downstream sync symbol time positions is set by the VCE and sent to the VTU-R in the O-SIGNATURE message.

The VCE may configure all VTU-Rs in the vectored group to transmit upstream sync symbols at the same time positions or at different time positions for one or more VTU-Rs in the vectored group.

The VTU-R shall keep a downstream sync symbol counter (MODULO N_SSC), counting continuously over Showtime. The counter value of the first downstream sync symbol transmitted in Showtime shall be set by the VTU-R to the value of the field First SSC of the first received Error Feedback command (see Table 8-3). Before receiving the first Error Feedback command, the value of the downstream sync symbol counter for the first downstream sync symbol transmitted in Showtime is vendor discretionary.

7.3.3 Modulation of pilot sequence

The VTU-R shall have the capability to modulate a VCE-specified upstream pilot sequence on all subcarriers of the upstream sync symbols during initialization (see clause 10.3.4.1) and on the probe tones (see clause 3.2.10) of the upstream sync symbols during Showtime. The upstream pilot sequence is vendor discretionary, determined by the VCE, with length *Npilot_u*s and sent to the VTU-R at initialization in the O-SIGNATURE message. Pilot sequence bits are indexed from 0 to *Npilot_us* – 1. The bit with index 0 shall be transmitted first, followed by the bit with index 1, up to bit with index *Npilot_us* – 1. If the "pilot sequence length multiple of 4" is enabled (see clause 10.2), then valid values of *Npilot_us* are all multiples of 4 in the range from 8 to 512. Otherwise, the valid values of *Npilot_us* shall be all powers of 2 in the range from 8 to 512. The pilot sequence shall be cyclically repeated after *Npilot_u*s bits, except for the case where the upstream pilot sequence is changed by the VCE through the procedure defined in clause 8.2.

The time position of the upstream pilot sequence is determined by the VCE and communicated to VTU-R during the initialization by special markers (see clause 10.3.3.5). Subcarriers of upstream sync symbols shall be modulated by the upstream pilot sequence bits corresponding to the time position of the upstream pilot sequence.

10 Initialization of a vectored group

This clause defines the initialization of a vectored group.

10.1 Overview

[. . .]

> In the downstream direction, at the beginning of the Channel Discovery phase, the VTU-O of the initializing line transmits O-P-VECTOR 1 signal which comprises only sync symbols modulated by the pilot sequence and which is aligned with sync symbols of vectored lines, see Figure 10-2. The O-P-VECTOR 1 signal allows the VCE to estimate FEXT channels from the initializing lines into the vectored lines. The VCE estimates these FEXT channels based on the reported clipped error samples from the VTU-Rs of the vectored lines and enables the pre-coding in the VTU-Os of these vectored lines to cancel FEXT from the initializing lines into these vectored lines during the remainder of the initialization of the initializing lines.
>
> At the beginning of the Training phase, the initializing VTU-O will transmit O-P-VECTOR 1-1 signal, which is the same as O-P-VECTOR 1 and allows the VCE to update the downstream FEXT channel estimates from the initializing lines into the vectored lines, prior to transitioning into the ITU-T G.993.2 Training phase.

139. The ’122 patent recites: “an analysis unit coupled to the collection unit, wherein the analysis unit is configured to: analyze the collected operational data; [and] determine an operational configuration for at least one DSL line in the new DSL line set that will allow the new DSL line set to join the already-operating DSL line set without disrupting the already-operating DSL line set.”

140. AT&T makes, uses, sells, offers to sell, and/or imports into the United States a controller capable of this functionality. For example, the VCE initially configures the operation of the new DSL line set to transmit only a modulated sync symbol during the sync symbol period, and to transmit nothing during the other symbol periods. This operational configuration will allow the new DSL line set to join the already-operating DSL line set without disrupting the already-operating DSL line set. See the above description of channel discovery in G.fast and initialization in G.vector.

141. The ’122 patent recites: “[the analysis unit is configured to] evaluate data received by the new DSL line set; and evaluate data received by the already-operating DSL line set.”

142. AT&T makes, uses, sells, offers to sell, and/or imports into the United States a controller capable of this functionality. For example, as the Accused Instrumentalities, evaluate

vectoring feedback data from the new DSL line set and form the already-operating DSL line set as explained in G.fast:[41]

> NOTE – By using the vectoring feedback, the VCE may estimate downstream crosstalk from the active lines into the joining lines and between joining lines, and computes precoder coefficients to cancel the crosstalk from active lines into the joining lines and between joining lines. Based on the computed precoder coefficients, the VCE may compute for all lines PSD updates, new gains and new bit loading for active lines (if required).

143. As another example, the Accused Instrumentalities, evaluate vectoring feedback data from the new DSL line set and form the already-operating DSL line set as explained in G.vector:[42]

> After the ITU-T G.993.2 Training phase, the VTU-O transmits the O-P-VECTOR 2 signal, followed by the O-P-VECTOR 2-1 signal, which both comprise sync symbols modulated by the pilot sequence and regular symbols carrying the SOC, see Figure 10-3. During the transmission of O-P-VECTOR 2-1, the VCE estimates FEXT channels from all vectored lines into each initializing line and vice versa. Finally, at the end of the transmission of O-P-VECTOR 2-1, the whole FEXT channel matrix, including FEXT coefficients from the initializing line into the vectored lines and FEXT coefficients from the vectored lines into each initializing line, is estimated by the VCE. At this point the initialization process is complete and the initializing lines may be included in the pre-coding operation. After O-P-VECTOR 2-1 transmission is complete, the VTU-O of the initializing line enters the Channel Analysis and Exchange phase for estimation of the signal-to-noise ratio (SNR) and determination of the bit loading to be used during Showtime.

144. The '122 patent recites: "a control signal generator coupled to the analysis unit, wherein the control signal generator is configured to send control signals to the new DSL line set and to the already-operating DSL line set, further wherein the control signals comprise signals controlling operation of at least one of the following: the new DSL line set; or the already-operating DSL line set; and wherein the controller is configured to evaluate whether crosstalk from the new DSL line set affects the already-operating DSL line set."

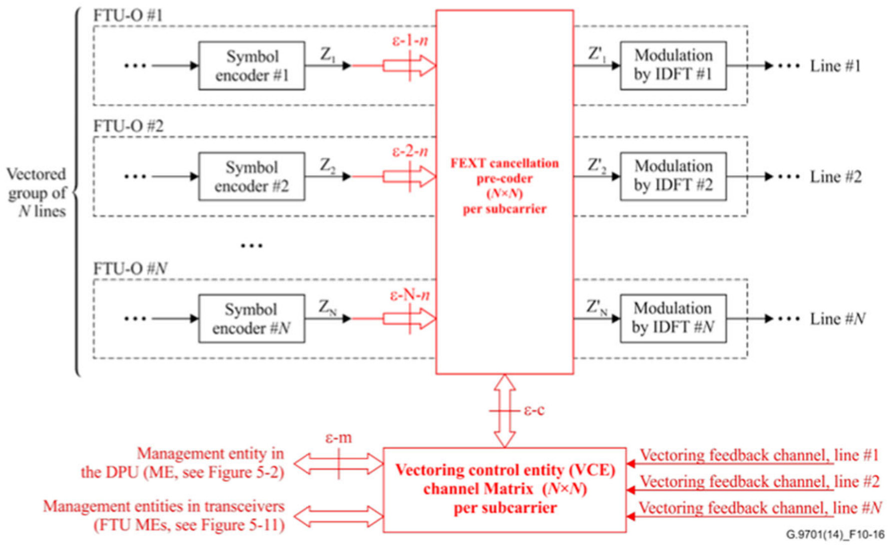
---

[41] G.fast at 12.3.

[42] G.vector at 10.1.

145. AT&T makes, uses, sells, offers to sell, and/or imports into the United States a controller capable of this functionality. For example, the VCE sends pre-coding coefficients to the FTU-Os at the end of the VECTOR 2 stage, as explained in G.fast:[43]

> At the end of the stage, the VCE applies precoder coefficients and PSD updates to all active and joining lines.



NOTE – Symbol encoder represents the data, sync, pilot or initialization symbol encoder shown in Figure 10-1.

Figure 10-16 – Vectored group functional model of PMD sub-layer using $N \times N$ precoder for downstream vectoring

146. As another example, the VCE sends pre-coding coefficients to the VTU-Os, as explained in G.vector:[44]

> **6.2.4 Pre-coding**
>
> A VTU-O, when enabled for downstream vectoring, shall support FEXT cancellation pre-coding, as shown in Figure 5-2 and Figure 6-1. The pre-coding coefficients for each individual VTU-O (see clause 6.1) shall be under VCE control.

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[43] G.fast at 12.3.3.1.7, 12.1, fig. 10-16.

[44] G.vector at 6.2.4, 10.1, fig. 6-1.

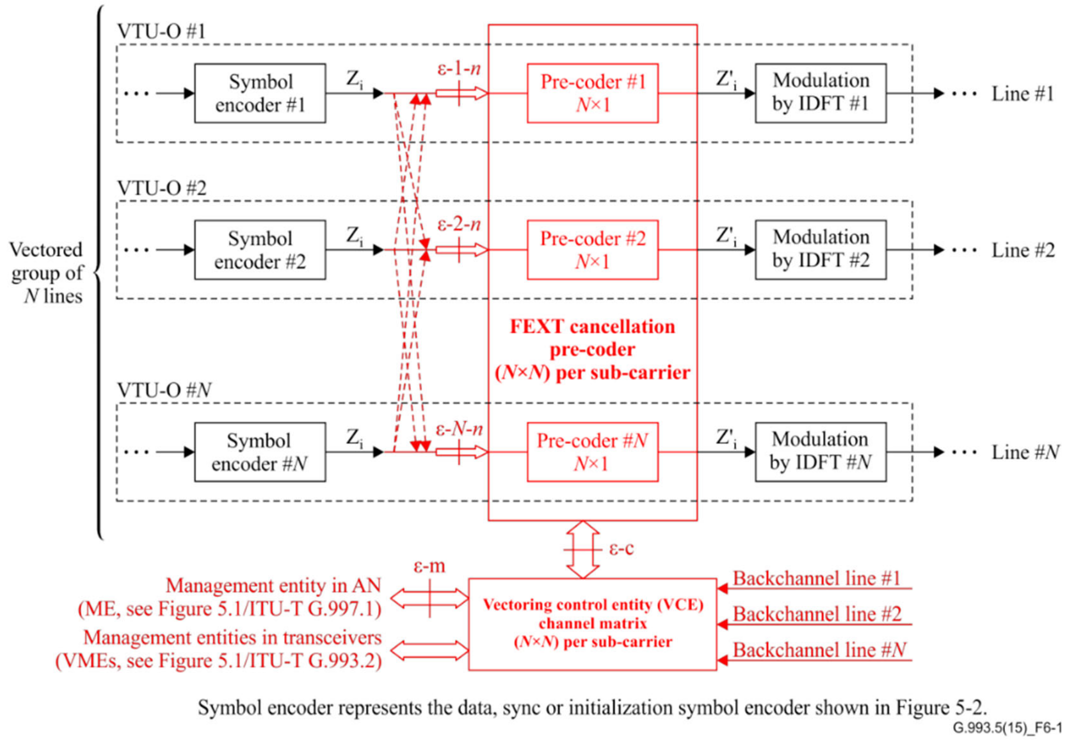

Figure 6-1 – Vectored group functional model of PMD sub-layer using *N*×*N* pre-coder for downstream vectoring

147. The control signals comprise the pre-coding coefficients control operation of at least the new DSL line set or the already-operating DSL line set and are used to cancel crosstalk. Thus, the controller of the Accused Instrumentalities is configured to evaluate whether crosstalk from the new DSL line set affects the already-operating DSL line set, as explained in G.fast and G.vector.

148. AT&T owns or controls the equipment, which is used to access AT&T's networks, that is on its customers' premises. The performance of the claimed steps by this equipment is thus attributable to AT&T.

149. In addition or in the alternative, to the extent that AT&T argues that its customers make or use the accused instrumentalities that meet the '122 patent claims, AT&T directs or controls its customers' making or using of the accused instrumentalities, conditions the benefits of

its Internet service on the making or using of the accused instrumentalities, and/or has the power, right, and ability to stop the making or using of the accused instrumentalities but declines to do so and instead profits from their performance. AT&T controls access to its networks, and limits the equipment customers may use to access the network. While customers may, e.g., turn a modem on or off, doing so will nonetheless cause the modem to interface with AT&T's network using the DSL Standards as controlled by AT&T. AT&T thus conditions its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T similarly conditions its customers' receipt of the benefit of the accused technologies' compatibility and capabilities on its customers' use and operation of the Accused Instrumentalities in a way that would cause the making or using of the accused instrumentalities. AT&T also has the power, right, and ability to stop the making or using of the accused instrumentalities by customers at least by AT&T's control and limitations over its networks and the equipment accessing them. AT&T does not stop this making and using and instead profits from customers' usage of its networks in ways that would cause the making or using of the accused instrumentalities. Thus, the making or using of the accused instrumentalities is attributable to AT&T.

150. AT&T directly infringes, literally and/or under the doctrine of equivalents, the '122 patent under 35 U.S.C. § 271(a).

151. In addition or in the alternative, when AT&T provides G.vector and G.fast-compliant equipment to its customers, they perform the method described above and thus directly infringe the '122 patent under 35 U.S.C. § 271(a).

152. In addition or in the alternative, AT&T has indirectly infringed the '122 patent under 35 U.S.C. § 271(b) by inducing infringement by others, such as its subsidiaries and end-user

customers, by, for example, implementing the infringing features in its G.vector and G.fast-compliant wired broadband lines, encouraging its users to use those lines within the United States, requiring its users to use those wired broadband lines in order to obtain AT&T's broadband services at a customer's desired performance level, and/or instructing, dictating, or training its customers to use the infringing features.

153. Similarly, AT&T's advertising, sales, design, development, and/or technical materials related to operation of the Accused Instrumentalities contained and continue to contain instructions, directions, suggestions, and/or invitations that invite, entice, lead on, influence, encourage, prevail on, move by persuasion, and/or cause its subsidiaries and customers to directly infringe at least one claim of the '122 patent, either literally or under the doctrine of equivalents.

154. AT&T took the above actions intending to cause infringing acts by others, and/or it willfully blinded itself as to the existence of the Asserted Patent and the Accused Instrumentalities' infringement thereof.

155. AT&T's acts of infringement have caused damage to ASSIA. ASSIA is entitled to recover from AT&T the damages sustained by ASSIA as a result of AT&T's wrongful acts in an amount subject to proof at trial.

COUNT IV
(Defendants' Infringement of the '631 Patent)

156. ASSIA incorporates the allegations of all of the foregoing paragraphs as if fully restated herein.

157. The '631 patent, entitled "Management System and Methods of Managing Time-Division Duplex (TDD) Transmission Over Copper," issued on April 24, 2018 and names as inventors Kenneth Kerpez, George Ginis, Marc Goldburg, and Ardavan Maleki Tehrani.

158. ASSIA owns all rights, title, and interest in the ’631 patent, and holds all substantial rights pertinent to this suit, including the right to sue and recover for all past, current, and future infringement.

159. The ’631 patent is valid and enforceable and directed to patentable subject matter.

160. AT&T infringes one or more claims of the ’631 patent by making, using, selling and/or offering to sell, in this District and elsewhere in the United States, and/or importing into this District and elsewhere in the United States, one or more of the Accused Instrumentalities. In particular, AT&T infringes by installing, configuring, servicing, and/or operating wired broadband lines employing the G.fast standard.[45]

161. ASSIA provides the following explanation of infringement with regard to an exemplary claim compared to exemplary functionality.

162. Claim 1 of the ’631 patent recites: A method in a data communications system for managing multiple time division physical channels that are subject to crosstalk.

163. AT&T performs this method. In particular, in operating the Accused Instrumentalities, AT&T operates multiple wired broadband lines in compliance with the G.fast Standard. This standard requires that these lines employ time division physical channels. These channels are subject to crosstalk due to the physical proximity of the lines.

164. Claim 1 of the ’631 patent recites: “scheduling upstream time slots for upstream transmission in a first physical channel” and “scheduling downstream time slots for downstream transmission in a second physical channel.”

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[45] AT&T advertises use of the G.fast standard. *See* https://about.att.com/story/att_g_fast_on_sale_now_to_apartment_and_condominium_properties.html; https://www.att.com/support/article/u-verse-high-speed-internet/KM1010095.

165. AT&T performs these steps, e.g., by employing the G.fast time slot structure as shown below:[46]

10.5 TDD frame structure

The TDD frame structure is presented in Figure 10-26 with the following notations describing the TDD frame parameters. Values of T_{g1} and T_{g2} are the gap times at the U interface of the FTU-O, while $T_{g1'}$ and $T_{g2'}$ are the gap times at the U interface of the FTU-R. Both the FTU-O and the FTU-R shall transmit in respect to downstream and upstream symbol boundaries, respectively. In all cases, the sum $T_{g1}+T_{g2} = T_{g1'}+T_{g2'}$ shall be equal to the duration of one symbol.

The actual value of $T_{g1'}$ is determined during initialization, as described in clause 12.3.3.1.2. The initial value of $T_{g1'}$ is communicated to the FTU-R in the O-SIGNATURE message. This value is further adjusted to align boundaries of received upstream symbols in all vectored lines. The valid range of $T_{g1'}$ is from 6.5 μs to 11.2 μs. The FTU-O shall support $T_{g1} \geq 6.5$ μs.

NOTE – With the defined range of $T_{g1'}$ (6.5μs $\leq T_{g1'} \leq$11.2μs), the maximum value of T_{g2} should not exceed 11.2 μs in the aim to support very short loops whose T_{pd} is close to 0. Using a setting T_{g2} = 11 μs, the DPU can accommodate propagation delays within the range from 0 to $T_{pd} \leq$ (11-6.5)/2 = 2.25 μs. This range of T_{pd}, assuming a typical propagation delay of 0.5 μs per 100 m, allows establishing a vectored group that includes loops with lengths from 0 to 450 m.

The variable T_F defines the frame period. The TDD frame length shall be an integer multiple of symbol periods. One TDD frame period shall consist of M_{ds} symbol periods dedicated for downstream transmission, M_{us} symbol periods dedicated for upstream transmission and a total gap time ($T_{g1} + T_{g2}$) equal to one symbol period; hence $T_F = M_F \times T_{symb}$, where $M_F = M_{ds} + M_{us} + 1$. The downstream transmit symbol boundary shall be aligned with the TDD frame boundary.

TDD frame lengths of $M_F = 36$ and $M_F = 23$ symbol periods shall be supported.

Additional values of M_F are for further study.

The particular values of M_F and TDD frame parameters M_{ds} and M_{us} are set during the initialization (ITU-T G.994 handshake, see clause 12.3.2.1), according to the corresponding DPU-MIB parameters; in all cases $M_{ds} + M_{us} \leq 35$. The FTU shall support the ranges of values of M_{ds} as a function of M_F according to Table 10-13.

Additional ranges of values of M_{ds} as a function of M_F are for further study.

[46] G.fast at 10.5.

Table 10-13 – M_{ds} values to support as a function of M_F

M_F	M_{ds} values supported
36	from 10 to 32
23	from 6 to 19

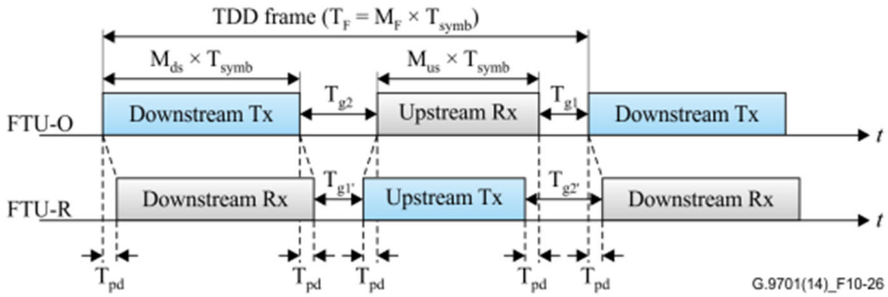

Figure 10-26 – TDD frame structure

The same TDD frame structure shall be used during both initialization and showtime.

During showtime, symbol periods in a TDD frame are used for transmission of data symbols (carrying DTUs) and the following special symbols:

– Sync symbol: See clauses 10.2.2.1 and 10.6.
– RMC symbol: See clause 10.5.1.
– Pilot symbol: See clauses 10.2.2.3 and 10.4.5.1.
– Idle symbols: See clauses 10.2.1.7 and 10.7.
– Quiet symbols: See clauses 10.2.1.6 and 10.7.

During the initialization, symbol periods in a TDD frame are used for transmission of the sync symbols and the initialization symbols (see clauses 12.3.3.3 and 12.3.4.3). The format of initialization symbols is defined in clause 10.2.2.2.

166. Moreover, AT&T employs this structure with a wire pair for each of multiple FTU-Os, and thus multiple physical channels, as shown, e.g., below:

The PHY blocks represent the physical layer of the DPU towards the access network and of the NT towards the customer premises (CP). These blocks are shown for completeness of the data flow but are out of scope of this Recommendation. The L2+ blocks represent the layer 2 and above functionalities contained in the DPU and the NT. These blocks are shown for completeness of the data flow but are out of scope of this Recommendation. An FTU-O represents the physical interface of the DPU related to a wire-pair. The DPU includes a number of ITU-T G.9701 transceivers (FTU-O-1 for line 1 in Figure 5-1); the peer transceiver at the NT is FTU-R-1. Functionalities related to maintaining POTS and power related functionality are not illustrated in either Figure 5-1 or Figure 5-2.

Figure 5-2 provides an overview of the reference model with the logical information flows within the DPU containing N FTU-Os. A DPU could comprise a single FTU-O or multiple FTU-Os. The fundamental principle of the system is synchronous and coordinated transmission and reception of signals from all N wire-pairs connected to the DPU. Thus, the signals may be represented as a vector where each component is the signal on one of the multiple lines (shown as thick lines in Figure 5-2).

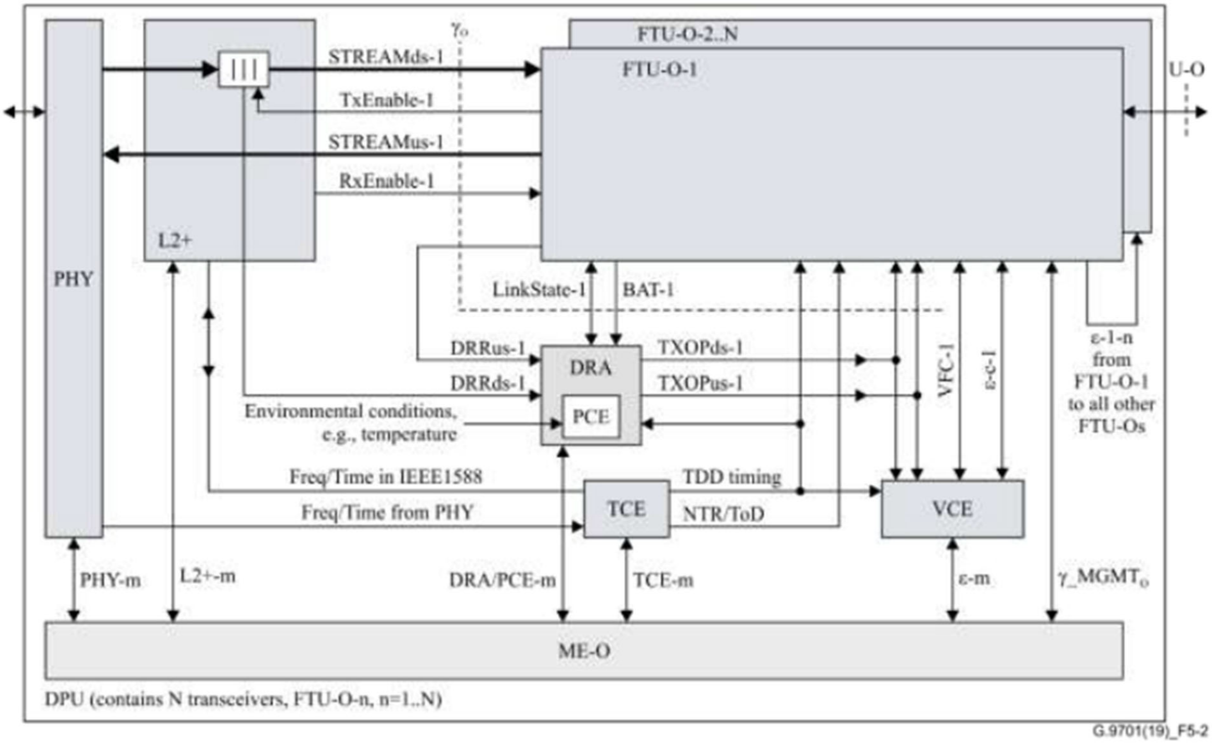

Figure 5-2 – Reference model of the DPU
(shown for line 1 of *N* lines connected to the DPU)

167. As shown above, the requirements for scheduling an upstream time slot on a first channel and a downstream time slot on a second channel are defined in G.fast. By operating its G.fast-compliant wired broadband lines, AT&T practices these steps.

168. Claim 1 of the '631 patent recites: "wherein transmission in the upstream time slots is substantially not simultaneous with transmission in the downstream time slots."

169. AT&T performs this step by operating its G.fast-compliant wired broadband lines. G.fast explains that no time overlap occurs between downstream transmission on any line and

upstream transmission on any other line, for lines connected to a particular DPU and forming a vectored group as explained, e.g., as shown below:[47]

7.1 Duplexing method

The ITU-T G.9701 transceivers shall use time-division duplexing (TDD) to separate upstream and downstream transmissions. The time allocation of the upstream and downstream transmission and the total guard time separating upstream and downstream are determined by the format of the TDD frame defined in clause 10.5.

Additionally, the ITU-T G.9701 transceivers serving the lines connected to a particular DPU and forming a vectored group shall have their symbols, TDD frames, and superframes synchronized, so that no time overlap occurs between downstream transmission on any line and upstream transmission on any other line. Symbol positions for downstream transmissions are aligned in time at the U-O reference points across all the lines of the vectored group. Similarly, symbol positions for upstream transmissions are aligned in time at the U-O reference points across all the lines of the vectored group. This arrangement is called synchronized time-division duplexing (STDD).

170. AT&T owns or controls the equipment, which is used to access AT&T's networks, that is on its customers' premises. The performance of the claimed steps by this equipment is thus attributable to AT&T.

171. In addition or in the alternative, to the extent that AT&T argues that its customers perform claimed steps of the '631 patent claims, AT&T directs or controls its customers' performance of those steps, conditions the benefits of its Internet service on the performance of those steps, and/or has the power, right, and ability to stop the performance of those steps but declines to do so and instead profits from their performance. AT&T controls access to its networks, and limits the equipment customers may use to access the network. While customers may, e.g., turn a modem on or off, doing so will nonetheless cause the modem to interface with AT&T's network using the DSL Standards as controlled by AT&T. AT&T thus conditions its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of

[47] G.fast at 7.1.

the claimed method steps. AT&T similarly conditions its customers' receipt of the benefit of the accused technologies' compatibility and capabilities on its customers' use and operation of the Accused Instrumentalities in a way that would cause the performance of the claimed method steps. AT&T also has the power, right, and ability to stop the performance of these steps by customers at least by AT&T's control and limitations over its networks and the equipment accessing them. AT&T does not stop this performance and instead profits from customers' usage of its networks in ways that would cause the performance of these steps. Thus, the performance of the claimed method steps is attributable to AT&T.

172. AT&T directly infringes, literally and/or under the doctrine of equivalents, the '631 patent under 35 U.S.C. § 271(a).

173. In addition or in the alternative, when AT&T provides G.fast-compliant equipment to its customers, they perform the method described above and thus directly infringes the '631 patent under 35 U.S.C. § 271(a).

174. In addition or in the alternative, AT&T has indirectly infringed the Asserted Patents under 35 U.S.C. § 271(b) by inducing infringement by others, such as its subsidiaries and end-user customers, by, for example, implementing the infringing features in its G.fast-compliant wired broadband lines, encouraging its users to use those lines within the United States, requiring its users to use those wired broadband lines in order to obtain AT&T's broadband services at a customer's desired performance level, and/or instructing, dictating, or training its customers to use the infringing features.

175. Similarly, AT&T's advertising, sales, design, development, and/or technical materials related to operation of the Accused Instrumentalities contained and continue to contain instructions, directions, suggestions, and/or invitations that invite, entice, lead on, influence,

encourage, prevail on, move by persuasion, and/or cause its subsidiaries and customers to directly infringe at least one claim of the ’631 patent, either literally or under the doctrine of equivalents.

176. AT&T took the above actions intending to cause infringing acts by others, and/or it willfully blinded itself as to the existence of the Asserted Patent and the Accused Instrumentalities’ infringement thereof.

177. AT&T’s acts of infringement have caused damage to ASSIA. ASSIA is entitled to recover from AT&T the damages sustained by ASSIA as a result of AT&T’s wrongful acts in an amount subject to proof at trial.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff respectfully requests the following relief:

a. a judgment in favor of Plaintiff that Defendants have infringed, either literally and/or under the doctrine of equivalents, the Asserted Patents under 35 U.S.C. § 271(a);

b. a judgment in favor of Plaintiff that Defendants have infringed, either literally and/or under the doctrine of equivalents, the Asserted Patents under 35 U.S.C. § 271(b);

c. a judgment that Defendants’ infringement has been and is willful;

d. a judgment and order requiring Defendants to pay Plaintiff its damages, costs, expenses, and any enhanced damages to which Plaintiff is entitled for Defendant’s infringement;

e. a judgment and order requiring Defendants to provide an accounting and to pay supplemental damages to Plaintiff, including without limitation, pre-judgment and post-judgment interest;

f. a judgment and order requiring Defendants to pay ongoing royalties;

g. a judgment and order finding that this is an exceptional case within the meaning of 35

U.S.C. § 285 and awarding Plaintiff its reasonable attorney fees against Defendants; and

h. any and all other legal or equitable relief as the Court may deem appropriate and just under the circumstances.

DEMAND FOR JURY TRIAL

Pursuant to Fed. R. Civ. P. 38, Plaintiff hereby demands trial by jury on all claims and issues so triable.

DATED: January 19, 2024

Respectfully submitted,

/s/ Bradley W. Caldwell

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