

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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AT&T SERVICES, INC. AND NOKIA OF AMERICA CORP.,

Petitioners

v.

ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC.,

Patent Owner.

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IPR2025-00395

U.S. PATENT NO. 7,428,669

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**DECLARATION OF DR. RICHARD GITLIN**

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### List of Exhibits

| <b>Exhibit</b>  | <b>Short Name</b> | <b>Description</b>                                                                                                                        |
|-----------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ex. 1001</b> | '669 Patent       | U.S. Patent No. 7,428,669                                                                                                                 |
| <b>Ex. 1002</b> | Declaration       | Declaration of Richard Gitlin                                                                                                             |
| <b>Ex. 1003</b> | CV                | <i>Curriculum Vitae</i> of Richard Gitlin                                                                                                 |
| <b>Ex. 1004</b> | '669 File History | File History of U.S. Patent No. 7,428,669                                                                                                 |
| <b>Ex. 1005</b> |                   | [Reserved]                                                                                                                                |
| <b>Ex. 1006</b> | Cooper            | U.S. Patent No. 6,772,388 to Cooper                                                                                                       |
| <b>Ex. 1007</b> | Klayman           | U.S. Patent No. 5,699,365 to Klayman                                                                                                      |
| <b>Ex. 1008</b> | Li                | U.S. Patent Publ. No. 2002/0140991 to Li                                                                                                  |
| <b>Ex. 1009</b> |                   | [Reserved]                                                                                                                                |
| <b>Ex. 1010</b> |                   | [Reserved]                                                                                                                                |
| <b>Ex. 1011</b> | G.992.1           | ITU-T Recommendation G.992.1, <i>Asymmetric digital subscriber line (ADSL) transceivers</i> (06/99)                                       |
| <b>Ex. 1012</b> | G.992.2           | ITU-T Recommendation G.992.2, <i>Splitterless asymmetric digital subscriber line (ADSL) transceivers</i> (06/99)                          |
| <b>Ex. 1013</b> | G.992.3           | ITU-T Recommendation G.992.3, <i>Asymmetric digital subscriber line transceivers 2 (ADSL2)</i> (07/2002)                                  |
| <b>Ex. 1014</b> | G.992.4           | ITU-T Recommendation G.992.4, <i>Splitterless asymmetric digital subscriber line transceivers 2 (splitterless ADSL2)</i> (07/2002)        |
| <b>Ex. 1015</b> | G.992.5           | ITU-T Recommendation G.992.5, <i>Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)</i> (05/2003) |

| <b>Exhibit</b>  | <b>Short Name</b>             | <b>Description</b>                                                                                                                                                                                                                                                                                                                  |
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| <b>Ex. 1016</b> | G.997.1                       | ITU-T Recommendation G.997.1, <i>Physical layer management for digital subscriber line (DSL) transceivers</i> (06/99)                                                                                                                                                                                                               |
| <b>Ex. 1017</b> | Docket Control Order          | Docket Control Order, <i>Adaptive Spectrum and Signal Alignment, Inc. v. AT&amp;T Inc., et al.</i> , Case No. 2:24-cv-00029-JRG-RSP (E.D. Tex. July 22, 2024) ECF No. 84.                                                                                                                                                           |
| <b>Ex. 1018</b> | Order Focusing Claims         | Order Focusing Patent Claims and Prior Art to Reduce Costs, <i>Adaptive Spectrum and Signal Alignment, Inc. v. AT&amp;T Inc., et al.</i> , Case No. 2:24-cv-00029-JRG-RSP (E.D. Tex. Oct. 23, 2024), ECF No. 104.                                                                                                                   |
| <b>Ex. 1019</b> | Motion to Transfer            | Defendants' Motion to Transfer Venue Based on the Parties' Contractual Forum-Selection Clause, and Alternatively, Motion to Stay Case Pending Arbitration, <i>Adaptive Spectrum and Signal Alignment, Inc. v. AT&amp;T Inc., et al.</i> , Case No. 2:24-cv-00029-JRG-RSP (E.D. Tex. Oct. 23, 2024), ECF No. 92 ( <i>Redacted</i> ). |
| <b>Ex. 1020</b> | Gagnaire                      | Maurice Gagnaire, <i>Broadband Local Loops for High-Speed Internet Access</i> (Artech House, 2003).                                                                                                                                                                                                                                 |
| <b>Ex. 1021</b> | DSL Advances                  | Thomas Starr, et al., <i>DSL Advances</i> , (Prentice Hall, 2002).                                                                                                                                                                                                                                                                  |
| <b>Ex. 1022</b> | ISDN Architecture             | Richard T. Roca, <i>ISDN architecture</i> (AT&T Technical Journal, 1986).                                                                                                                                                                                                                                                           |
| <b>Ex. 1023</b> | Gitlin                        | U.S. Patent No. 4,924,492 to Gitlin                                                                                                                                                                                                                                                                                                 |
| <b>Ex. 1024</b> | Data Communication Principles | Richard D. Gitlin, Jeremiah F. Hayes and Stephen B. Weinstein, <i>Data Communication Principles</i> Plenum Press, 1992).                                                                                                                                                                                                            |
| <b>Ex. 1025</b> | A Review of HDSL Progress     | Joseph W. Lechleider, <i>High Bit Rate Digital Subscriber Lines: A Review of HDSL Progress</i> , Vol. 9, No. 6, IEEE Journal on Selected Areas in Comm. 769 (1991).                                                                                                                                                                 |
| <b>Ex. 1026</b> | Haykin                        | Simon Haykin, <i>Communication Systems</i> (4 <sup>th</sup> Edition, John Wiley, 2001).                                                                                                                                                                                                                                             |

| <b>Exhibit</b>  | <b>Short Name</b> | <b>Description</b>                                                                                                                   |
|-----------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ex. 1027</b> | Proakis           | John G. Proakis, Digital Communications (4 <sup>th</sup> Edition, McGraw Hill, 2000).                                                |
| <b>Ex. 1028</b> | Kerpez            | Kenneth J. Kerpez, et al., <i>Advanced DSL Management</i> (IEEE Communication Magazine, Sept. 2003).                                 |
| <b>Ex. 1029</b> | Song              | Kee Bong Song, et al., <i>Dynamic Spectrum Management for Next-Generation DSL Systems</i> (IEEE Communications Magazine, Oct. 2002). |
| <b>Ex. 1030</b> | Locke             | U.S. Patent No. 6,598,188 to Locke                                                                                                   |
| <b>Ex. 1031</b> | Annamalai         | U.S. Patent No. 5,023,872 to Annamalai                                                                                               |

## **I. INTRODUCTION**

1. My name is Richard D. Gitlin, and I have been retained as a technical expert by counsel for Petitioners AT&T Services Inc. (“AT&T”) and Nokia of America Corp. (“Nokia”) to address certain issues regarding U.S. Patent No. 7,428,669 (the “’669 Patent”).

2. I have personal knowledge of the facts contained in this Declaration, am of legal age, and am otherwise competent to testify.

3. Unless otherwise stated, the matters contained in this Declaration are of my own personal knowledge and, if called as a witness, I could and would testify completely and truthfully with regard to the matters set forth herein.

4. My opinions are based on my years of education, research, development, and management experience, as well as my study of the relevant materials. I have considered all of the documents that are included in the list of Exhibits at the beginning of this Declaration.

5. I reserve all available rights to supplement this Declaration if further information becomes available, or if I am asked to consider additional information. This Declaration represents only those opinions I have formed to date.

6. Further, I reserve all available rights to consider and comment on any additional expert statements or testimony of Patent Owner’s expert(s) in this matter.

7. I am being compensated at my usual consulting rate of \$750 per hour for my time spent working on issues in this matter. My compensation does not depend on the outcome of this matter or the opinions I express.

## **II. QUALIFICATIONS**

8. In 1964, I graduated from the City College of New York with a Bachelor's Degree in electrical engineering, with honors, and a Master of Science in electrical engineering in 1965 and a Doctor of Engineering Science from Columbia University in 1969.

9. After graduating from Columbia University with my doctorate, I joined Bell Laboratories. At that time, Bell Laboratories was the research and development arm of the Bell System.

10. Through various acquisitions, Bell Laboratories became AT&T Bell Labs, then Lucent Technologies-Bell Labs before my retirement. Subsequent to my employment, Lucent Technologies Bell Labs became Alcatel-Lucent Bell Labs, and is now Nokia Bell Labs.

11. Altogether, I was with Bell Laboratories, AT&T Bell Labs, and Lucent Technologies Bell Labs for thirty-two years.

12. Upon starting at Bell Labs, I worked with data communications (i.e., modems) technologies, where I contributed to the invention of many voice-band modem technologies.

13. In the early 1980s, I contributed to the technical development of the V.32 and V.34 modems and I was the leader of the development teams for those projects.

14. In addition to inventing and developing modem technologies, I was a co-inventor of foundational technology for Digital Subscriber Line (“DSL”), with work starting in 1986. This fundamental advancement demonstrated that megabits per second could be transported over conventional telephone wiring between the home and telephone networks and was instrumental in the development of broadband communications technologies used today.

15. The successes in creating and realizing this foundational technology was a major reason that I was elected as a member of the National Academy of Engineering (“NAE”) in 2005 and recently awarded the 2025 IEEE Alexander Graham Bell Medal.

16. In 1987, I moved to Bell Labs Research to lead research on wireless systems, high-speed packet switching, optical networking, and related areas. I held several senior executive positions in Bell Labs Research, including Senior Vice President for Communications and Networking Research.

17. As the Senior Vice President for Communications and Networking Research, I was responsible for all wireless and wireline communications research projects at Bell Labs, including time division multiple access (“TDMA”), code

division multiple access (“CDMA”), and OFDM research for both cellular and wireless local area network (“WLAN” or WiFi) systems, packet networking, and optical research in coherent detection and Wavelength Division Multiplexing (“WDM”) optical systems.

18. As part of my responsibilities in this role, I oversaw and managed more than 500 professionals, many of whom were involved in wireless and communications and networking research, and were responsible for significant innovations in wireless and wireline (including optical) technologies.

19. Additionally, as Senior Vice President for Communications and Networking Research with Bell Labs, I established and oversaw the first Bell Labs research group located outside the United States in Utrecht, Netherlands, which was focused on creating a wireless LAN (“WLA”), which later became standardized and known as WiFi technology.

20. I further oversaw a cellular wireless research group located in Swindon, United Kingdom and United States based Bell Labs research groups working on wireless research, many of whom worked on OFDM and MIMO technologies.

21. I was also personally involved in advancing CDMA (e.g., multi-code CDMA) and pioneering MIMO (smart antenna) wireless technologies, packet networking, and technology for enabling coherent optical communications.

22. In addition to my responsibilities at Bell Laboratories and Lucent Technologies, from 1999 to 2001, I was a Visiting Professor of Electrical Engineering at Columbia University where I taught courses, conducted research, and supervised doctoral students in the area of communications and wireless networking. In 2001 I became an Adjunct Professor at Columbia, and maintained that role until 2003.

23. In 2001, I became Vice President, Technology and Chief Technical Officer of NEC Laboratories America, Inc., where I had responsibility for wireless networking, broadband and IP systems, systems LSI, quantum communications, and bio-informatics. I served in this role until 2004.

24. From 2002 to 2005, I served on the Board of Directors of PCTEL, a NASDAQ listed company focused on wireless technologies.

25. From 2005 to 2008, I served as Chief Technical Officer of Hammerhead Systems, a Silicon Valley venture-funded start-up providing innovative data networking solutions for wireline, wireless, and cable service providers that uniquely combined existing Layer 2 and 3 technologies to efficiently manage streaming data. At Hammerhead Systems, I was responsible for product line vision and system architecture, creating and developing novel technologies, representing product technology and directions with customers, partners, and standard bodies.

26. From August 2008 to August 2019, I was a State of Florida 21st Century Scholar, Distinguished University Professor, and the Agere Systems Endowed Chaired Professor in Electrical Engineering at the University of South Florida.

27. As part of my research at USF, I worked on technology for 4G/5G wireless systems and the Internet of Things (“IoT”), and also at the intersection of wireless communications and networking with medicine to advance minimally invasive surgery and other cyber-physical health care systems. Some of the courses I taught at USF include graduate-level courses in Random Processes, Digital Communications, and Wireless Networking.

28. In total, I have more than fifty years of experience in the field of telecommunication technologies through roles with companies and universities, including managing and leading research in wireline and wireless systems, broadband data, and optical networking.

29. As a part of my career, I have led pioneering research in the development in digital communications, wired and wireless systems, and broadband networking resulting in many innovative products.

30. I am the named inventor on 75 issued United States patents, the author, or co-author, of over 170 journals, conference articles, and a graduate level communications textbook, *Data Communications Principles*. I have presented multiple keynote presentations, including at some of the most premier and well-

renown conferences such as COMCAS 2019, WAMICON 2016, Wireless Communications and Networking Conference 2015 (WCNC 2015), Wireless Telecommunications Symposium 2015), Mobicom 2004, Wireless Communications and Networking Conference 2003 (WCNC 2003), and the Wireless Telecommunications Symposium 2010 (WTS 2010).

31. For more than 15 years, I presented two intensive five-day short courses on wireless systems and broadband networking to industrial, government, and academic participants from wireless organizations around the world.

32. In 1986 I was named a Fellow of the IEEE. I also served as the Chair of the Communication Theory Committee of the IEEE Communications Society (“COMSOC”), the Editor for Communications Theory of the IEEE Transactions on Communications, as a member for the Board of Governors of the IEEE Communications Society, and as a member of the Nominations and Elections Board of the IEEE Communications Society.

33. In 1987, I was named an AT&T Bell Laboratories Fellow.

34. Also, I am the co-recipient of three prize paper awards including the 1995 IEEE Communications Society’s Steven O. Rice Award, the 1993 IEEE Communications Society’s Frederick Ellersick Award, and the 1982 Bell System Technical Journal Award.

35. As mentioned above, in 2005 I was elected to the National Academy of Engineering. In 2012 I was named a Charter Fellow of the National Academy of Inventors (NAI). In 2017, I was inducted into the Florida Inventors Hall of Fame, in 2020 I was named a Fellow of American Association for the Advancement of Science, and recently I was awarded the 2025 IEEE Alexander Graham Bell Medal

### **III. SCOPE OF ENGAGEMENT**

36. I have been retained by Alston & Bird LLP on behalf of Petitioner to analyze the technology claimed in the '669 Patent and to evaluate whether a POSITA would find certain claims of the '669 Patent obvious in view of certain prior art references.

37. All of the opinions I express in this Declaration have been made from the standpoint of a person of ordinary skill in the relevant art ("POSITA") at the time of the invention of the '669 Patent, which I am informed is the earliest claimed priority date of December 7, 2003 for purposes of this matter. I explain what level of skill a person of ordinary skill in the art as of December 7, 2003 would have had below in Section IV.D.

### **IV. LEGAL STANDARDS**

38. For purposes of this Declaration, counsel for AT&T have instructed me to make the following assumptions:

39. Claims are construed from the perspective of a POSITA as of the effective filing date of the patent application. Persons of ordinary skill in the art are deemed to read the claims in the context of the entire patent, including the specification and prosecution history. In other words, the terms are not considered in a vacuum.

40. It is my understanding that information that satisfies one of the categories of prior art set forth in 35 U.S.C. § 102 may be used in an invalidity analysis under §§ 102 or 103. If information is not properly classified as prior art under one of the subsections of § 102 of the Patent Act, then it may not form the basis of an anticipation or obviousness determination. It is also my understanding that, for *inter partes* review, applicable prior art is limited to patents and printed publications.

**A. Presumption of Validity**

41. I understand that in deciding whether to issue a patent, the U.S. Patent and Trademark Office (“USPTO”) examines the patent specification, its claims, and relevant prior art references to determine whether the patent application and its claims meet the requirements for patentability. I understand that if the USPTO then issues the patent, it has determined that the claims are valid. I understand that the law recognizes that the USPTO possesses special expertise to conduct such determinations, and that, as a result, each claim of a patent issued by the USPTO is

presumed valid by law. This presumption of validity can be overcome only if the party seeking to invalidate a claim proves invalidity by clear and convincing evidence, which I understand to mean evidence that convinces you that it is highly probable that the particular proposition is true. I understand that clear and convincing evidence is more than a preponderance of the evidence but less than beyond a reasonable doubt. I understand that the clear and convincing evidence standard applies to all aspects of an allegation of anticipation or obviousness, including the prior art status of the relevant reference(s).

42. I understand the first step in determining whether or not a patent claim is valid is to properly construe the claims. I also understand that the claims must be construed the same way in determining validity/invalidity and infringement/non-infringement. I also understand that, as a general matter, a claim should not be limited to a preferred embodiment, but that in certain cases, the scope of the right to exclude may be limited by a narrow disclosure or by positions taken, such as by statements made during patent prosecution. I also understand the claims must be supported by the specification. Also, to the extent that a patent claims priority to an earlier filed application, the claims must be supported by the disclosure in that application. For terms that have not been construed I understand that they should be afforded their plain and ordinary meaning to one of ordinary skill in the art.

## **B. Obviousness**

43. I have been informed that a claim is invalid as obvious under 35 U.S.C. § 103 (pre-AIA) if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person of ordinary skill in the art. I have been informed that the following matters are relevant to determining whether the claimed invention would have been obvious: (1) the scope and content of the prior art, (2) the difference or differences between the patent claim and the prior art, (3) the level of ordinary skill in the art at the time the invention of the patent, and (4) any secondary considerations or objective indicia of non-obviousness.

44. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a claim simply arranges prior art elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, then such a combination is obvious. When a patent claims a structure already known in the prior art altered by the mere substitution of one element for another known in the field, the combination is likely to be obvious unless the combination yields an unpredictable result.

45. I have been informed that when a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill in the art can

implement a predictable variation, such a variation is likely unpatentable. For the same reason, if a technique has been used to improve one device, and one of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill. One question to consider is whether the improvement is more than predictably using prior art elements according to their established functions.

46. I have been informed that it may often be necessary, in a validity analysis, to consider whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. This can be accomplished by looking to interrelated teachings of multiple patents or other publications or pieces of prior art; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by one of ordinary skill in the art.

47. I have been informed that a validity analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim; it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I have been informed that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton.

48. I have been informed that a claim composed of several elements is not proved obvious merely by demonstrating that each element was, independently,

known in the prior art. I have been informed that it can be important to identify a reason that would have prompted a person of ordinary skill in the art in the relevant field to combine the elements in the way the claimed new invention does. I am told that one way that subject matter can be proved obvious is by noting there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I have been informed that any need or problem known in the field of endeavor at the time of the claimed invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

49. I have been informed that one should not assume that a person of ordinary skill in the art attempting to solve a problem will be led only to those elements of prior art designed to solve the same problem. Instead, I have been informed that since familiar items may have obvious uses beyond their primary purposes, in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like pieces of a puzzle.

50. I have been informed that, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, persons of ordinary skill in the art have good reason to pursue the known options within their technical grasp. If this leads to the anticipated success, the product was likely not accomplished by innovation but by using ordinary skill and

common sense. I have been informed that, in such an instance, the fact that the combination was obvious to try may show that the combination was obvious.

51. I have been informed that, when determining whether a claimed combination would have been obvious, the correct analysis is not whether a person of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I have been informed that the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

52. I have been informed that, when determining whether a claimed invention is obvious, any “secondary considerations” of non-obviousness identified by the patentee should also be considered. These secondary considerations can include:

- commercial success of the invention, causally related to the invention itself rather than to companion factors, such as advertising or attractive packaging;
- the invention taught away from the technical direction followed by those skilled in the art;
- a long-felt but unsatisfied need for the invention while the needed implementing arts and elements had long been available;

- the invention achieves results unexpected to those skilled in the art;
- copying of the invention by competitors as distinguished from their independent development
- unsuccessful attempts by those skilled in the art to make the invention;
- acquiescence by the industry to the patent's validity by honoring the patent through taking licenses or not infringing the patent, or both; and
- skepticism, disbelief in or incredulity by those skilled in the art that the patentee's approach worked.

53. I have been informed that, for the above information to impact the obviousness of a patent claim, there must be a nexus between the alleged secondary considerations and the claims. In addition, I have been informed that the burden of introducing evidence of secondary considerations generally is on the Patent Owner. If the Patent Owner or its expert should assert secondary considerations of non-obviousness, I reserve the right to provide a Declaration addressing assertions of non-obviousness due to secondary considerations.

### **C. Claim Construction**

54. I have been informed that claim terms are typically given their plain and ordinary meanings, as would have been understood by a person of ordinary skill in the art at the time of the earliest alleged priority date. I have further been informed that when considering the meaning of any terms in the challenged claims of the '669 Patent, I should apply the plain and ordinary meaning of those terms. I have further been informed that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record.

55. I have been informed that, in general, a preamble limits the invention if it recites essential structure or steps, or if it is necessary to give life, meaning, and vitality to the claim. I have further been informed that a preamble is not limiting where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I have further been informed that dependence on a particular disputed preamble phrase for antecedent basis may limit claim scope because it indicates a reliance on both the preamble and claim body to define the claimed invention. I have further been informed that clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.

56. I have also been informed that claim terms reciting a “means” are considered “means-plus-function” terms that should be construed to include the structure described in the specification that performs the recited function. To show that a means-plus-function claim limitation is taught by prior art, the prior art must include a discussion of the same function as recited in the challenged claim, using substantially the same structure, materials, or acts, or their equivalents as discussed in the specification of the challenged patent, to achieve the claimed function; essentially, proving that the prior art discloses or teaches that the claimed function is performed in a substantially similar way with a substantially similar result as the disclosed structure in the challenged patent.

**D. Person of Ordinary Skill in the Art**

57. I have been asked to identify the level of skill in the art pertinent to the '669 Patent. It is my opinion that a person of ordinary skill in the art pertinent to the '669 Patent would have had at least a Bachelor's Degree in electrical engineering, computer engineering, or similar discipline and had approximately two years of experience with electronic communication systems and familiarity with standards governing DSL systems. A person with a different degree but with additional relevant experience could still qualify if the additional experience compensates for the different educational background.

58. I consider myself a person of ordinary skill in the art as of at least the earliest claimed priority date (December 7, 2003).

59. My opinions regarding the level of ordinary skill in the art are based on, among other things, my more than 50 years of experience with optical, wireless, and wireline (e.g., DSL) networks and the components used in those communication systems, my understanding of the basic qualifications that would be relevant to an engineer or scientist tasked with investigating DSL networks and components therefor, my knowledge and experience with the capabilities of such systems by 2003, and my familiarity with the backgrounds of colleagues, both past and present. Although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art defined above, my analysis and opinions regarding the '669 Patent have been based on the perspective of a person of ordinary skill in the art as of December 2003. I am able to take on that perspective based on my experience as I have worked with individuals who had this level of experience in the 2003-time frame and I am familiar with their level of knowledge.

60. My opinions are also based on the information I have reviewed as of the date of this Declaration. In connection with my analysis, I have reviewed the exhibits listed in the above list of exhibits, as well as each of the items referenced herein. I attest that the foregoing exhibits are true and accurate copies that I

downloaded. My opinions directed to the invalidity of the challenged claims are based, at least in part, on the following patents and publications:

- “Cooper” (Ex. 1006), which is U.S. Patent No. 6,772,388 to Cooper *et al.*, filed on December 6, 2000 and granted on August 3, 2004;
- “Klayman” (Ex. 1007), which is U.S. Patent No. 5,699,365 to Klayman *et al.* filed on March 27, 1996 and granted on December 16, 1997; and
- “Li” (Ex. 1008), which is U.S. Patent Publication No. 2002/0140991 to Li *et al.*, filed on October 26, 2001 and published October 3, 2002. Li later granted as U.S. Patent No. 7,673,221 on March 2, 2010.

## V. SUMMARY OF OPINIONS

61. I have been asked to consider whether the claims of the ’669 Patent are obvious over certain prior art references. As explained in detail in the following sections, it is my opinion that:

- Ground 1: Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 are rendered obvious by U.S. Patent No. 6,772,388 (“Cooper”) and U.S. Patent Publication No. 2002/0140991 (“Li”).
- Ground 2: Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 are rendered obvious by U.S. Patent No. 5,699,365 (“Klayman”) and Li.

62. The following table is a summary of the above grounds:

| Ground | Prior Art | Claims |
|--------|-----------|--------|
|--------|-----------|--------|

|   |                |                                      |
|---|----------------|--------------------------------------|
| 1 | Cooper and Li  | 1-4, 11, 14-17, 19-20, 23, and 26-29 |
| 2 | Klayman and Li | 1-4, 11, 14-17, 19-20, 23, and 26-29 |

## VI. TECHNICAL BACKGROUND

63. The '669 Patent purports to describe an invention that mitigates and corrects errors in Digital Subscriber Line (DSL) communications. However, the processes described in the '669 Patent to correct errors were well established methods for correcting communication errors before the priority date of the patent and appeared in communication textbooks and literature. These error correcting techniques were being used in other communication systems, including commercial cable and wireless systems such as 2G (CDMA2000-2000), 3G (UMTS-2001), and WiFi (802.11b-1999 and 802.11-2003) wireless systems and cable systems (DOCSIS-1997). Given that these error correction techniques have been proven effective for other communication systems, a POSITA would have recognized that these error correction techniques are applicable to DSL communication networks.

64. At the most basic level, DSL systems provide high speed data communication over an existing telephone network of twisted wire pairs that were installed for voice communication decades ago. Updating the existing network of twisted wire pairs to accommodate high speed DSL data transmissions required

some new equipment to be added to the network, and the communications industry quickly determined that operating standards were necessary to ensure that newly installed DSL equipment (including DSL modems) could communicate with other equipment installed on the same network. Those standards specify how data can be communicated in a manner that is understandable by both transmitters and receivers on the communication network, and which dictates how the DSL network mitigates errors caused by noise, crosstalk, and other distortions on the communication channel. Those standards give complete and unambiguous detail for the functionality of the transmitter to enable compatibility between different vendors' equipment by teaching how to generate the exact same transmitted signal, so that receivers are able to process a known signal format. However, those standards give much less detail about the functionality of the receiver. So that vendors can differentiate their products using different receiver algorithms, components, and/or architectures.

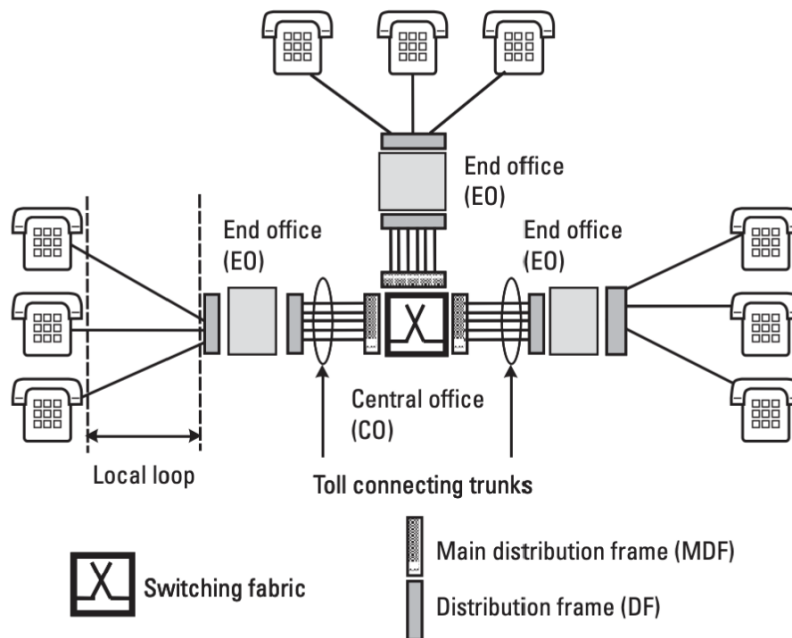
#### **A. Telephony System Architecture**

65. After the invention of the telephone in 1876, the telephone network slowly transformed from being a short distance point-to-point service to today's ubiquitous broadband network that enables high-speed, low-latency, and reliable communication over large distances. The beginning of this transformation was the development of local end offices (EOs), which are physical "hubs" that terminate multiple subscriber lines. These were "nodes" of the public switched telephone

network (PSTN), that provided POTS (Plain Old Telephone Service). The network enabled interconnection between all users of a particular EO through a network of central offices (COs) via backbone trunk systems that linked various COs and enabled first inter-urban, then international, connections.

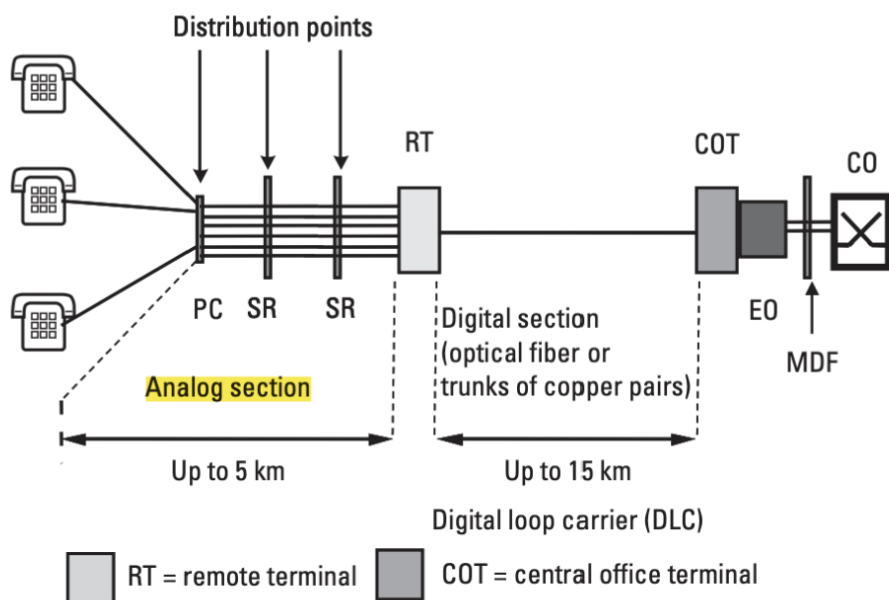
66. The original backbone (toll connecting) trunks between central offices were made up of traditional telephony cables, but by the 1980's many of the trunks were replaced with optical fibers using high-speed digital transmission. However, the connections from end offices to customers *i.e.*, the subscriber lines leading to each end customer, remained traditional pairs of twisted copper wires. This section, often referred to as the "local loop" or the "last mile" of the telephony network is where DSL technology was been introduced to enable multi-megabits per second networking.

67. In general, the local loop could extend from the telephone company central office to the customer premises and the figure below shows the telephone network architecture prior to DSL, where data service was provided via voice-band modems that operated within the same spectrum as voice calls.



Ex. 1020, Figure 2.7.

68. To improve the quality of connections, it was of interest to minimize the effective length of the local loop, i.e., decreasing the distance between the subscribers and an extension of the local exchange. For this reason, “remote terminals” (RTs) were introduced in the 1970’s, as shown in the figure below, where the local end office (EO) is connected to a RT via a high-speed link known as a digital loop carrier (DLC) that uses similar technology to the toll-connecting trunks described above. The “Analog section” highlighted in the figure refers the individual local loops from the premises to the RT.



Ex. 1020, Figure 2.13 (emphasis added).

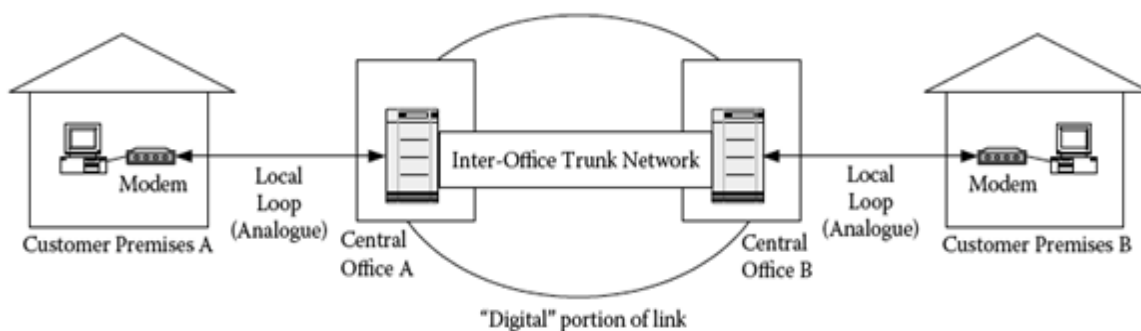
## B. Telecomm Network Evolution to DSL

69. The PSTN was originally designed to carry voice signals within a limited frequency bandwidth from approximately 200 Hz to 3.4 kHz. By the early 1980's, voice signals were transmitted in the PSTN as analog signals from the originating user to the local EO across a copper twisted pair (the local loop), where the signals were digitized by a codec ("coder/decoder"), and then transmitted as a digital signal over the trunk network to the EO serving the intended recipient. At the recipient's EO, it was converted from digital form back to analog by another codec, and then it was transmitted across the recipient user's local loop to the recipient's telephone.

70. Voiceband data modems were introduced for the purpose of transmitting data across the PSTN using a spectrum that roughly resembled speech

signals. Data transmission technology developed in the 1970's and 1980's provided bit rates up to 33.6 kbit/s, with various fallback options. In the late 1990s, pulse coded modulation (PCM) modems operating at 56 kbits/s were developed and standardized as ITU-T Recommendation V.90.

71. The figure below shows a block diagram of a typical voiceband end-to-end (non-PCM) modem communication link as it existed in the mid 1980's prior to the introduction of DSL.



Ex. 1021, Figure 1.3.

### C. Integrated Services Digital Network (ISDN)

72. In 1986 AT&T developed technology to digitize the telephone network, including the local loop. *See* Ex. 1022. This effort included the development of the digital network known as the Integrated Services Digital Network (ISDN), which some consider the first digital subscriber line (DSL). Ex. 1021, Chapter 1. ISDN provided voice, data, and video services over the telephone network. ISDN digitized the local loop and used a baseband transmission format capable of transmission speeds up to 160 kb/s of symmetric digital information.

#### **D. Digital Subscriber Line (DSL)**

73. As users (both residential and commercial) continued to demand ever-increasing bit rates, the local loop remained a bottleneck even with ISDN. However, network traffic was found to be asymmetric for many users. For example, web browsing (typical of home users) requires higher bit rates in the downstream direction (from the network to customer premises) than in the upstream direction (from the customer premises to the network). Business users required more symmetric networking speeds for remote office connectivity, LAN-extension, file sharing, video-conferencing, etc.

74. Beginning in the late 1980s, user requirements for higher-speed service focused attention on the local-loop bottleneck, namely the need for local loop access transmission systems capable of providing transmission speeds on the order of megabits per second. DSL, which refers to a group of digital technologies that met this need, provides high-speed (i.e., megabit/sec) digital signal transmission over the existing twisted-wire pair analog local loop between each customer premises and its local central/end office. Through the central office, the user is connected directly to the existing broadband digital backbone network.

75. The twisted-wire pair used in the local loop was originally designed for voice analog signals and was loaded with inductive coils spaced regularly along the local loop to make the frequency response flat across the effective 4kHz voice band.

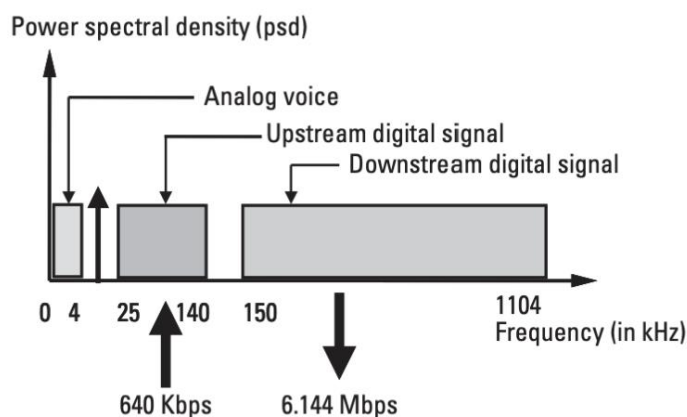
This improved voice quality, but limited the bandwidth to 4 kHz. Loops shorter than 18Kft did not require loading coils and subsequent research demonstrated that these shorter loops supported high-speed megabit/sec data transmission.

76. To provide megabit per second data over twisted pair, AT&T and Bellcore research developed several foundational technologies that evolved into the DSL we recognize today. In 1986, I led a research team that created and developed the foundational technology of DSL and demonstrated megabit per second, full-duplex transmission over twisted pairs (Ex. 1023; Ex. 1024, Sections 1.6.2 and 2.7.2) was achievable. This breakthrough technology demonstrated reliable upstream and downstream transmission between an end user and a CO at the DS-1 rate of 1.544 Mb/s over a twisted pair on loops up to 18 kft in length, even in the presence of near-end and far-end (NEXT and FEXT respectively) crosstalk.

77. The underlying technology of DSL uses modulation of higher-frequency carrier waves above the 4KHz voiceband and corresponding technology at the receiver (generally, receiver processing is in reverse functional order from that of the transmitter). A DSL system has a transmitting modem at the premises and at the end/central office (or equivalent network distribution point, such as a DSL Access Multiplexer-DSLAM) that modulates patterns of bits into signals for transmission to the receiving modem. Signals received at the far-end modem are

demodulated to form a corresponding bit pattern that the modem passes on, in digital form, to its interfaced equipment, such as a computer, router, switch, etc.

78. When products were developed to support DSL, those products used frequency division multiplexing (FDM) to separate DSL data signals from standard POTS (voice or modem) services by using a different frequency band to provide a data-over-voice (in frequency) capability. As an example data was transmitted in a frequency band above the voiceband on ordinary telephone lines, as shown in the frequency plan in the figure below.



Ex. 1020, Figure 6.2.

79. In the above figure the upstream and downstream data channels use FDM, and the downstream bandwidth is larger to accommodate the more typical download use case. This model is called Asymmetric DSL (ADSL), developed by Joseph W. Lechleider of Bellcore. Ex. 1025, 779. This allowed Internet service providers to offer efficient service to consumers, who benefited from the ability to

download large amounts of data but rarely needed to upload comparable amounts. ADSL was standardized in part by the T1E1.4 working group, a technical subcommittee of T1 – an ANSI accredited standards committee that developed telecommunications. Later in the 1990’s, John Cioffi proposed a highly adaptive modulation approach known as Discrete Multitone (DMT) that became widely used in many DSL systems. *See* Ex. 1021.

#### **E. DSL Network Architecture**

80. A block diagram of a typical DSL system is shown below. A DSL modem is required at each end of the local loop (typically the customer premises and the telephone company CO or a DSL Access Multiplexer (DSLAM)). DSL service is provided by an “overlay” network that is not part of the normal switched telephone network. Consequently, the service provider Central/End Office (CO/EO) separates the DSL service from the voice (POTS) service and sends the voice service over the ordinary trunk network and the data carried by the DSL is sent over a separate data network (e.g., in the figure below ATM, Frame Relay, Ethernet). The CO/EO will generally provide DSL service to the user premises using a DSLAM, shown in the figure below (highlights added), where the DSLAM contains many DSL modems serving multiple data customers.



communicated to the central offices and/or directly to modems for implementation to mitigate the effects of noise on DSL lines. *Id.*, 118, Ex. 1029, 102.

#### **F. DSL Channel Impairments**

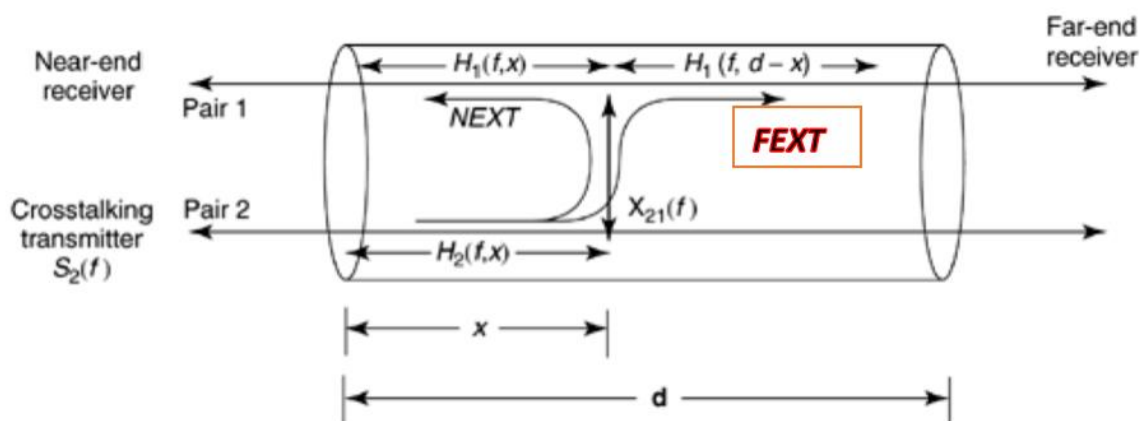
82. Digital Subscriber Line (DSL) signals travel over twisted pairs of copper telephone lines, which are subject to various impairments that degrade signal quality and reduce achievable data rates. Ex. 1024. These impairments in DSL channels include:

83. Linear Distortion: Attenuation (Signal Loss) and Phase Distortion: Attenuation is the gradual weakening of the signal as it travels over a distance. The longer the copper line, the more the signal is weakened. Phase distortion spreads a transmitted signal out over time and can create inter-symbol interference between signals transmitted at different times. Higher frequencies attenuate more than lower frequencies, limiting data rates, especially over long distances. Attenuation generally increases linearly as a function of transmission length, and is mitigated by use of adaptive equalizers (either in the time or frequency domain, or in combination).

84. Thermal Noise: Thermal noise, often just referred to as noise, is caused by random motion of electrons along a copper pair or within the end-point modems. When the signal-to-noise ratio (SNR) is evaluated between the receiver modem and the data receiver, generally thermal noise has a much lower power compared to the power of the received signal. Noise is also characterized by very low-speed

fluctuations and is often modeled as additive Gaussian noise with a variable power across the frequency band.

85. Crosstalk: Crosstalk from other DSL systems has a substantial influence on the maximum data rate achievable for a DSL communication channel. Crosstalk refers to the leakage of a detectable signal from one communication channel (denoted as a “pair” in the figure below) into another channel. For DSL, crosstalk often occurs between twisted pairs in the same cable. Crosstalk becomes more prevalent for longer cables and for higher frequency signals. As shown in the figure below, there are two forms of crosstalk that limit the capacity of DSL systems, near-end crosstalk (NEXT) and far-end crosstalk (FEXT, which I added as an annotation in the figure below). NEXT is the coupling between transmitters and receivers at the same end of a cable and frequency separation between upstream and downstream bands reduces NEXT in ADSL systems.



Ex. 1021, Figure 2.15 (annotated).

86. Impulse Noise: Unlike crosstalk, impulse noise is intermittent and unpredictable, and is characterized by an abrupt and transient variation of the voltage level observed on a twisted copper pair in the local loop. Ex. 1011, 221. This can be caused by electronic devices coming in close proximity to the twisted wire pair and creating a voltage change detectable on the twisted wire pair and often cause major impacts on DSL circuits and can lead to data loss, high error rates, and loss of synchronization.

#### **G. DSL Impairment Mitigation**

87. Equalization of Linear Distortion and Noise Suppression: Equalization is a signal processing technique used in digital subscriber line (DSL) transmission to correct for linear distortion that occurs when a signal is transmitted through a channel. Equalizers are used to flatten the frequency response of a DSL line from end to end, while minimally enhancing the received noise. This ensures that the input signal is accurately reproduced at the output.

88. Equalization systems compensate for transmission channel impairments, such as amplitude and phase distortion that depends on frequency. Equalizing systems also cancel out any phase delay and group delay between different frequency components. Since most DSL systems use DMT modulation, the equalizers are structured to operate on the subchannels between the transmitter and receiver.

89. Error Control: Error Detection and Forward Error Correction (FEC) are error control techniques that add redundancy to the data and enable more reliable delivery of digital data over unreliable communication channels. As noted above, DSL channels are subject to channel impairments, and may induce errors during transmission from the source to a receiver. Error detection techniques, often referred as “ARQ”(Automatic Repeat ReQuest) use Cyclic Redundancy Check (CRC) codes, that enable detection (but not correction) of errors at the receiver, while forward error correction strives to effect reconstruction of the original data and is preferred when real-time information is being transmitted (e.g., multimedia). When choosing error control technology, system designers consider how often errors are expected to occur, will they be randomly distributed or bursty, and can they be detected and/or corrected.

90. All error-detection and correction schemes add redundancy (i.e., extra data, referred to as parity bits or bytes) to a message, which receivers can use to check consistency of the delivered message and to recover and/or detect data that has been corrupted. For typical error correction, the transmitter sends the original (error-free) data and attaches a fixed number of check bits/bytes (or parity data), which are derived from the data bits/bytes by an encoding algorithm (e.g., Reed Solomon) and the decoding algorithm is applied to the received data to attempt to recover the original error-free data. If error detection is also employed, a Cyclic

Redundancy Check (CRC) code can be used that adds a short, fixed-length checksum (the CRC) to the original data, based on the result of an algorithm. The receiver performs the same calculation and compares the result to the received CRC value. If they match, the data is considered error-free; if not, an error is detected.

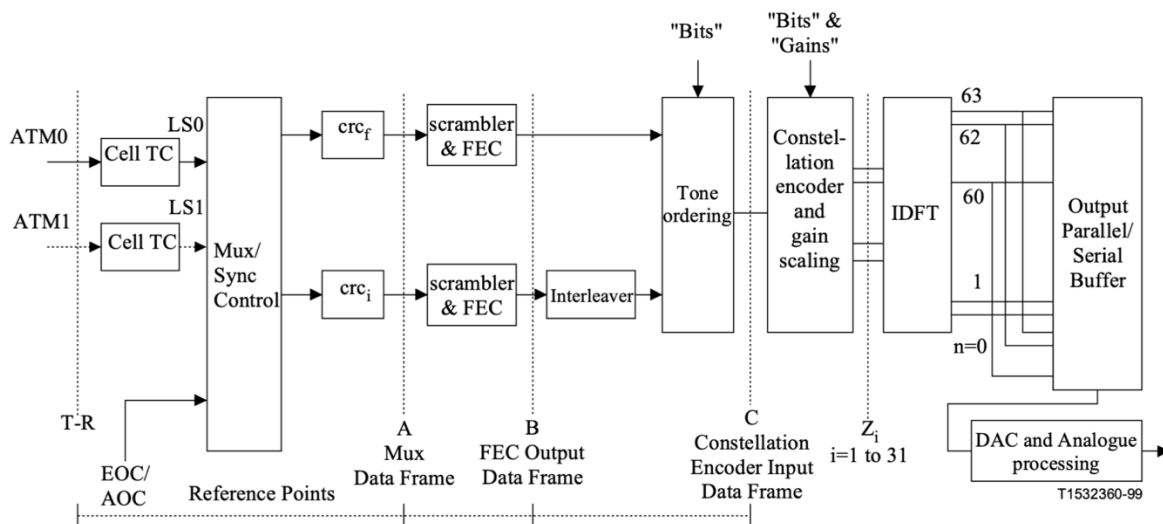
91. When Forward Error Correction (FEC) and Cyclic Redundancy Check (CRC) are used together, the CRC (of the original data) typically precedes the FEC during transmission, and the FEC decoding precedes the CRC validation during reception.

92. The relationship between the number of errors a code can detect and the number of errors it can correct is governed by the Hamming distance of the code. Ex. 1024, 176. The Hamming distance is the minimum number of bit changes required to transform one valid codeword into another. More specifically: a code will detect, but not necessarily correct, up to  $d$  errors, if the Hamming distance of the code is at least  $d + 1$ ; a code will correct up to  $t$  errors, if the Hamming distance of the code is at least  $2t + 1$ .

93. Combining an FEC error correction system, such as a Reed-Solomon code, with an ARQ/CRC error detection system can be used to improve performance. Ex. 1024, 226. The function of the FEC portion is to reduce the frequency of retransmission requests by correcting as many of the erroneous blocks as possible. The receiving terminal may then request retransmission only for those blocks where

the CRC error-detection decoder determines that errors exist in the FEC decoder output.

94. Below is a figure of a typical standardized DSL Transmitter that illustrates the error detection (CRC), (Reed-Solomon) Forward Error Control (FEC), and Interleaving (see below for a discussion of interleaving) functionality in the lower (interleaved) path.



NOTE – Solid versus dashed lines are used to indicate required versus optional capabilities respectively. This figure is not intended to be complete in this respect, see clauses 6 and 8 for specific details.

**Figure 5-4/G.992.1 – ATU-R transmitter reference model for ATM transport**

Ex. 1011, Figure 5-4.

95. Reed-Solomon Coding: The encoder for Reed-Solomon (RS) coding, which is widely used in DSL standardized systems, processes groups of bits, generally bytes, and produces code words consisting of  $n$  bytes including,  $k$  information bytes and  $2t$  parity bytes. Ex. 1026, 654.

96. RS codes with  $2t$  parity bytes have a Hamming distance of  $2t+1$  and thus can detect  $2t$  byte errors and can correct up to  $t$  byte errors. RS codes have wide application in DSL systems, such as ADSL, because of the powerful error correction capabilities and their ease of decoding. ADSL uses Reed-Solomon codes to provide coding gain and also to mitigate impulse noise disturbance. Ex. 1021.

97. Interleaving: An effective method for dealing with burst error channels is, prior to transmission, to interleave the coded data in such a way that the bursty channel is transformed, from the receiver's perspective, into a channel having independent errors. Thus, a code designed for independent random channel errors may be used for error control with a bursty channel. Ex. 1024, 173-74.

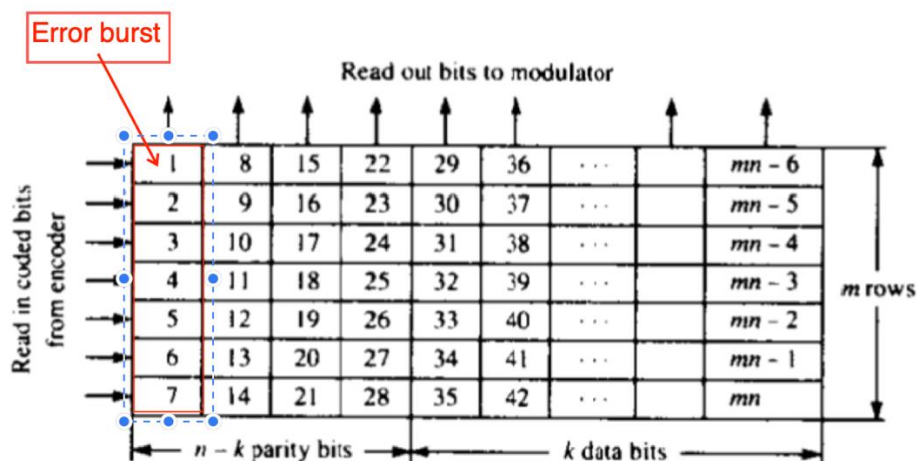
98. RS encoded data would be reordered before transmission by the interleaver such that consecutive channel errors that occur during transmission are distributed over multiple code words. After demodulation, the receiver performs operations in the reverse order of the transmitter: the deinterleaver puts the data in proper sequence and passes it to the RS decoder. As a result of the interleaving/deinterleaving, error bursts are spread out in time so that, at the receiver, errors within a code word appear to be independent.

99. As shown in the figure below,<sup>1</sup> (my emphasis in red) the interleaver formats the encoded data in a rectangular array of  $m$  rows and  $n$  columns, where each entry in the array is a byte of data (because Reed Solomon codes work well on processing bytes). Each row of the array constitutes a code word of length  $n$ . An interleaver of depth  $m$  consists of  $m$  rows. A R-S code of length  $n$  with  $k$  parity bytes can correct up to  $\lfloor (n-k)/2 \rfloor$  errors.

100. As an example, assume that there is an error burst that affects the first column transmitted (which is 7 bytes in the figure below). Because of interleaving, this error burst causes only a single error in each row (i.e., a single errored byte in each code word). As long as the number of parity bytes is greater than or equal to 2 in each row, then the receiver can correct the single error in each code word during decoding, so that the entire burst is corrected. In the illustrated example below, because the burst error impacts only a single byte in each codeword, the entire burst can be corrected. If the FEC cannot correct all the errors, the CRC (error detection code) will subsequently detect the errors in the decoded output stream and may request a retransmission.

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<sup>1</sup> Note that the figure illustrates bits in each of the matrix cells, but for the purposes of this discussion I note that the interleaving methodology is the same for bytes.



Ex. 1027, 469 (annotated).

## H. DSL Standardization

101. As DSL standards advanced, Discrete Multitone (DMT),<sup>2</sup> became the dominant modulation method. Ex. 1021. Today, DSL includes a broad family of standards, often referred to as xDSL. The first generation of digital subscriber line technologies was based on ADSL and SDSL (symmetric digital subscriber line, with the same capacity in uplink and downlink) transmission technologies. They achieved data rates in the range of tens of Mbits/s and support a twisted pair line length of several kilometers. ADSL and SDSL are served from a central office or a DSLAM (i.e., a network node that supplies several thousand subscribers).

<sup>2</sup> DMT was introduced by John Cioffi and his colleagues several years before the '669 Patent was filed. *See* Ex. 1021.

102. Of particular relevance, some DSL standards introduced new terminology, including some derived characteristics of data transmissions over twisted wire pairs. As an example, G.992.3 included a table of derived characteristics (Table 7-7 of Ex.1013), which included a definition of Impulse Noise Protection<sup>3</sup> ( $INP_P$ ) relative to other terminology, as specified by the formula below.

$$INP_P = \left(\frac{1}{2}\right) \times (S \times D) \times \left(\frac{R}{N_{FEC}}\right)$$

Ex. 1013, 32.

103. The symbols S, D, R, and N\_FEC are commonly used variables that are discussed throughout this declaration. S defines the number of symbols per codeword, D is the interleaving depth (in codewords), R is the number of parity (redundancy) bytes per codeword, and N\_FEC is the codeword length, inclusive of payload and parity bytes.

## **I. DSL Transmitter**

104. Below is a figure (emphasis added) of a typical DSL Transmitter that illustrates the error control functionality.

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<sup>3</sup> INP defines the amount of protection afforded against bursts of impulse noise.

INP defines the number of symbols that can be impacted by impulse noise and corrected without requiring retransmissions.

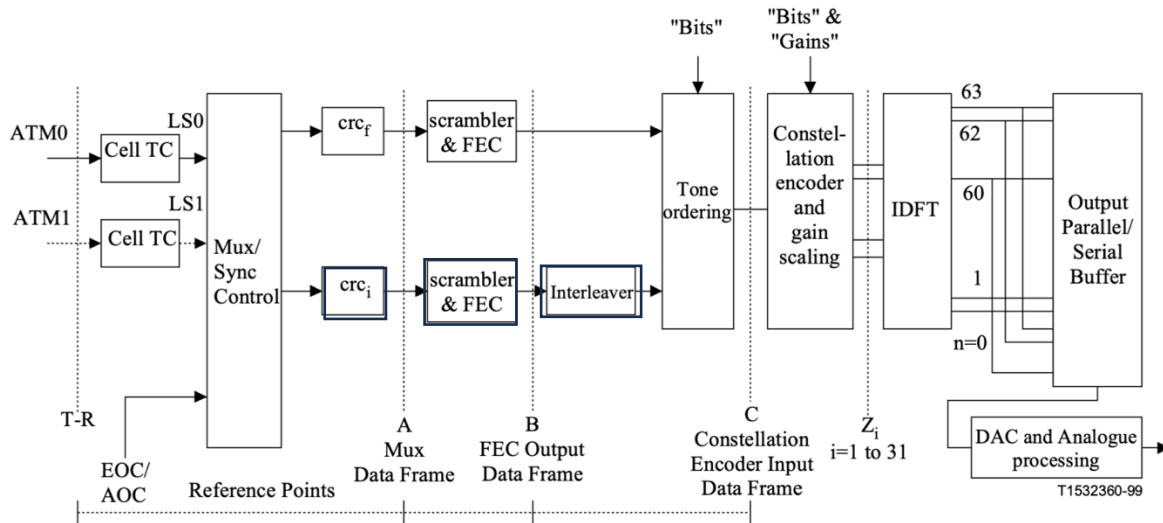


**Figure 5-4/G.992.1 – ATU-R transmitter reference model for ATM transport**

Ex. 1011, Figure 5-4 (annotated).

105. The input data is on the left and the error control functionality is first performed by a “crc” encoder, then a FEC Reed-Solomon encoder, and an Interleaver. At the receiver the processing is in the reverse order, a de-interleaver, FEC decoder, and the “crc” decoder that determines if there are any residual errors in the FEC decoded bit stream. If so, the frame in error may be retransmitted. For example, G.992.1 can support retransmission of data if ARQ is enabled, but it primarily relies on FEC to handle most errors without needing retransmission.

## VII. OVERVIEW OF THE '669 PATENT

### A. Prosecution History

106. U.S. Patent Application No. 10/795,593 (the '593 Application) was filed on March 8, 2004 with the following claim language:

## CLAIMS

### What is claimed is:

5

1. A controller for an adaptive FEC coder using a codeword composition ratio (CCR), wherein the FEC coder is used in a communication system in which a transmitter sends data to a receiver via a channel using FEC coding, interleaving and an original transmission latency, the controller comprising:

10 means for acquiring a measured transmission error value (MEV) coupled to the communication system;

means for analyzing the MEV relative to a target transmission error value (TEV), wherein the analyzing means is coupled to the acquiring means; and

15 means for generating a CCR adjustment control signal, wherein the generating means is coupled to the analyzing means and to the communication system.

2. The controller of Claim 1 wherein the MEV is based on at least one of the following:

a bit error rate;

20 errored seconds;

errored minutes;

code violations over a fixed period of time;

a signal-to-noise ratio measured at the receiver; or

TCP/IP throughput.

3. The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as computer readable program code.

5

4. The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as hardware.

5. The controller of Claim 1 wherein the TEV is a threshold error rate limit.

10

6. The controller of Claim 1 wherein the generating means comprises means for generating an interleave depth adjustment control signal.

15

7. The controller of Claim 6 wherein the interleave depth control signal is computed to maintain the original transmission latency by compensating for adjustments to the CCR.

8. The controller of Claim 1 further comprising a historical data module coupled to the analyzing means.

20

9. The controller of Claim 8 wherein the historical data module is a database.

10. The controller of Claim 1 wherein the communication system is a DSL system.
11. The controller of Claim 1 wherein the controller comprises a dynamic spectrum  
5 manager.
12. The controller of Claim 1 wherein the communication system is an ADSL2  
system and further wherein the CCR adjustment control signal adjusts at least one of the  
following:
- 10 INP; or
- maximum interleaving delay.
13. The controller of Claim 1 wherein the communication system is an ADSL1  
system and further wherein the CCR adjustment control signal adjusts at least one of the  
15 following:
- N;
- K; or
- R.
- 20 14. The controller of Claim 1 wherein the means for acquiring the MEV comprises  
means for receiving an input signal representative of the MEV.

15. A method of adjusting FEC coding in a communication system in which data is transmitted between a transmitter and a receiver on a channel, the method comprising:

- (a) selecting a CCR representing the relation between payload and parity bytes in an FEC coding scheme;
- (b) transmitting data via the channel using the CCR and the FEC coding scheme;
- (c) acquiring an MEV;
- (d) analyzing the MEV relative to a TEV; and
- (e) adjusting the CCR when the MEV differs sufficiently from the TEV.

16. The method of Claim 15 wherein acquiring an MEV comprises at least one of the following:

directly measuring a characteristic of the communication system;

collecting a value from an element management system; or

computing the MEV from collected data.

17. The method of Claim 15 wherein steps (b) through (e) are repeated.

18. The method of Claim 15 wherein the method is performed by a controller.

19. The method of Claim 15 wherein the communication system is a DSL system and further wherein the method is performed by a controller.
20. The method of Claim 19 wherein the controller is a dynamic spectrum manager.
- 5
21. The method of Claim 19 wherein the controller is in a CO.
22. The method of Claim 19 wherein the controller is outside a CO.
- 10 23. The method of Claim 19 wherein the controller is an operator of the DSL system.
24. The method of Claim 19 wherein the controller is independent of any operator of the DSL system.
- 15 25. The method of Claim 15 wherein the CCR is K/N.
26. The method of Claim 15 wherein the communication system is an ADSL2 system and further wherein the CCR is dependent upon and can be adjusted by changing at least one of the following:
- 20 INP; or

maximum interleaving delay.

27. The method of Claim 15 wherein the communication system is an ADSL1 system and further wherein the CCR is dependent upon and can be adjusted by changing at least one of the following:

N;

K; or

R.

28. The method of Claim 15 wherein the communication system has an original transmission latency resulting from interleaving of FEC codewords using an interleave depth and further wherein the method further comprises adjusting the interleave depth to compensate for adjustments to the CCR to maintain the original transmission latency.

29. The method of Claim 15 wherein analyzing the MEV relative to the TEV comprises evaluating historical data relating to prior transmissions on the channel.

30. The method of Claim 15 wherein the MEV is based on at least one of the following:

a bit error rate;

errored seconds;

errored minutes;

code violations over a fixed period of time;

a signal-to-noise ratio measured at the receiver; or

TCP/IP throughput.

5

31. The method of Claim 15 wherein acquiring the MEV, analyzing the MEV relative to the TEV, and adjusting the CCR are implemented by computer readable program code.

32. The method of Claim 15 wherein acquiring the MEV, analyzing the MEV relative  
10 to the TEV, and adjusting the CCR are implemented by hardware.

33. The method of Claim 15 wherein the communication system is an ADSL2 system and further wherein adjusting the CCR comprises adjusting at least one of the following:

INP; or

15 maximum interleaving delay.

34. The method of Claim 15 wherein the communication system is an ADSL1 system and further wherein adjusting the CCR comprises adjusting at least one of the following:

N;

20 K; or

R.

35. A transmission system comprising:

a transmission channel;

5 a transmitter coupled to the transmission channel;

an adaptive FEC coder coupled to the transmitter;

a receiver/decoder coupled to the transmission channel; and

a transmission error value monitor coupled to the receiver/decoder, the  
transmission error value monitor being operative to monitor a transmission error value  
10 and generate an input signal, wherein the transmission error value is based upon at least  
one of the group consisting of bit error rate, errored seconds, errored minutes, number of  
code violations over a fixed period of time, signal-to-noise ratio measured at the  
receiver/decoder, TCP/IP throughput; and

a controller coupled with the adaptive FEC coder, the controller being operative to  
15 receive the input signal and generate a CCR adjustment control signal in response to the  
input signal.

Attorney Docket No. 0101-p02

45

Patent Application

Ex. 1004, 48-55.

107. A first office action was mailed on March 21, 2007, and all of the pending claims were rejected as obvious over U.S. Patent No. 6,598,188 (“Locke”). Ex. 1004, 95; Ex. 1030. As a part of this rejection, the Examiner argued that “Locke does not explicitly teach a controller to perform the process of adaptive FEC” (Ex. 1004, 101), however “the process of comparing the MEV and a TEV would inherently require some type of processor/controller. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to include a controller to control the adaptive FEC coding of Locke.” Ex. 1004, 101.

108. The Applicant responded on August 21, 2007 with claim amendments as indicated below.

## Claims

Following is a complete set of claims as amended with this response.

1. (Currently Amended) A controller for an adaptive Forward Error Correction (FEC) coder using a codeword composition ratio (CCR), wherein the FEC coder is used in a [communication system] DSL modem in which a transmitter sends data [to a receiver] via a channel using FEC coding, interleaving and according to an original transmission latency, the controller comprising:

means for repeatedly acquiring a measured transmission error value (MEV) representing impulse noise events detected on the channel, wherein the means is coupled to the communication system;

means for analyzing the repeated MEVs relative to a target transmission error value (TEV), wherein the analyzing means is coupled to the acquiring means; and

means for generating a CCR adjustment control signal responsive to the means for analyzing, and transmitting the same to the DSL modem, wherein the generating means is coupled to the analyzing means and to the communication system.

2. The controller of Claim 1 wherein the MEV is based on at least one of the following:

a bit error rate;

errored seconds;

errored minutes;

code violations over a fixed period of time;

a signal-to-noise ratio measured at the receiver; or

TCP/IP throughput.

3. The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as computer readable program code.
4. The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as hardware.
5. The controller of Claim 1 wherein the TEV is a threshold error rate limit.
6. (Currently Amended) The controller of Claim 1 wherein the generating means comprises means for generating an interleave depth adjustment control signal responsive to the means for analyzing.
7. The controller of Claim 6 wherein the interleave depth control signal is computed to maintain the original transmission latency by compensating for adjustments to the CCR.
8. (Currently Amended) The controller of Claim 1 further comprising a historical data module coupled to the analyzing means to access historical information about impulse noise events that occurred during prior transmissions on the channel in analyzing the MEV relative to the TEV.
9. The controller of Claim 8 wherein the historical data module is a database.

10. (Canceled)

11. The controller of Claim 1 wherein the controller comprises a dynamic spectrum manager.

12. (Currently Amended) The controller of Claim 1 wherein the [communication system] DSL modem is an Asynchronous Digital Subscriber Line modem operable in compatibility with the ADSL2 [system] standard and further wherein the CCR adjustment control signal adjusts at least one of the following:

Impulse Noise Protection (INP); or

maximum interleaving delay.

13. (Currently Amended) The controller of Claim 1 wherein the [communication system] DSL modem is an Asynchronous Digital Subscriber Line modem operable in compatibility with the ADSL1 [system] standard and further wherein the CCR adjustment control signal adjusts at least one of the following:

N, wherein N represents a total number of bytes of a codeword;

K, wherein K represents a total number of payload bytes in the codeword; or

R, wherein R represents a total number of parity bytes in the codeword.

14. (Currently Amended) The controller of Claim 1 wherein the means for repeatedly acquiring the MEV comprises means for receiving an input signal representative of the MEV.

15. (Currently Amended) A method of adjusting forward error correcting (FEC) coding in a [communication system] a DSL modem in which data is transmitted between a transmitter and a receiver on a channel, the method comprising:

- (a) selecting a codeword composition ratio (CCR) representing [the] a relation between payload and parity bytes in an FEC coding scheme;
- (b) transmitting a control signal for transmitting data from the DSL modem via the channel [using] the control signal specifying the CCR and the FEC coding scheme;
- (c) repeatedly acquiring [an] a measured transmission error value (MEV) representing impulse noise events detected on the channel;
- (d) analyzing the repeated MEVs relative to a target transmission error value (TEV); and
- (e) adjusting the CCR when the MEV differs sufficiently from the TEV.

16. (Currently Amended) The method of Claim 15 wherein repeatedly acquiring [an] the MEV comprises at least one of the following:

- directly measuring a characteristic of the communication system;
- collecting a value from an element management system; or
- computing the MEV from collected data.

17. The method of Claim 15 wherein steps (b) through (e) are repeated.

18. The method of Claim 15 wherein the method is performed by a controller.

19. (Canceled)

20. (Currently amended) The method of Claim [19] 18 wherein the controller is a dynamic spectrum manager.

21. (Currently Amended) The method of Claim [19] 18 wherein the controller is in a Central Office (CO).

22. (Currently Amended) The method of Claim [19] 18 wherein the controller is outside a Central Office (CO).

23. (Currently amended) The method of Claim [19] 18 wherein the controller is an operator of the DSL system.

24. (Currently amended) The method of Claim [19] 18 wherein the controller is independent of any operator of the DSL system.

25. (Currently Amended) The method of Claim 15 wherein the CCR is  $K/N$ , wherein  $K$  = a total number of payload bytes in the codeword and  $N$  = a total number of bytes in the codeword.

26. (Canceled)

27. (Canceled)

28. The method of Claim 15 wherein the communication system has an original transmission latency resulting from interleaving of FEC codewords using an interleave depth and further wherein the method further comprises adjusting the interleave depth to compensate for adjustments to the CCR to maintain the original transmission latency.

29. (Currently Amended) The method of Claim 15 wherein analyzing the repeated MEV<sub>s</sub> relative to the TEV comprises evaluating historical data relating to impulse noise events that occurred during prior transmissions on the channel.

30. The method of Claim 15 wherein the MEV is based on at least one of the following:

a bit error rate;

errored seconds;

errored minutes;

code violations over a fixed period of time;

a signal-to-noise ratio measured at the receiver; or

TCP/IP throughput.

31. (Currently Amended) The method of Claim 15 wherein repeatedly acquiring the MEV<sub>s</sub>, analyzing the repeated MEV<sub>s</sub> relative to the TEV, and adjusting the CCR are implemented by computer readable program code.

32. (Currently Amended) The method of Claim 15 wherein repeatedly acquiring the MEV<sub>s</sub>, analyzing the repeated MEV<sub>s</sub> relative to the TEV, and adjusting the CCR are implemented by hardware.

33. (Currently Amended) The method of Claim 15 wherein the communication system is an Asynchronous Digital Subscriber Line system operable in compatibility with the ADSL2 [system] standard and further wherein adjusting the CCR comprises adjusting at least one of the following:

impulse noise protection (INP); or

maximum interleaving delay.

34. The method of Claim 15 wherein the [communication system] DSL modem is an Asynchronous Digital Subscriber Line modem operable in compatibility with the ADSL1 [system] standard and further wherein adjusting the CCR comprises adjusting at least one of the following:

N, wherein N equals a total number of bytes in a codeword;

K, wherein K equals a total number of bytes in a payload of the codeword; or

R, wherein R equals a total number of parity bytes in the codeword.

35. (Currently Amended) A transmission system comprising:

a transmission channel;

a transmitter coupled to the transmission channel;

an adaptive forward error correction (FEC) coder coupled to the transmitter;

a receiver/decoder coupled to the transmission channel; and

a transmission error value monitor coupled to the receiver/decoder, the transmission error value monitor being operative to periodically monitor [a] for transmission error values representative of impulse noise events detected on the channel and generate an input signal, wherein the transmission error values [is] are based upon at least one of the group consisting of bit error rate, errored seconds, errored minutes, number of code violations over a fixed period of time, signal-to-noise ratio measured at the receiver/decoder, TCP/IP throughput; and

a controller coupled with the adaptive FEC coder, the controller being operative to receive the input signal and generate a CCR adjustment control signal to the FEC coder in response to the input signal.

Ex. 1004, 123-132.

109. As a part of the Remarks, the Applicant distinguished Locke by explaining that Locke addresses MSE, which “is defined as ‘the average squared distance between constellation points and the received data points’ in the modulated symbols.” *Id.*, 133. The Applicant further explains “MSE is not a measure of transmission errors detected on a channel. Rather, MSE is a value determined by the modem based on the average squared distance between constellation points and received data points during the short period of time during which the modem performs initialization and training, for example, on power up or reset.” *Id.* According to the Applicant, the MSE is used to determine the probability of a bit error due to additive Gaussian white noise, which is “white noise having a constant spectral density and a normal distribution of amplitude, in other words, stationary

noise.” *Id.*, 134. The Applicant contrasts this white noise against the claimed “repeatedly acquiring a measured transmission error value (MEV) representing impulse noise events detected on the channel.” *Id.* The “impulse noise occurs as random and unpredictable events on the channel.” *Id.*

110. A final office action was mailed on October 22, 2007. *Id.*, 161. The Office Action rejected all of the pending claims as obvious over Locke in view of U.S. Patent No. 5,023,872 (“Annamalai”). *Id.*; Ex. 1031.

111. The Applicant responded on March 21, 2008 with further amendments to the claims, as indicated below.

## SECTION I—CLAIMS

### Amendment to the Claims:

This listing of the claims will replace all prior versions and listings of claims in the application. Claims 1-2, 7-8, 12-16, 23-24, 28, and 30-35 are amended herein. Claims 10, 19, and 26-27 remain canceled herein without prejudice. No new claims are added. Accordingly, claims 1-9, 11-18, 20-25, and 28-35 remain pending in the application.

### Listing of Claims:

1. (Currently amended) A controller for an adaptive Forward Error Correction (FEC) coder using a ~~[[c]]Codeword~~ ~~[[c]]Composition~~ ~~[[r]]Ratio~~ (CCR), wherein the FEC coder is used in a Digital Subscriber Line (DSL) modem in which a transmitter sends data via a channel using FEC coding~~[[,]]~~ and interleaving ~~and~~ according to an original transmission latency, wherein the controller ~~comprises:~~ comprising:  
means for repeatedly acquiring ~~a measured transmission error value~~ Measured transmission Error Values (MEVs) representing impulse noise events detected on the channel, ~~the MEVs acquired after training and initializations on the DSL modem,~~ wherein the means is coupled with ~~[[to]] the communication system~~ DSL modem;  
means for analyzing the acquired ~~repeated~~ MEVs relative to a ~~target transmission error value~~ Target transmission Error Value (TEV), wherein the analyzing means is coupled with ~~[[to]]~~ the acquiring means; and  
means for generating a CCR adjustment control signal during normal operation of the DSL modem ("SHOWTIME") responsive to the means for analyzing, and transmitting the

same to the DSL modem, wherein the generating means is coupled with ~~[[to]]~~ the analyzing means, ~~and to the communication system.~~

2. (Currently amended) The controller of Claim 1 wherein the MEVs are ~~[[is]]~~ based on at least one of the following:

a bit error rate;

errored seconds;

errored minutes;

code violations over a fixed period of time;

a Signal-to-Noise Ratio (SNR) ~~signal-to-noise ratio~~ measured at the receiver; or

Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.

3. (Original) The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as computer readable program code.

4. (Original) The controller of Claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as hardware.

5. (Original) The controller of Claim 1 wherein the TEV is a threshold error rate limit.

6. (Previously presented) The controller of Claim 1 wherein the generating means comprises means for generating an interleave depth adjustment control signal responsive to the means for analyzing.

7. (Currently amended) The controller of Claim 6 wherein the interleave depth adjustment control signal is computed to maintain the original transmission latency by compensating for adjustments to the CCR.

8. (Currently amended) The controller of Claim 1 further comprising a historical data module coupled with ~~[[to]]~~ the analyzing means for the analyzing means to access historical

information about impulse noise events that occurred during prior transmissions on the channel in analyzing the MEV<sub>s</sub> relative to the TEV.

9. (Original) The controller of Claim 8 wherein the historical data module is a database.
10. (Canceled).
11. (Original) The controller of Claim 1 wherein the controller comprises a dynamic spectrum manager.
12. (Currently amended) The controller of Claim 1 wherein the DSL modem is an ~~Asynchronous~~ Asymmetric Digital Subscriber Line (ADSL) modem operable in compatibility with an ~~the~~ ADSL2 standard and further wherein the CCR adjustment control signal adjusts at least one of the following:
- Impulse Noise Protection (INP); or
- maximum interleaving delay.
13. (Currently amended) The controller of Claim 1 wherein the DSL modem is an ~~Asynchronous~~ Asymmetric Digital Subscriber Line (ADSL) modem operable in compatibility with an ~~the~~ ADSL1 standard and further wherein the CCR adjustment control signal adjusts at least one of the following:
- N, wherein N represents a total number of bytes of a codeword;
- K, wherein K represents a total number of payload bytes in the codeword; or
- R, wherein R represents a total number of parity bytes in the codeword.
14. (Currently amended) The controller of Claim 1 wherein the means for repeatedly acquiring the MEV<sub>s</sub> comprises means for receiving an input signal representative of the MEV<sub>s</sub>.
15. (Currently amended) A method of adjusting Forward Error Correcting ~~forward error~~ ~~correcting~~ (FEC) coding in [[a]] a Digital Subscriber Line (DSL) modem in which data is

- transmitted between a transmitter and a receiver on a channel, the method comprising:
- (a) selecting a Codeword Composition Ratio ~~codeword-composition-ratio~~ (CCR) representing a relation between payload and parity bytes in an FEC coding scheme;
  - (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;
  - (c) repeatedly acquiring Measured transmission Error Values ~~a-measured-transmission-error value~~ (MEVs) representing impulse noise events detected on the channel, the MEVs acquired after training and initializations on the DSL modem; and
  - (d) analyzing the acquired ~~repeated~~ MEVs relative to a Target transmission Error Value ~~target transmission-error-value~~ (TEV); and
  - (e) adjusting the CCR when the MEV differs sufficiently from the TEV.

16. (Currently amended) The method of Claim 15 wherein repeatedly acquiring the MEVs comprises at least one of the following:

directly measuring a characteristic of the ~~communication-system~~ DSL modem;

collecting a value from an element management system; or

computing the MEVs from collected data.

17. (Original) The method of Claim 15 wherein steps (b) through (e) are repeated.

18. (Original) The method of Claim 15 wherein the method is performed by a controller.

19. (Canceled).

20. (Previously presented) The method of Claim 18 wherein the controller is a dynamic spectrum manager.

21. (Previously presented) The method of Claim 18 wherein the controller is in a Central Office (CO).

22. (Previously presented) The method of Claim 18 wherein the controller is outside a Central Office (CO).
23. (Currently amended) The method of Claim 18 wherein the controller is an operator of the DSL ~~system~~ modem.
24. (Currently amended) The method of Claim 18 wherein the controller is independent of any operator of the DSL ~~system~~ modem.
25. (Previously presented) The method of Claim 15 wherein the CCR is  $K/N$ , wherein  $K$  = a total number of payload bytes in the codeword and  $N$  = a total number of bytes in the codeword.
- 26-27. (Canceled).
28. (Currently amended) The method of Claim 15 wherein the DSL modem ~~communication system~~ has an original transmission latency resulting from interleaving of FEC codewords using an interleave depth and ~~further~~ wherein the method further comprises adjusting the interleave depth ~~to compensate for adjustments responsive to adjusting the~~ CCR to maintain the original transmission latency.
29. (Previously presented) The method of Claim 15 wherein analyzing the repeated MEVs relative to the TEV comprises evaluating historical data relating to impulse noise events that occurred during prior transmissions on the channel.
30. (Currently amended) The method of Claim 15 wherein the MEV is based on at least one of the following:
- a Bit Error Rate (BER) ~~bit error rate~~;
  - errored seconds;
  - errored minutes;

code violations over a fixed period of time;

a Signal-to-Noise Ratio (SNR) ~~signal-to-noise ratio~~ measured at the receiver; or

Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.

31. (Currently amended) The method of Claim 15 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented ~~[[by]]~~ in computer readable program code.

32. (Currently amended) The method of Claim 15 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented ~~[[by]]~~ in hardware.

33. (Currently amended) The method of Claim 15 wherein the DSL modem ~~communication system~~ is an ~~Asynchronous~~ Asymmetric Digital Subscriber Line (ADSL) system operable in compatibility with an ~~the~~ ADSL2 standard and further wherein adjusting the CCR comprises adjusting at least one of the following:  
Impulse Noise Protection ~~impulse noise protection~~ (INP); or  
maximum interleaving delay.

34. (Currently amended) The method of Claim 15 wherein the DSL modem is an ~~Asynchronous~~ Asymmetric Digital Subscriber Line (ADSL) modem operable in compatibility with an ~~the~~ ADSL1 standard and further wherein adjusting the CCR comprises adjusting at least one of the following:

N, wherein N equals a total number of bytes in a codeword;

K, wherein K equals a total number of bytes in a payload of the codeword; or

R, wherein R equals a total number of parity bytes in the codeword.

35. (Currently amended) A transmission system comprising:

a transmission channel;

a transmitter coupled ~~[[to]]~~ with the transmission channel;

an adaptive Forward Error Correction ~~forward error correction~~ (FEC) coder coupled ~~[[to]]~~ with the transmitter;

a receiver/decoder coupled ~~[[to]]~~ with the transmission channel; ~~and~~

a transmission error value monitor coupled ~~[[to]]~~ with the receiver/decoder, the transmission error value monitor ~~being operative to:~~

periodically monitor for transmission error values representative of impulse noise events detected on the channel, wherein the transmission error values are monitored for after training and initializations on the DSL modem and generate an input signal, wherein the transmission error values are based upon at least one of the group consisting of bit error rate, errored seconds, errored minutes, number of code violations over a fixed period of time, Signal-to-Noise Ratio (SNR) ~~signal-to-noise ratio~~ measured at the receiver/decoder, and Transmission Control Protocol and Internet Protocol (TCP/IP) throughput, and

generate an input signal based on the transmission error values; and

a controller coupled with the adaptive FEC coder, the controller ~~being operative~~ to receive the input signal and generate a CCR adjustment control signal to the FEC coder in response to the input signal.

*Id.*, 179-185.

112. These amendments were accompanied with remarks further emphasizing that repeatedly acquiring MEVs representing impulse noise events is distinguishable from Locke's discussion of MSEs, which relate to “the bit error rate (derived from MSE)’ [which] is related to ‘additive white gaussian noise.’” *Id.*, 187. Moreover, the Applicant further argued that “[u]nlike Locke’s AGWN, or stationary noise, ‘impulse noise events’ occur as random and unpredictable events on the channel, and therefore are detected over a period of hours, days, or weeks, making collecting and storing such information impracticable for Locke’s modems.” *Id.* This response led to a Notice of Allowance, mailed on May 5, 2008.

### **B. Priority Date**

113. I understand that the ’669 Patent issued on September 23, 2008, from the ’593 Application that was filed March 8, 2004. I understand that the ’593 Application claims priority to U.S. Provisional Application No. 60/527,853, filed on December 7, 2003. Ex. 1001, 1. For purposes of this Declaration, I have assumed that the earliest alleged priority date of the ’669 Patent is not earlier than December 7, 2003.

### **C. The ’669 Patent’s Specification**

114. The ’669 Patent describes an adaptive FEC coding scheme that is used to adjust a codeword composition of FEC codewords in response to the variance of

a measured transmission error value from a target transmission error value. Ex. 1001, Abstract. Depending on whether the communication system follows ADSL1 or ADSL2 standards, adjusting the codeword encompasses (a) adjusting parameters such as the N, K, and/or R values (for ADSL1 systems) or (b) adjusting the impulse noise protection (INP) and/or maximum interleaving delay value (for ADSL2 systems). *Id.*

115. The '669 Patent describes that “impulse noise, other noise and other sources of error can substantially impact the accuracy of data transmitted by ADSL and other communication systems.” *Id.*, 1:46-48. The '669 Patent recognizes that there are several existing techniques for mitigating the effects of impulse noise or other sources of error, including interleaving – by distributing errors generated by noise and other sources among spaced codewords according to an interleaving depth, D – and using redundancy coding (e.g., FEC using Reed-Solomon encoding) that uses parity bytes to correct errors within a codeword. *Id.*, 1:51-2:16.

116. The '669 Patent continues its description of known Reed-Solomon encoding by defining relevant variables. Codewords are made up of K data or information bytes and R parity bytes; the sum of which is N total bytes per codeword. *Id.*, 2:17-20. The ADSL1 standard further specifies that “the FEC coder takes in S mux data frames of  $K_{mux}$  bytes of payload data and appends R FEC redundancy bytes to produce the FEC codeword of length  $N_{FEC}=S \times K_{mux}+R$  bytes.” *Id.*, 2:21-28. The

'669 Patent recognizes that parameters N, K, S, and D are directly specified by modem pairs according to ADSL standards. "In ADSL1 (or G.992.1/2), the downstream FEC settings for N, R, S, and D are determined by the transmitter (or ATU-C), while in ADSL2 (or G.992.3/4/5) the downstream FEC settings N, R, S and D and related parameters are determined by the downstream receiver (ATU-R) during loading." *Id.*, 2:39-45. Specifically in ADSL2, the N, R, and D parameters are selected "using a minimum impulse noise protection value or impulse strength indicator (called INP in G.992.3/4/5 and the related G.997.1)." *Id.*, 3:41-44.

117. The '669 Patent indicates that adjustments can be made to the transmission error rate "using changes to a codeword composition ratio (for example, by changing at least one codeword length parameter) when a measured transmission error value (MEV) differs sufficiently from a target transmission error value (or TEV)." *Id.*, 5:50-55. For example, the bit error rate (BER) can be measured and compared against a target BER, and the composition of codewords used in FEC/interleaving can be changed when the measured BER differs sufficiently from the target BER. *Id.*, 5:55-62. Other values can be measured as transmission error values, including "the bit error rate, errored seconds, errored minutes, the number of code violations over a fixed period of time, the signal-to-noise ratio measured at the receiver, the TCP/IP or other protocol throughput at a higher level and/or other

quantities obvious to those skilled in the art that represent the amount or level of error detectable in a given system.” *Id.*, 5:65-6:4.

118. The transmission error values may be monitored, and the FEC codeword parameters may be adjusted by a controller (e.g., a dynamic spectrum manager or spectrum management center) encompassing a computer-implemented device or a combination of devices. *Id.*, 6:11-30. The controller may be coupled to transmitters and may reside in the same location (e.g., a DSL central office) as the transmitters. *Id.* The ’669 Patent states that the phrases “coupled with” and “coupled to” are used “to describe a connection between two elements and/or components and are intended to mean coupled either directly together, or indirectly, for example via one or more intervening elements.” *Id.*

119. Before describing the details of the ’669 Patent’s adaptive scheme for adjusting FEC codewords, I believe it is helpful to keep the following table in mind, which defines variables used throughout the ’669 Patent specification and claims. This table is reproduced from 6:36-50 of the ’669 Patent.

| Value/<br>variable                  | Description                                                                                  |
|-------------------------------------|----------------------------------------------------------------------------------------------|
| K                                   | Number of payload data bytes in each mux data frame, which is a DMT symbol (FIG. 2, Point A) |
| S                                   | Number of DMT symbols per codeword                                                           |
| $(S \times K)$                      | Number of payload data bytes per codeword                                                    |
| R                                   | Number of parity (or redundancy) bytes per codeword                                          |
| $N_{\text{FEC}} = (S \times K) + R$ | Total number of bytes (combined payload data and parity/redundancy) per codeword             |
| $N_1 = N/S$                         | Number of bytes per FEC output data frame (FIG. 2, Point B)                                  |
| D                                   | Interleaving depth in codewords                                                              |

*Id.*, 6:36-50.

120. The '669 Patent “focuses on adjusting one or more codeword parameters outside of the interleaver in a typical communication system.” *Id.*, 8:15-17. For example, adjusting the R, K, or S values, while maintaining compliance with relevant standards. For ADSL1, that can mean keeping the values of R and S within allowable values (summarized in the table below from 8:41-48 of the '669 Patent).

| Value | ATU-C                         | ATU-R                         |
|-------|-------------------------------|-------------------------------|
| R     | 0, 2, 4, 6, 8, 10, 12, 14, 16 | 0, 2, 4, 6, 8, 10, 12, 14, 16 |
| S     | 1, 2, 4, 8, 16                | 1, 2, 4, 8, 16                |
| D     | 1, 2, 4, 8, 16, 32, 64        | 1, 2, 4, 8                    |

*Id.*, 8:41-48.

121. Maintaining compliance with ADSL1 can also mean staying within a maximum latency (line delay) when data is interleaved. That delay is defined based on the number of DMT symbols per codeword (S) and the interleaving depth (D). The delay (in milliseconds) is calculated using the following formula, and S and D

values have been traditionally selected for a delay that comes as close as possible to the requested delay value. *Id.*, 8:61-9:7.

$$Delay = 4 + \frac{(S - 1)}{4} + \frac{S * D}{4}$$

*Id.*, 9:1-3.

122. The '669 Patent uses a ratio—the codeword composition ratio (CCR) to discuss how to adjust the FEC parameters. That CCR is defined as any quantity or value that “represents the relation between the payload and parity bytes in the applicable FEC coding scheme,” and the '669 patent gives a specific example as:

$$CCR = \frac{\text{Payload data bytes}}{\text{Total data bytes}}$$

*Id.*, 9:20-28.

123. Using a Reed-Solomon encoding scheme, this example CCR is the ratio of K/N. Adjustments to the CCR in ADSL1 systems can encompass adjusting the ratio between (S×K) to N<sub>FEC</sub>. *Id.*, 9:16-35. Changing these parameters will either increase or decrease the CCR, “which measures the linear reduction in the data rate as the ratio increases or decreases.” *Id.*

124. The '669 Patent describes a method for adjusting the CCR—which would include adjusting either of the K or N parameters—in reference to FIG. 4, reproduced below with annotations.

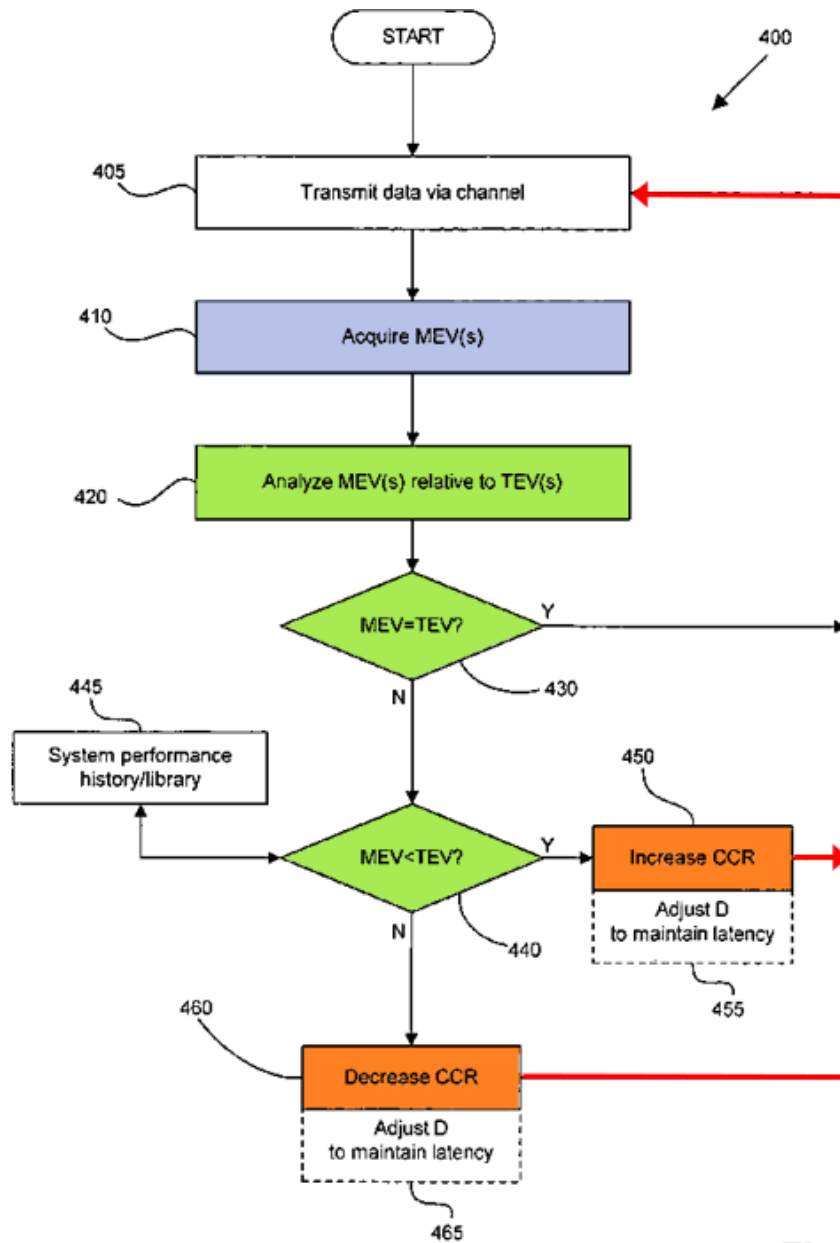


**Figure 4**

*Id.*, Figure 4 (annotated).

125. Data is transmitted on a communication channel between a transmitter and a receiver, as shown in Step 405. *Id.*, 9:12-16. Transmission error values are measured (indicated as acquiring MEVs in step 410, shown in light purple) and compared against target error values (step 420, all of the comparison steps, including

decision steps based on whether the MEV is higher or lower than the TEV are shown in green). *Id.*, at 9:36-61. If the MEVs equal the TEVs (meaning that the measured error values at least approximate a target error value), then the process repeats without changing the CCR, as indicated at step 430. *Id.* However, if the MEV does not equal the TEV, then the CCR is adjusted (shown in orange), depending on whether the MEV is above or below the TEV as shown at steps 440, 450, and 460. *Id.* If the MEV value is below the TEV, then the CCR is increased (e.g., by increasing the amount of payload data and/or decreasing the total codeword size). *Id.*, 10:1-13. If the MEV value is above the TEV, then the CCR is decreased (e.g., by decreasing the amount of payload data and/or increasing the total codeword size). *Id.* I have shown the two steps for changing the CCR – whether increasing or decreasing the CCR, in orange. After the CCR is changed, the process repeats, as indicated by the line I’ve emphasized in red.

126. The CCR is adjusted based on the variables specified in the relevant ADSL standard. Specifically, the CCR can be adjusted by changing N, K, and/or R values (R being equal to N-K) for ADSL1 compliant modems, or by adjusting the INP and/or maximum interleaving delay for ADSL2 compliant modems. *Id.*, 10:23-31. In the latter embodiments, the INP or maximum interleaving delay values are exchanged between the transmitter and receiver in a “handshake,” and then each of the transmitter and receiver convert these values into traditional FEC parameters

using the following formulas (note if erasures are used,  $t=R$ , the number of parity bytes, and if erasures are not used and rate includes information and synch/control bits,  $t=R/2$ ). *Id.*, 10:30-46.

$$D' = \text{depth in bytes} = \frac{\left(\frac{INP}{4}\right) \times \left(\frac{\text{rate in kbps}}{8}\right)}{t}$$

$$N = \frac{(\text{delay in ms}) \times \left(\frac{\text{rate in kbps}}{8}\right)}{(D' - 1)} + 1 \approx \frac{\text{delay}}{\text{burst length}} \cdot t$$

*Id.*, 10:37-47.

127. The ratio of INP to interleaving depth determines the codeword block size. A higher upper limit for INP is usable when intermittent noise (not an isolated impulse) is present and a greater fraction of parity bytes per codeword is desired. *Id.*, 10:47-53.

128. A controller can implement the steps of monitoring MEVs, comparing MEVs to TEVs, and adjusting a CCR. *Id.*, 13:4-17. Measurements of MEVs “may be made directly by the controller 500 or may be sent by the receiver to controller 500 by any suitable alternative means (for example, sending the data to a DSL central office via the transmitter-receiver pair’s communication).” *Id.*, 13:45-49. The controller may be hardware, software, or a combination of hardware and software. *Id.*, 13:50-52. The controller can be a part of a transmission system that includes a transmitter including an FEC coder for generating FEC codewords having a given CCR. *Id.*, 14:20-22.

129. A receiver includes a de-interleaver and an FEC decoder that decodes FEC codewords. *Id.*, 14:34-51. The receiver de-interleaves and decodes FEC codewords using a control signal generated by the controller that sets INP and maximum interleaving delay parameters used by a receiver to set the CCR and decode FEC codewords. *Id.*, 14:66-15:2. The receiver is connected with the transmitter over a transmission channel that “preferably comprises twisted-pair conductive wire.” *Id.*, 16:27-29. The ’669 Patent also specifies that the describes methods can be used over other transmission channels, including “coaxial cable, optical fiber, free-space laser, radio or any other type of transmission media as known to those skilled in the art.” *Id.*, 16:29-32.

130. The ’669 Patent indicates that the method can be performed in a common DSL system, as illustrated in FIG. 7, reproduced below. The system includes a central office (710) shown in yellow, connected with downstream remote locations (704) (shown in blue) via a common binder 724. As shown, a controller is coupled to transceivers in the central office. *Id.*, 17:63-18:25.

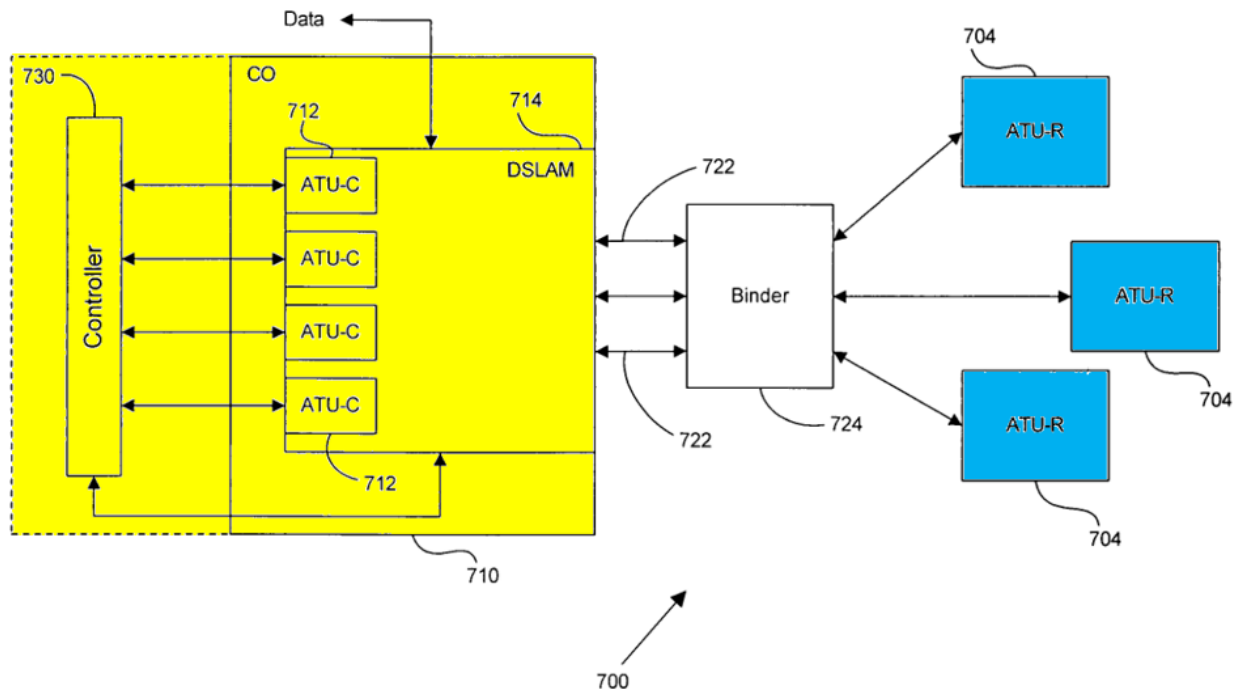


**Figure 7**

*Id.*, Figure 7 (annotated).

## VIII. CLAIM CONSTRUCTION

131. Based on my review of the '669 Patent and its file history, a POSITA would have understood the claim terms in light of the specification, and interpreted them by using their plain and ordinary meaning in accordance with the then current state of the art.

### A. “Means for” Limitations

132. Notwithstanding the above, Claim 1 of the '669 patent recites several “means” limitations, and I understand that these claim terms are to be interpreted to include the corresponding structure described in the specification. I have listed these

limitations in the table below with citations to the relevant description of the structure in the specification of the '669 patent.

| Claim Term                                                                                  | Citation to Specification                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| “means for repeatedly acquiring Measured transmission Error Values (MEVs)”                  | “a transmission error value monitor for acquiring a transmission error value and generating a signal representative of that MEV.” <i>Id.</i> at 13:18-21, 16:63-17:30. This can be a part of a “controller 500 [that] is a computer or computer system attached to an ADSL element management system interface” that implements the “[m]onitoring, measuring, analysis, comparing, processing, evaluation, and N, R, D or INP/Maximum Interleaving Delay recommendations.” <i>Id.</i> , 13:50-59. |
| “means for analyzing the acquired MEVs relative to a Target transmission Error Value (TEV)” | Structure includes “software, hardware or a combination of the two.” <i>Id.</i> , 13:50-52.                                                                                                                                                                                                                                                                                                                                                                                                       |
| “means for generating a CCR adjustment control signal”                                      | Structure includes one of a “controller” ( <i>id.</i> , 13:9-10), or “software, hardware and/or a combination of the two.” <i>Id.</i> , 14:1-3.                                                                                                                                                                                                                                                                                                                                                   |

133. The '669 patent specification includes a limited description of the structure performing the functionality of the recited “means” limitations as noted

above, but the detailed discussion in the Opinions section (*infra*, Section X), demonstrates that the prior art discloses at least the same structure and level of detail as the '669 patent specification for performing the functions recited in independent claim 1.

## **IX. SUMMARY OF THE PRIOR ART**

### **A. U.S. Patent No. 6,772,388 to Cooper et al. (“Cooper”) (Ex. 1006)**

134. Cooper is a U.S. patent issued from application no. 09/731,095, filed on December 6, 2000. Ex. 1006 1. I understand that Cooper has been attached as Exhibit 1006. *See* Ex. 1006. Cooper was not cited and was not considered during prosecution of the '669 Patent.

135. Cooper is directed to an “adaptive and dynamic forward error correction scheme for a communication channel.” *Id.*, Abstract.

136. Cooper focuses on high-speed data connections, and describes one example high-speed communication medium in the background section – a “hybrid optical fiber and coaxial cable [that] is utilized to provide substantial bandwidth over existing cable television lines to receiving stations, such as individual subscriber access units located at, for example, households having cable television capability. The coaxial cables are further connected to fiber optic cables terminating at a central location (referred to as the ‘head end’) where controlling, receiving and transmitting equipment resides.” *Id.*, 1:31-39. Data “can be transmitted both in the downstream

direction, from the head end to an individual or multiple users, or in the upstream direction, from the user to the head end.” *Id.*, 1:43-45.

137. As further background, Cooper explains that “[i]mpairments in the transmission channel and failures within the communication devices inevitably produce noise conditions errors in one or more bits.” *Id.*, 2:18-20. Cooper further explains that the “basic premise of error detection and correction (referred to as forward error correction or FEC) is to transmit additional bits, referred to as check bits (or check bytes, check sum bits or forward error correcting bits), in addition to the information.” *Id.*, 2:25-29. Recognizing that the inclusion of error correction information increases the overhead for data transmission and correspondingly decreases data throughput, Cooper states that there may be situations “such as low noise conditions, in which the forward error correcting power is ‘excessive,’ and therefore a higher data throughput can be achieved by reducing the forward error correction power.” *Id.* 2:48-51. Therefore, Cooper’s method seeks to balance the amount of payload and parity bytes within an FEC codeword. Cooper specifically states that since “the impairment or noise levels on a channel may vary with time, an adaptable and flexible error correction capability is required for providing sufficient error correction for accurate data reception while simultaneously minimizing overhead for increased data throughput.” *Id.*, 2:66-3:3; *see also id.*, 3:51-58.

138. Cooper addresses the need for adaptive and flexible error correction by providing “an algorithm for an improved forward error correction parameter optimization technique, which minimizes overhead and satisfies system latency requirements, thereby providing increased data throughput.” *Id.*, 3:59-63. Cooper explains that the described method “can adaptively respond to changing noise-related conditions in the communications channel *by adapting the forward error correcting power* due to those changing conditions” on a communications medium between a primary transceiver and a secondary station—either of which may operate as a transmitter or receiver. Ex. 1006, 3:63-67, 4:3-47.

139. Cooper explains that the disclosed FEC scheme is applicable to high-speed data communication channels including “hybrid optical fiber and coaxial cable” as well as “coaxial cable, fiber optic cable, twisted pair copper wires, etc., and may also include the air, atmosphere or space for wireless and satellite-based communications.” *Id.*, 4:5-15. As I discuss in the Technical Background section, *supra* Section VI, DSL data transmissions are performed over twisted pair copper wires, and so a POSITA would recognize that Cooper’s mention of “twisted pair copper wires,” particularly in the context of “high-speed data application[s]” (*Id.*, 4:11-15) is intended to refer to DSL data transmission, and the described FEC coding scheme can be implemented for DSL (among other communication media). Moreover, Cooper’s FIG. 1 (reproduced below), which is described as “a block

diagram illustrating a communications system 100 in accordance with the teachings of the present invention” is an illustration of a system in which a ”primary station” communicates with a plurality of ”secondary stations” over twisted pair copper wires connected with modems at each of the primary station and secondary station locations. While Figure 1 illustrates a point-to-multipoint architecture, Cooper teaches that the patent also applies to the point-to-point DSL architecture. “Dependent upon the specific application of the present invention, the primary station **101** can be a simple transmitter for point-to-point or point-to-multipoint communications with one or more of the secondary stations **110, 112, 114, and 116.**” Ex. 1001, 4:48-51.

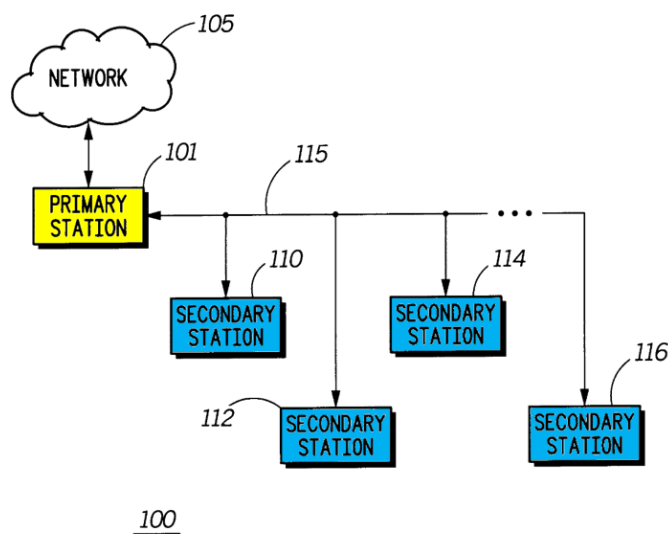


**FIG. 1**

Ex. 1006, Figure 1 (annotated).

140. Cooper explains that the primary station 101 may include “a plurality of processors, memory units, receivers and transmitters for bidirectionally communicating with each of the secondary stations.” *Id.*, 4:56-61. Those processors “control the various functions associated with the primary station 101.” *Id.* 4:64-66. The receivers include, among other components, a Reed-Solomon decoder for decoding forward error detection and correction bytes. *Id.*, 4:66-5:3. The transmitters include a Reed-Solomon encoder for modulation and for coding a forward error correction and cyclic redundancy checks. *Id.*, 5:5-8. Secondary stations include similar components for decoding or encoding forward error correction. *Id.*, 5:20-50.

141. Because communication channels (specifically, upstream communication channels in Cooper’s preferred embodiments) are susceptible to interference from multiple noise sources during data transmission, Cooper explains that forward error correction is employed in a communications channel “to compensate for data transmission errors caused by noise or other distortions.” *Id.*, 5:57-61. Cooper describes FEC as comprising “an error correcting code that is appended to the information or application bits to allow a receiver to detect and correct certain types and sizes of errors that may have occurred during the transmission of the data.” *Id.*, 5:61-65. Cooper explains that both the transmitter and receiver on a communications channel “must know, prior to the receipt of the data, the type of error correcting code employed at the transmitter so that proper decoding

and error correction can be accomplished at the receiver. This exchange of forward error correction can be accomplished by prior arrangement, during a parameter exchange message sequence that occurs at fixed periodic intervals or at sporadic intervals that coincide with changes in the quality of the communications link.” *Id.* 6:7-15.

142. Cooper describes that the FEC code is a Reed-Solomon error correcting code. *Id.*, 6:17-20. “A Reed-Solomon code is typically specified by a parameter pair  $(n, k)$ , where “ $n$ ” is the code word size and “ $k$ ” is the block size (i.e., the number of information bytes). An  $n$ -byte codeword therefore consists of  $k$  information bytes plus  $(n-k)$  error correcting code bytes.” *Id.*, 6:20-28. The Reed-Solomon code scheme enables correction of a maximum of  $t=(n-k)/2$  errors. *Id.*, 6:28-30. For bitstreams that are divided into a plurality of frames (each frame referred to as a codeword), the  $(n, k)$  parameters further define the division of each code word into an information portion and an error correcting portion. *Id.*, 8:52-9:14.

143. Cooper describes a dynamic FEC coding scheme to balance the relationship between the payload ( $k$  bytes) and parity bytes (or error correcting bytes)  $(n-k)$  bytes), and describes this relationship in terms of an “overhead”—a ratio of “ $n-k$ ” bytes (error correcting bytes) to  $n$  bytes (total bytes) and teaches how to optimize the overhead because “[m]ore error correcting capability lowers throughput” while too little overhead results in significant errors that require

retransmission. *Id.*, 6:67-7:3; 10:30-37. Cooper optimizes the amount of overhead by adjusting the  $n$  and  $k$  parameters based on real-time or near real-time noise characteristics encountered on a communication channel. *Id.*, 7:43-47. Because each parameter “ $n$ ,” “ $k$ ,” and “ $n-k$ ” is inherently related to one another such that increasing the parity byte length will inherently decrease the payload byte length for a codeword of a fixed length, adjusting the “overhead” ratio  $(n-k)/n$  will inherently adjust another other ratio between these variables, such as the ratio of “ $k/n$ ”—the number of payload bytes divided by the total codeword length.

144. The receiver determines real-time or near real-time noise characteristics, and by extension, the receiver “executes a process for determining if and when the code word length or the check byte length can be dynamically adjusted, while still satisfying the system performance objectives.” *Id.*, 7:53-62. Once the receiver determines that a change in FEC parameters is warranted, “this information must be communicated to the transmitter so that both units are operating with the same forward error correction parameters.” *Id.* Cooper recognizes several types of errors that may be on a communication line, which can be characterized as “a bit error rate, packet error rate, burst error rate, block error rate, or frame error rate.” *Id.*, 8:2-3. The described algorithm addresses changes in any of these error rates by adjusting the FEC scheme, specifically the  $(n, k)$  parameters of a Reed-Solomon code word in response to changes in real-time or near real-time noise characteristics.

For example, if a burst error rate increases, the “correcting power of any forward error correction scheme can be increased by increasing the number of error correcting bytes, decreasing the amount of information data contained in a code word (i.e., the number of information bytes in the code word), or performing both of these operations.” *Id.*, 8:59-64. Conversely, if a burst error rate decreases, the “correcting power of any forward error correction scheme can be decreased by decreasing the number of error correcting bytes, increasing the amount of information data contained in a code word, or performing both of these operations.” *Id.*, 9:1-5.

145. Cooper’s described algorithm dynamically achieves a target error rate while minimizing overhead and not exceeding a maximum system latency requirement by adjusting forward error correction parameters including CW\_LENGTH (the total codeword length, equivalent to “n” in the Reed Solomon parameters) and CB\_LENGTH (the number of bytes in the error correcting portion, equivalent to “n-k” in the Reed Solomon parameters). *Id.*, 9:15-42. As mentioned above, Cooper explicitly discusses the relationship between the error correcting byte length and the total codeword length in terms of an “overhead” defined as the error correcting byte length (n-k) divided by the codeword length (n). *Id.*, 6:67-7:3; 10:30-37. Adjusting the “overhead” by changing either “n” or “k” would necessarily change other ratios, such as a ratio between the payload length and the total

codeword length. Moreover, Cooper explains that the target error rate is a bit error rate in one embodiment. *Id.*, 9:61-62.

146. Cooper describes a method for dynamically establishing the forward error correction parameters, including the code word length and the error correcting byte length in reference to FIG. 2, reproduced below with annotations. *Id.*, 11:31-35. The process of FIG. 2 can be performed by a dedicated microprocessor or a microprocessor with multiple functions in the receiver on a communications channel. *Id.*, 11:35-38.

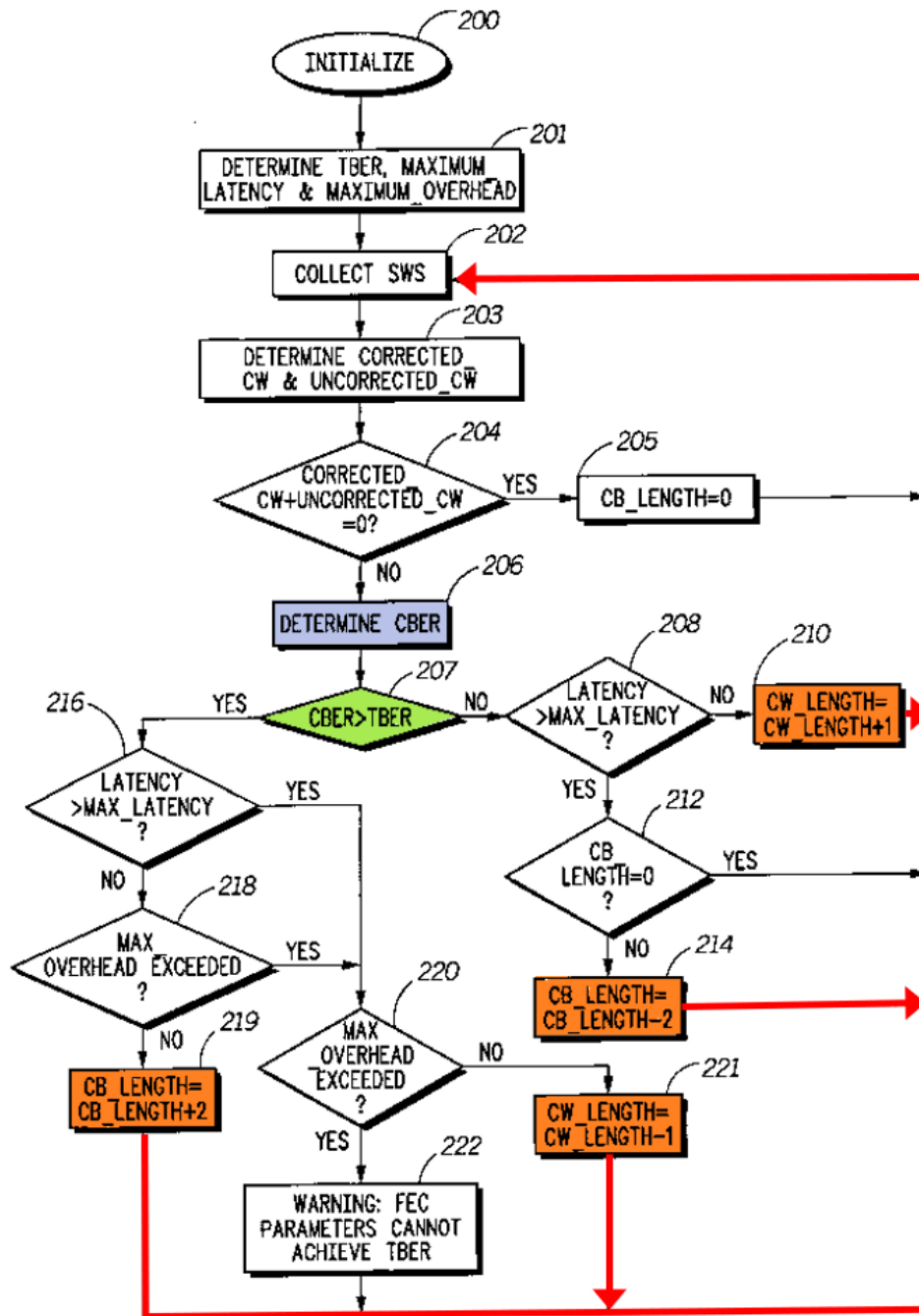


**FIG. 2**

*Id.*, Figure 2 (annotated).

147. As mentioned, Cooper explains that the dynamic determination of Reed-Solomon parameters maintains a desired target bit error rate (TBER),

maximum latency, and maximum overhead, which are specified as indicated at step 201. *Id.*, 11:39-41. The remaining steps (beginning at step 202) are performed in a repetitive cycle (as reflected by the line I emphasized in red), where determinations of error rates, and adjustments to the Reed-Solomon parameters are constantly repeated to remain compliant with the specified target bit error rate, maximum latency, and maximum overhead.

148. At step 202, samples are collected to determine the number of corrected and uncorrected codewords at step 203, and to determine the calculated bit error rate at step 206 (colored light purple). *Id.*, 11:41-67. Steps 204 and 205 in FIG. 2 reflect the uncommon situation where FEC coding is unnecessary, where no errors are detected.

149. At step 207 (shown in green), the calculated bit error rate is compared against the target bit error rate. *Id.*, 12:10-12. If the calculated bit error rate is less than the target bit error rate, then recalling that an  $n$ -byte codeword consists of  $k$  information bytes plus  $(n-k)$  error correcting code bytes, the forward error correcting power should be decreased, such as by increasing CW\_LENGTH (i.e., increasing the Reed-Solomon parameter “ $n$ ”) according to steps 208-210, or by decreasing CB\_LENGTH (i.e., increasing the Reed-Solomon parameter “ $k$ ” (payload length) to decrease the value of “ $n-k$ ” for a fixed codeword length “ $n$ ”) according to steps 212-214. *Id.*, 12:31-13:5. I’ve emphasized each block where the Reed-Solomon

parameters are changed in orange. If the calculated bit error rate is greater than the target bit error rate, then the forward error correcting power should be increased, such as by increasing the CB\_LENGTH value according to steps 216-219 (if the maximum latency and maximum overhead values are not exceeded) or by decreasing the CW\_LENGTH according to step 221. *Id.*, 13:6-57.

150. Although not shown in FIG. 2, once the Reed-Solomon parameters are calculated “they must be transmitted back to the transmitter for implementation as the data stream is encoded” to inform the transmitter of the FEC coding scheme and parameters for data transmission. *Id.*, 13:58-61. Because both the transmitter and receiver must know the FEC parameters and FEC coding scheme, once a device determines the FEC coding parameters to be utilized for transmitting data, both the receiver and transmitter must be informed about what FEC coding scheme and corresponding parameters are to be used. *Id.*, 1:35-39, 4:64-66. In all instances, once the Reed-Solomon parameters are updated, the flowchart of FIG. 2 returns to step 202 (again, as emphasized with the red line in the above figure) for collection of new samples and to repeat the process of determining a current bit error rate and adjusting the Reed-Solomon parameters based on the newly received real-time or near real-time data.

151. Cooper’s claims closely track FIG. 2 and describe a method for adaptive forward error correction including monitoring channel parameters (e.g., bit error

rate), comparing the monitored channel parameters against a threshold value (e.g., target bit error rate), adjusting the code word length or error correcting portion length of the codeword if the monitored channel parameters do not satisfy the threshold value, and repeating the process. *See e.g., id.*, 14:44-15:52, 16:19-59.

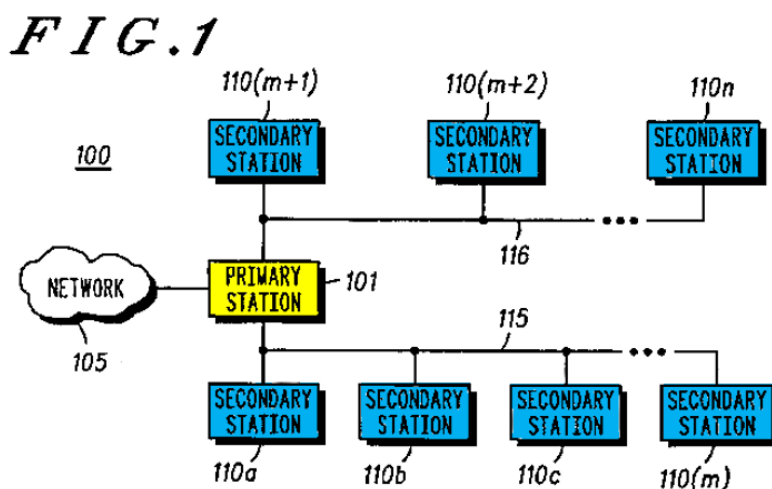
**B. U.S. Patent No. 5,699,365 to Klayman et al. (“Klayman”) (Ex. 1007)**

152. Klayman is a U.S. Patent that issued on December 16, 1997. Ex. 1007,

1. Klayman was not cited and was not considered during prosecution of the '669 Patent.

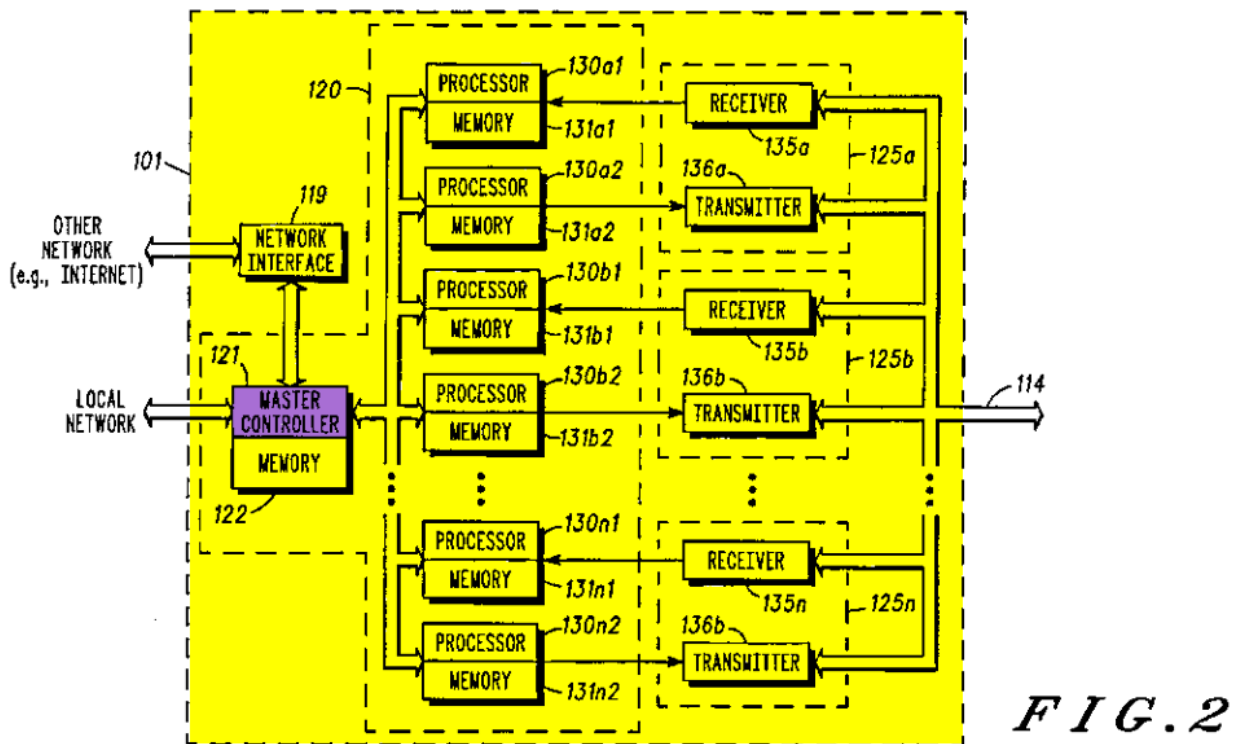
153. Klayman is directed to “adaptive forward error correction in a data communication system (100) provid[ing] for dynamically changing forward error correction parameters based upon communication channel conditions, such as noise levels or error rates.” *Id.*, Abstract. Klayman explains that the disclosed FEC scheme is applicable to “hybrid optical fiber and coaxial cable” as well as “coaxial cable, fiber optic cable, twisted pair wires, and so on, and may also include air, atmosphere or space for wireless and satellite communication.” *Id.*, 3:1-8. As I discuss in the Technical Background section, *supra* Section VI, DSL data transmissions are performed over twisted pair wires (e.g., twisted pair copper wires), and so a POSITA would recognize that Klayman’s reference to “twisted pair wires” (*Id.*) is intended to refer to DSL data transmission, and the described FEC coding scheme can be implemented for DSL (among other communication media). Moreover, Klayman’s

FIG. 1 (reproduced below), which is described as “a block diagram illustrating a communication system 100 in accordance with the present invention” is an illustration of a system in which a “primary station” (shown in yellow) communicates with a plurality of “secondary stations” (shown in blue) over twisted pair wires connected with modems at each of the primary station and secondary station locations. Klayman describes a point-to-multipoint architecture, but Klayman teaches that patent applies to “twisted pair wires” (*Id.*) which refers to DSL data transmission with a point-to-point architecture.



*Id.*, Figure 1 (annotated).

154. Klayman’s FIG. 2 (reproduced below with annotations) “is a block diagram illustrating a primary station 101.” *Id.*, 3:44-45.

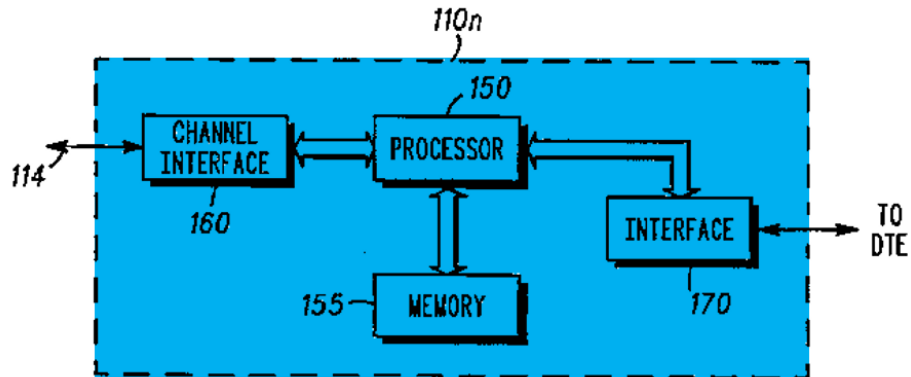


*Id.*, Figure 2 (annotated).

155. As shown, the primary station includes a processor arrangement 120 that includes a master controller 121 (purple) that performs higher level functions and a plurality of other processors that are connected to corresponding receivers and transmitters. *Id.*, 3:44-4:16. The receivers and transmitters include Reed-Solomon decoders and encoders, respectively, for decoding or coding forward error correction and cyclic redundancy checks. *Id.*, 4:20-44.

156. FIG. 3 (reproduced below) illustrates a representative secondary station. *Id.*, 4:45-47.

**FIG. 3**



*Id.*, Figure 3, annotated).

157. As shown, the secondary station includes a processor and a channel interface, the latter of which “performs such functions as forward error correction encoding and decoding.” *Id.*, 4:45-65.

158. Klayman explains that communication channels may be susceptible to interference from typical noise sources, and so forward error correction is employed in a communication channel “as a way of compensating for data transmission errors which may have been caused by noise or other distortions.” *Id.*, 5:12-19. Klayman describes FEC as comprising “an error correcting code that is added to the user data to allow a receiver to correct certain types of and sizes of errors that may have occurred during the transmission of the data.” *Id.*, 5:19-22. Klayman explains that both the transmitter and receiver on a communications channel “should know, prior to the receipt of actual data, what type of error correcting code is to be employed by the transmitting unit, for proper decoding and error correction. This may be typically done by prior agreement (e.g., during initial set up or configuration of the

communication system), or during a negotiation ‘handshake’ during establishment of the communications link.” *Id.*, 5:29-36.

159. Klayman describes that “there are many types of error correcting codes, which are generally categorized as either convolutional codes, which correct random bit errors, and block codes, which correct burst errors.” *Id.*, 5:37-40. Block error correcting codes can be made more effective “using an ‘interleaving’ technique, in which data which may be subject to a burst error is spread out over multiple blocks, thereby providing each block code a higher probability of correcting a small portion of the large burst error.” *Id.*, 5:46-51. The correcting power of an interleaver is determined as a function of interleaver depth. *Id.*, 5:51-54.

160. Klayman utilizes a Reed-Solomon error correcting code as an FEC coding scheme. *Id.*, 5:55-58. “A Reed-Solomon code is typically specified by a parameter pair  $(n, k)$ , in which ‘ $n$ ’ is the code word size and ‘ $k$ ’ is the block size, such that an  $n$ -byte code word consists of  $k$  data bytes and  $(n-k)$  redundancy bytes (which represent the error correcting code information).” *Id.*, 5:61-65. The Reed-Solomon code scheme enables correction of a maximum of  $t=(n-k)/2$  errors. *Id.*, 5:65-67.

161. Klayman signals the FEC coding scheme and changes the forward error correction parameters “based upon variable channel quality, such as variable noise or error levels.” *Id.*, 6:65-7:3. Specifically, Klayman’s FIG. 4 (reproduced below

with annotations, including a dashed line between the “return” block and block 305 to reflect the repetition described by Klayman at 8:42-47) is a flowchart illustrating the process for determining and changing Reed-Solomon parameters to accommodate real-time changes in error rates.

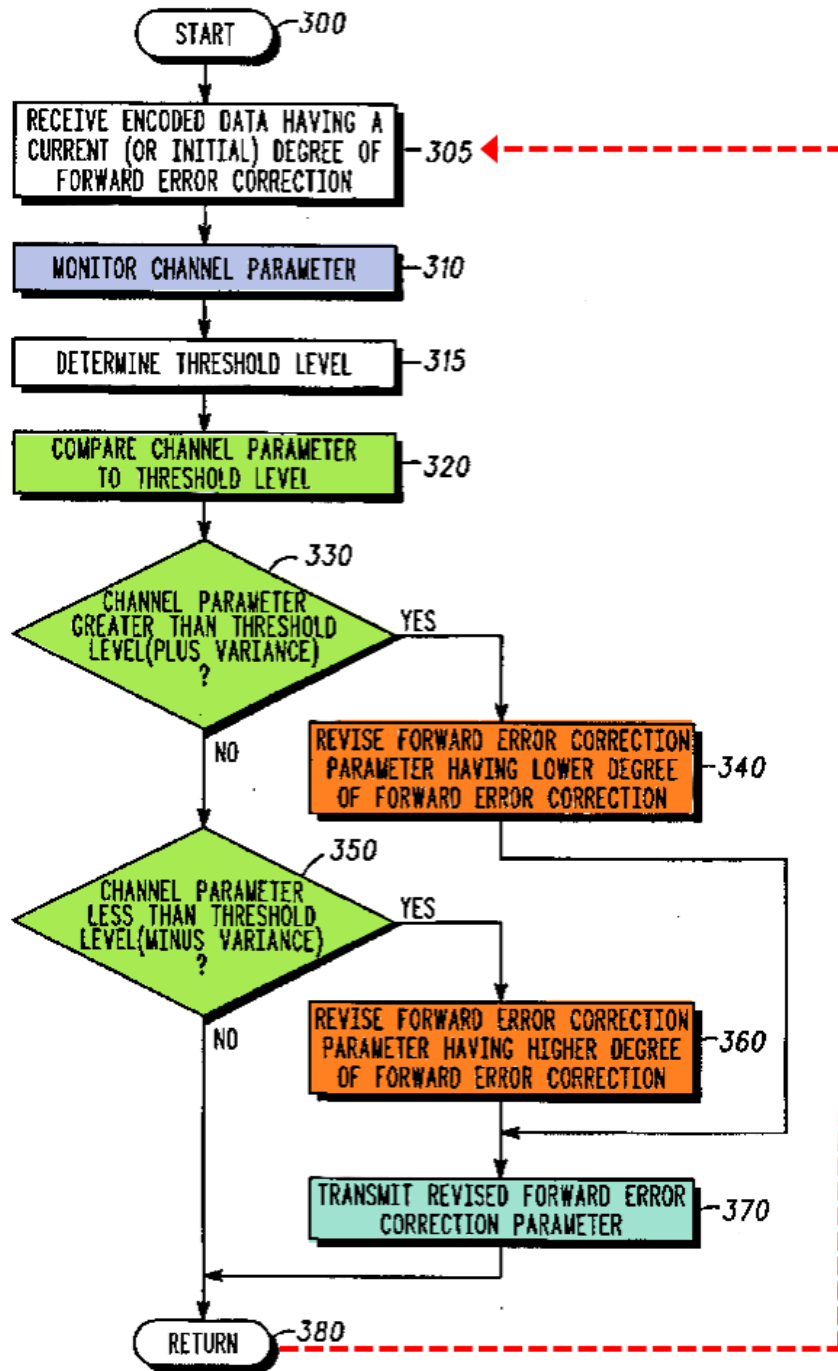


**FIG. 4**

*Id.*, Figure 4 (annotated).

162. FIG. 4 begins with the reception of encoded data that that has an initial degree of forward error correction, at step 305. *Id.*, 7:10-23. Klayman indicates that

the different degrees of forward error correction are the result of different Reed-Solomon parameters applied (e.g., different values of  $n$  or  $k$ , which inherently changes the ratio between  $n$  and  $k$ ), or whether other error correction is applied, such as concatenation of error correcting codes or the inclusion of interleaving of a specified depth. *Id.* These “[f]orward error correction parameters . . . illustrate a balance between the amount of overhead added by the error correcting code itself (which utilizes space which could have been used for data and therefore decreases data throughput), on the one hand, and the amount of error correction needed due to channel conditions (which may serve to increase data throughput through avoidance of retransmission), on the other hand.” *Id.*, 6:19-26. Klayman explains that “to maximize throughput of user data over a given communications channel, the optimal error correcting methodology would utilize precisely enough error correction to compensate for the existing noise level, and no more or less.” *Id.*, 6:26-30. Klayman thus teaches an optimal ratio of error correcting bytes ( $n-k$ ) to the total bytes ( $n$ ) is achieved by balancing the overhead (reflecting the length of the codeword dedicated to error correcting bytes) to the amount of error correction needed. Changing either “ $n$ ” or “ $k$ ” to change the error correcting byte length ( $n-k$ ) or total codeword length (“ $n$ ”) would necessarily change other ratios between these parameters, such as a ratio of the payload byte length ( $k$ ) to the total codeword length ( $n$ ).

163. The method continues with monitoring channel parameters as shown in light purple at step 310, “such as packet error rates, bit error rates, noise levels (such as levels of impulse noise or ingress noise), other interference, or other parameters or factors which could be correlated with channel quality, error rates, and a desired or necessary degree of error correction capability.” *Id.*, 7:37-50. Monitoring channel parameters may specifically include monitoring a combination of a bit error rate, a packet error rate, a burst error rate, a block error rate, and a frame error rate. *Id.*

164. A threshold level is determined (e.g., a predetermined threshold error rate) and the monitored channel parameters are compared against the threshold level, in steps 315-320 (shown in green). *Id.*, 7:50-66. If the monitored channel parameters are greater than the threshold level (suggesting the channel has few errors), then the level of forward error correction is decreased (to increase data throughput) by revising a forward error correcting parameter to have a lower degree of forward error correction, as indicated at steps 330 and 340. *Id.*, 8:2-10. Conversely, if the monitored channel parameters are less than the threshold level (suggesting the channel has many errors), then the level of forward error correction is increased (to increase the error correcting capabilities, while decreasing data throughput) by revising a forward error correcting parameter to have a greater degree of forward error correction, as indicated at steps 350 and 360. *Id.*, 8:16-24. I have shown each

of the steps for revising the FEC parameters in orange, in the annotated version of FIG. 2, above.

165. If the forward error correction parameters are revised, then the FEC scheme and the revised parameters are shared between the transmitter and receiver (by transmitting the revised FEC scheme parameters to the secondary station, as reflected in step 370, shown in teal). *Id.*, 8:39-42. This process is repeated over time so the forward error correction parameters are appropriate to real-time or near real-time error rates as reflected by the dashed red line I added to annotated FIG. 2. *Id.*, 8:42-47 (explaining that the process is repeated over time). Moreover, this process may be performed for either the upstream or downstream direction. *Id.*, 9:40-46.

**C. U.S. Patent Publication No. 2002/0140991 to Li et al. (“Li”) (Ex. 1008)**

166. Li is a publication of U.S. Patent Application 10/046,639, which was filed October 26, 2001. Li published on October 3, 2002. Ex. 1008, 1. Li later issued as U.S. Patent No. 7,673,221 on March 2, 2010. Li was not cited and was not considered during prosecution of the ’669 Patent.

167. Li “relates generally to a method and apparatus for providing a forward error correction scheme for data transmission and specifically to an improved method for selecting error correction parameters.” *Id.*, [0001]. Li explains that this FEC scheme is specifically usable for DSL technology, which “uses an infrastructure that already exists; namely, copper twisted pair lines typically used for telephone

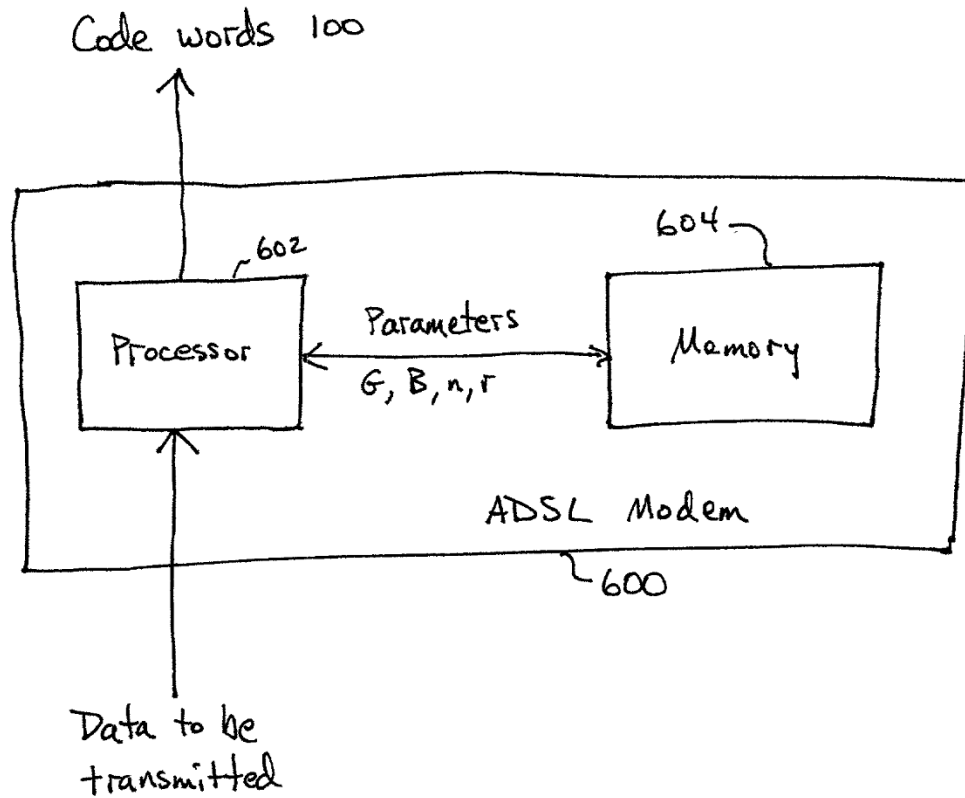
communication.” *Id.*, [0002]. Li explains that the FEC scheme is also usable for “other communication technologies, such as cable modems, CD and DVD players, digital audio and broadcast, HDTV/Digital TV, data storage, wireless communications, wireless enabled personal digital assistants, digital satellite communication and broadcast, and Redundant Array of Independent Disk (RAID) controllers with fault tolerance.” *Id.*, [0006].

168. As is well known, Li explains that ADSL “is the most widely implemented form of DSL technology.” *Id.*, [0003]. In background, Li states that “the performance of an ADSL modem is generally limited by cross-talk. In order to improve system performance and capacity, an error-correcting code such as the Reed-Solomon (RS) code is used.” *Id.*, [0004]. The benefits of the RS code is only achievable “by selecting appropriate error-correcting code parameters, such as code-word length (n) and redundant, or parity, length (r).” *Id.*

169. Li mentions that modems capable of implementing the described FEC coding include “G.992.1 and G.992.2 compliant modems.” *Id.*, [0025]. G.992.1 and G.992.2 are standards documents published by [ITU] and collectively describe the ADSL1 standard.

170. Li describes an example ADSL modem in reference to FIG. 6, reproduced below. As shown, the modem (600) includes a memory (604) that stores data including Reed-Solomon coding parameters and the data to be transmitted, and

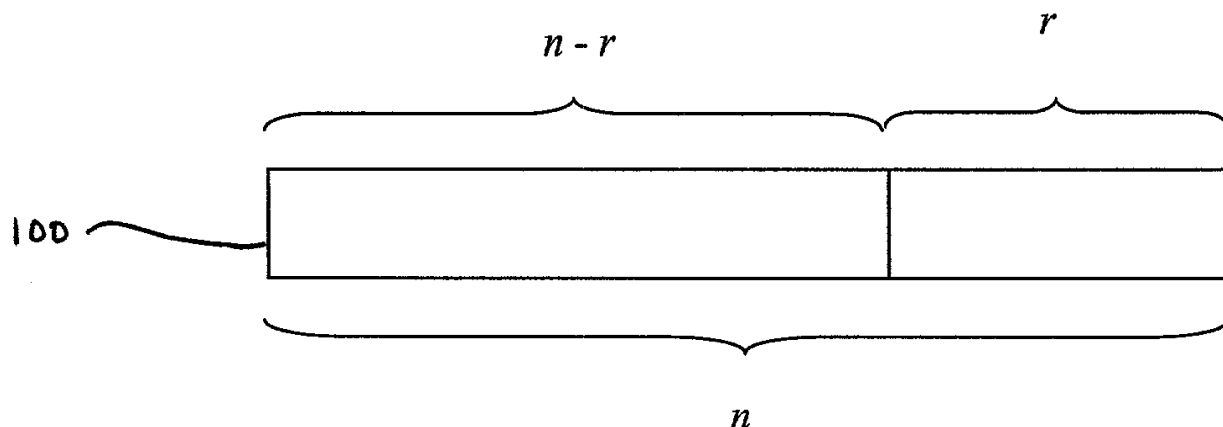
a processor (602) that implements the processes discussed throughout Li, and “may also code the data to be transmitted according to the resulting preferred set of parameters and may generate code words 100 corresponding thereto.” *Id.* [0039].



*Id.*, Figure 6.

171. Li further explains that the modem shown in FIG. 6 is an example, and other processor and memory configurations could perform the FEC coding schemes discussed throughout Li. The processor (602) may alternatively be “implemented as a dedicated processor or application-specific integrated circuit.” *Id.*, [0040]. The processor could alternatively be “implemented as a more general device that executes a computer program, microcode, or other software.” *Id.*

172. Li's detailed description begins with a general discussion of a Reed-Solomon code word, with reference to FIG. 1, reproduced below.



*Id.*, Figure 1.

173. The code word has a length  $n$  (in number of symbols), that consists of  $r$  redundant symbols (also referred to as error correcting symbols) and  $n-r$  information symbols (also referred to as payload symbols, which the '669 patent, Cooper, and Klayman refer to using the variable “k”). *Id.*, [0017]. Each symbol is 8 bits (or the equivalent of one byte). *Id.* Consistent with common knowledge as reflected in the references discussed above, Li explains that an “RS decoder can correct up to  $t$  symbols that contain errors in a code word, where  $2t=r$ .” *Id.*

174. Li describes a process for selecting Reed-Solomon code parameters that will satisfy a minimum gross coding gain,  $G$ , based on an established relationship between the gain  $G$ , the code word length  $n$ , and the redundant length  $r$ . Li explains that multiple  $n$  and  $r$  combinations can satisfy the minimum coding gain  $G$ , requirement and so “[f]or each code pair RS ( $n$ ,  $r$ ) providing a gross coding gain not

less than  $G$ , a number of information bytes per symbol  $B_{\text{inf}}(G)$  is calculated as  $B_{\text{inf}}(G) = B - r/S$  (where  $B$  is a total number of bytes that can be transmitted over one Discrete Multi-Tone (DMT) symbol, and  $S$  is the total number of symbols). *Id.*, [0027]. The “code pair RS ( $n$ ,  $r$ ) having the largest number of information bytes per symbol  $B_{\text{inf}}(G)$  available is selected as the best code pair  $B_{\text{inf—max—local}}(G)$ .” *Id.*

175. Li explains that where “other (external) factors such as a delay or impulse noise protection<sup>4</sup> requirements are considered, the selection of  $S$  and  $r$  is limited by those factors.” *Id.*, [0028]. Because  $S$  and  $r$  are used for calculating  $B_{\text{inf}}(G)$  for each code pair RS ( $n$ ,  $r$ ) (more specifically,  $r$  is directly indicated as a part of the code pair RS ( $n$ ,  $r$ )), impulse noise protection requirements can be used for selecting which code pair RS ( $n$ ,  $r$ ) is the “best” code pair with the largest number of information bytes per symbol  $B_{\text{inf—max—local}}(G)$ . The impulse noise protection requirements are used for “protection against an error burst” and are used with an interleaver having an interleaver depth  $D$ . Li explains “if protection against an error burst longer than  $P$  bytes is desired, the constraint to be used is  $r \cdot D/2 > P$ .” *Id.* Continuing with this example, Li explains:

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<sup>4</sup> Recall that ‘impulse noise protection’ is referred to as INP in DSL standards, the ‘669 patent, and elsewhere in this Declaration.

If a maximum latency of the system is to be less than  $L_{\max}$  ms, then the constraint to be used is

$$x + \frac{(S - 1)}{4} + \frac{S \cdot D}{4} < L_{\max}$$

where  $x$  is a constant system delay in milliseconds. Modifications of this nature in the selection of  $S$  and  $r$  are known, and their use in the present invention will be apparent to a person skilled in the art.

*Id.*

176. As the foregoing paragraph explains, the use of impulse noise protection (INP) to adjust  $S$  and  $r$ , and consequently to adjust the selection of a code pair  $RS(n, r)$ , has been known to those of skill in the art.

177. Li explains that the process for selecting code pairs based on  $B_{\text{inf-max-local}}(G)$  is repeated for different values of  $G$  between  $G_{\min}$  and  $G_{\max}$  to determine the code pair having the largest number of information bytes per symbol on  $B_{\text{inf-max}}$  (by comparing the  $B_{\text{inf-max-local}}(G)$  values calculated for each value of  $G$ ). The code pair  $RS(n, r)$  corresponding to the  $B_{\text{inf-max}}$  value is used if the  $B_{\text{inf-max}}$  value is greater than  $B_0$  – the maximum number of bytes per symbol if the  $RS$  code has not been used. The overall process is illustrated in FIG. 2, reproduced below.

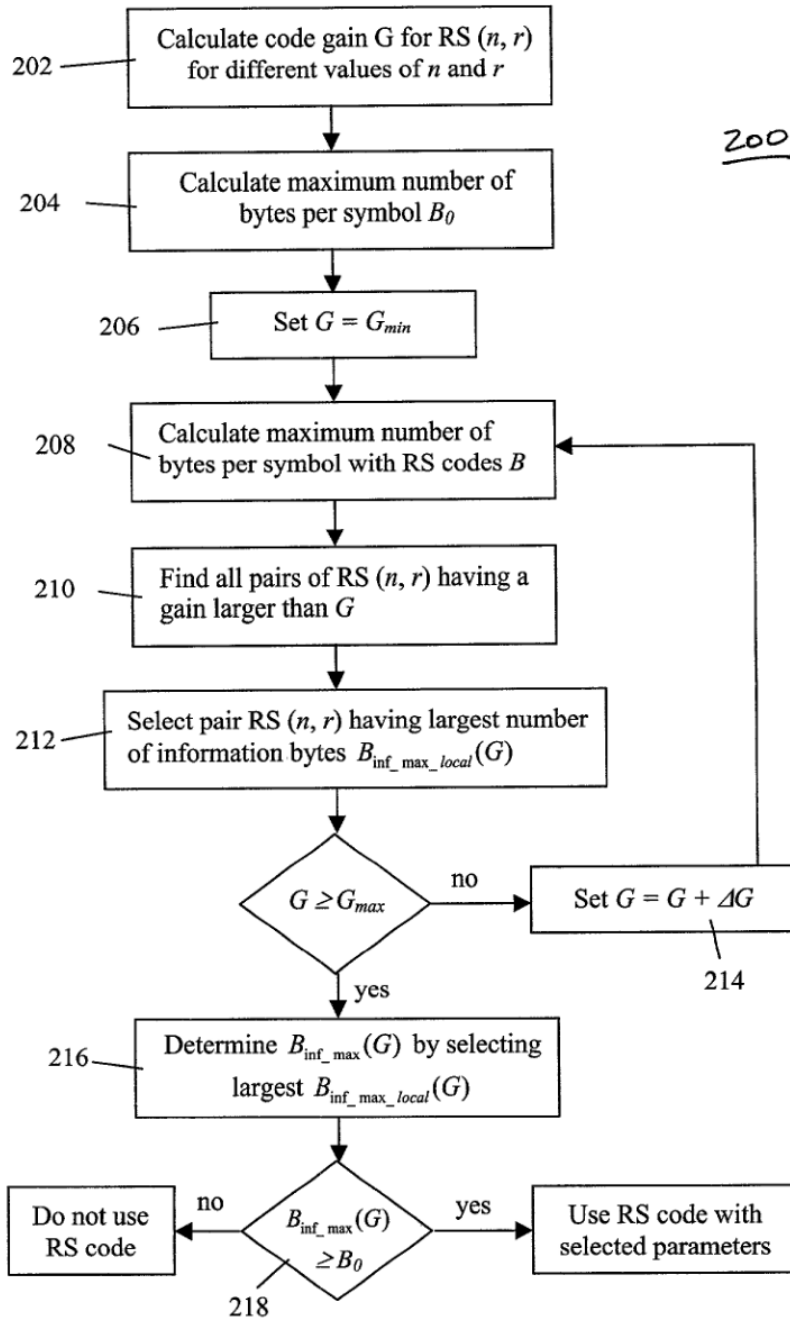


Figure 2

*Id.*, Figure 2.

## X. OPINIONS

178. It is my opinion that Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 are rendered obvious by Cooper and Li or are rendered obvious by Klayman and Li. As

I discuss below, both Cooper and Klayman disclose nearly every limitation in the challenged claims, and a POSITA would understand that Li's discussion of a DSL system provides explicit disclosure of the limitations that are not explicitly disclosed in either Cooper or Klayman.

**A. Ground 1: Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 are rendered obvious by Cooper and Li**

179. Cooper or Cooper in view of Li teaches all of the limitations of Claims 1-4, 11, 14-17, 19-20, 23, and 26-29.

**1. Motivation to Combine Cooper and Li**

180. A POSITA would have been motivated to modify Cooper with the teachings of Li to perform dynamic FEC coding in real-time using a DSL modem that complies with ADSL standards, including the G.992.1 and G.992.2 standards disclosed in Li and the G.992.3/4/5 standards discussed in background in the '669 patent.

181. Cooper and Li are analogous art, at least because both references discuss FEC coding for error correction in data transmission systems, including for data transmitted over twisted pair wires. *See e.g.*, Ex. 1006, *Abstract*, 4:3-15; Ex. 1008, [0001]-[0006], [0017].

182. Cooper states that the described dynamic FEC coding scheme is usable with a communication system using a "twisted pair copper wire" communication medium (Ex. 1006, 4:11-15), which a POSITA would recognize refers to a DSL

communication medium. *See* Ex. 1008, [0002] (“DSL uses an infrastructure that already exists; namely, copper twisted pair lines typically used for telephone communication.”). A POSITA would have understood that use of a twisted pair copper wire communication medium used for high-speed data throughput would refer to a DSL system that would require DSL modems at the primary and secondary stations. Moreover, a POSITA would have recognized benefits of using DSL modems that are compliant with current ADSL standards, such as those disclosed in Li. Using a DSL modem (as discussed in Li) at both the primary station and secondary station(s) would enable Cooper’s system to use the twisted pair copper wire communication medium for DSL data transmission in a point-to-point network architecture<sup>5</sup> to encode and decode communications to be passed along the twisted pair copper wire using a Discrete Multi-Tone (DMT) scheme as is well-known for DSL communications and as discussed in Li. Ex. 1008, [0001]-[0003]. Specifically, a POSITA would have recognized the benefits of using DSL modems that are

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<sup>5</sup> While Figure 1 illustrates a point-to multipoint architecture, Cooper teaches that the patent also applies to the point-to-point DSL architecture. “Dependent upon the specific application of the present invention, the primary station **101** can be a simple transmitter for point-to-point or point-to-multipoint communications with one or more of the secondary stations **110, 112, 114, and 116.**” Ex. 1001, 4:48-51.

compliant with current ADSL standards, including the G.992.1 and G.992.2 standards discussed in Li and the more recent G.992.3/4/5 standards discussed in background of the '669 Patent to ensure the modems are compatible with existing modems within a DSL network to enable effective communication across the twisted wire pairs. *Id.*, [0025], Ex. 1001, 2:39-56; *see also* Ex. 1011, 1012, 1013, 1014, 1015. Those standards include consideration of external factors “such as a delay or impulse noise protection requirements” when determining Reed-Solomon coding scheme pairs. *See* Ex. 1013, 32. At the time of filing of the '669 Patent, applicable standards included G.992.3/4/5 and G.997.1. Ex. 1001, 3:29-60; *see also* Ex. 1013, 1014, 1015, 1016. Indeed, the '669 Patent explains in background “ADSL standards prescribe some latencies....In ADSL2 and ADSL2+ (G.992.5), the available latencies are set by the operator between 2 ms and 20 ms using the element management system (a data acquisition system, described in detail in G.997.1, ***that allows a service provider to implement control parameters such as the INP value and maximum interleaving delay***), which conveys the preference to the line’s modems, including the downstream receiver (ATU-R).” *Id.* Although not explicitly discussed in Li, a POSITA would have been motivated to maintain compliance with the most up-to-date ADSL standards when developing a DSL system in compliance with Cooper and Li to maintain compatibility with commercially available DSL modems. The ADSL standards that were published at the time of the '669 Patent

filing date included at least G.992.1/2/3/4/5 and G.997.1. *See* Ex. 1011, 1012, 1013, 1014, 1015, 1016.

183. More generally, a POSITA would recognize benefits of using Cooper's dynamic FEC coding scheme with DSL modems that are compliant with ADSL standards so that the DSL modem located at the primary station can communicate with the DSL modem at the secondary station. *See* Ex. 1008, [0003] ("ADSL is the most widely implemented form of DSL technology"), [0025] (discussing G.992.1 and G.992.2 compliant modems). Both modems must have an understanding of the communication scheme used (and the FEC coding scheme used), and so ensuring that those modems are compliant with ADSL standards—including the use of parameters defined by those standards for setting an FEC coding scheme (e.g., setting INP or maximum interleaving delay), would ensure that modems at each location in the communication system can communicate with one another. Ex. 1006, 7:58-62 (discussing that both the transmitter and receiver must operate with the same FEC communication parameters to enable successful communication).

184. Moreover, Cooper and Li discuss methods for determining FEC coding parameters that can be used for transmitting code words across the twisted pair copper wires. Cooper focuses on dynamic determinations of FEC coding parameters using a controller that may be located at a primary station or elsewhere. Ex. 1006, 9:31-46, 11:31-35. Li discusses determinations of FEC coding parameters for

implementation on a DSL system (Ex. 1008, [0020]-[0028]) would have led a POSITA to extend Cooper's dynamic FEC coding scheme to DSL communication system as disclosed in Li. Moreover, a POSITA would have recognized that the location of a controller for determining FEC coding parameters (e.g., the controller discussed in Cooper) could be located inside or outside of a central office, so long as the controller can communicate determined FEC coding parameters to the transmitter and receiver. *See* Ex. 1028, 1029.

185. A POSITA would have had a reasonable expectation of success in combining Cooper and Li because Cooper already discusses that the described dynamic FEC coding scheme can be used with twisted pair copper wires that are used for DSL communications. Ex. 1006, 4:3-26; Ex. 1008, [0002]-[0006]. A POSITA would have recognized that DSL modems such as those described in Li would have been integrated into Cooper's communication system to enable use of the twisted pair copper wires that Cooper discusses as an eligible communication medium. Moreover, a POSITA would have understood that FEC coding parameters (and other communication parameters) can be determined by a controller based on characteristics of a DSL communication line (*see e.g.*, Ex. 1028, 1029), and therefore a POSITA would have recognized that the FEC coding parameters determined in accordance with Cooper could be distributed to both a transmitting DSL modem and

a receiving DSL modem for use of the determined FEC coding parameters during a DSL data transmission, as discussed in Li.

## 2. Independent Claim 14<sup>6</sup>

186. Even a cursory comparison between Cooper's abstract and the language of claim 14 of the '669 patent demonstrates the lack of inventiveness of the '669 patent. I have color-coded the side-by-side comparison below to show how each limitation in claim 14 of the '669 patent is mention in Cooper's abstract.

| Claim 14, '669 Patent                                                                                                                                                                                           | Cooper Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14. 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, the method comprising: | An adaptive and dynamic forward error correction scheme for a communication channel is disclosed. The method and apparatus calculates the actual bit error rate for comparison with a target bit error rate. When a channel is performing better than required by the performance specifications, the forward error correction power can be reduced to provide greater throughput. If the calculated actual bit error rate is greater than the target bit error rate, then the forward error correction power is increased in an attempt to lower the calculated bit error rate. A feedback loop is employed to continually calculate revised bit error rates as the forward error correction power is increased or decreased. |
| (a) selecting a Codeword Composition Ratio (CCR) representing a relation between payload and parity bytes in an FEC coding scheme;                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| (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;                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| (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.                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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<sup>6</sup> I discuss claims 14-17, 19020, 23, and 26-29 before claims 1-4 and 11 because the disclosures addressed with respect to claims 14-17, 19-20, 23, and 26-29 fully captures the scope of claims 1-4, and 11.

***a. Element 14[pre]: 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, the method comprising:***

187. Cooper or Cooper in view of Li teaches the preamble of Claim 1, to the extent it is determined to be limiting. Cooper discloses a method of adjusting FEC coding using an “adaptive and dynamic forward error correction scheme” that “can adaptively respond to changing noise-related conditions in the communications channel *by adapting the forward error correcting power* due to those changing conditions” on a communications medium between a primary transceiver and a secondary station—either of which may operate as a transmitter or receiver. Ex. 1006, Abstract, 3:63-67, 4:3-47. Those adjustments enable the FEC power to be reduced when a channel is performing better than required and enable the FEC power to be increased when a calculated actual bit error rate is greater than a target bit error rate. *Id.*

188. Cooper’s adaptive FEC is applied to communications over a communications medium between a primary transceiver and a secondary station. *Id.*, 4:3-26. The communications medium connecting the primary station and the secondary station can be “twisted pair copper wires” (*Id.*, 4:3-16), which a POSITA would have recognized as being utilized for DSL data transmissions between modems at the transmitter and receiver. For upstream communications, the

secondary station functions as a transmitter and the primary transceiver functions as a receiver. For downstream communications, the primary transceiver functions as a transmitter and the secondary station functions as a receiver. *Id.*, 4:27-47. The communications medium connecting the primary station and the secondary station can be “twisted pair copper wires” (*Id.*, 4:3-16), which a POSITA would recognize as being the communications medium utilized for DSL data transmissions that utilize DSL modems at the transmitter and receiver to enable encoding and decoding of data transmitted across a DSL system’s communication medium (e.g., twisted pair copper wires).

189. Cooper focuses on the FEC coding scheme and a POSITA would understand that DSL modems are a necessity when implementing this coding scheme for DSL communications over “twisted pair copper wires.” Nevertheless, in the event that Cooper is found not to teach DSL modems, Li discloses a DSL modem capable of implementing dynamically-determined FEC coding parameters for optimizing data transmission in a specific environment . Ex. 1008, [0003]-[0004]. And Li describes that the DSL modems are capable of implementing FEC coding parameters that are determined “dynamically” for optimizing data transmission in a specific environment. *Id.*, [0008]. Therefore, Li’s DSL modems are capable of implementing FEC coding that has been adjusted in accordance with Cooper’s disclosure. Because Cooper discloses that the adaptive and dynamic FEC scheme

can be implemented for a “twisted pair copper wire” communication medium, a POSITA would recognize that a DSL modem (such as the DSL modems disclosed in Li) would be usable to implement Cooper’s dynamic FEC coding scheme in a DSL communication system.

***b. Element 14[a]: (a) selecting a Codeword Composition Ratio (CCR) representing a relation between payload and parity bytes in an FEC coding scheme;***

190. Cooper teaches Element 14[a].

191. As referenced in the Abstract of Cooper (and the above highlighted claim comparison), “the number of data errors that can be corrected” is “referred to as the forward error correcting power.” Ex. 1006, 2:41-45. The crux of Cooper’s invention is dynamically “adapting [this] forward error correcting power” (*Id.*, 3:63-67) to balance the amount of overhead incurred by the system relative to the selected forward error correcting power.” *Id.*, 2:45-47.

192. The ’669 patent defines a CCR as any quantity or value that “represents the relation between the payload and parity bytes in the applicable FEC coding scheme” – specifically a “Reed-Solomon” FEC technique which is “made up of K data or information bytes (the user’s payload data) and R parity bytes, totaling N bytes in each codeword (that is,  $K+R=N$ ).” Ex. 1001, 2:6-19. Specifically, the ’669 Patent defines an example CCR as:

$$\text{CCR} = \frac{\text{Payload data bytes}}{\text{Total data bytes}} \text{ OR } (\text{Payload bytes}) : (\text{Total bytes})$$

Ex. 1001, 9:8-28.

193. The “Payload data bytes” is equivalent to the variable K: “Number of payload data bytes in each mux data frame” and the “total data bytes” is equivalent to the variable N “total number of bytes (combined payload data and parity/redundancy) per codeword.” *Id.*, 6:36-50. The above CCR formula yields a value reflecting what percentage of a total codeword length are characterized by payload bytes. The remainder of the total codeword length is the number of parity bytes.

194. Cooper discusses adjusting the percentage of a codeword that is attributed to payload versus parity bytes. Specifically, Cooper teaches selecting a CCR representing a relation between payload and error correcting bytes in a Reed-Solomon encoding scheme (i.e., an FEC coding scheme) by selecting a “parameter pair (n, k).” Ex. 1006, 6:17-20. Cooper defines the relation between the payload (k) and error correcting (n-k) bytes in terms of “overhead”—a ratio of “n-k” bytes (error correcting bytes) to n bytes (total bytes) and teaches to optimize the overhead because “[m]ore error correcting capability lowers throughput” while too little overhead results in significant errors that require retransmission. *Id.*, 6:67-7:3; 10:30-37. Adjusting either “n” or “k” to adjust the “overhead” ((n-k)/n) of Cooper

necessarily would adjust the example CCR defined in the '669 patent as “k/n,” as both ratios include the same variables and because the codeword only includes two components: payload bytes and parity bytes. Adjusting the percentage of the codeword attributed to the payload bytes will necessarily adjust the percentage of the codeword attributed to the parity bytes.

***c. Element 14[b]: (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;<sup>7</sup>***

195. Cooper or Cooper in view of Li teaches Element 14[b].

196. Cooper teaches an algorithm that “provides a technique for changing the forward error correction parameters in a communications channel between two or more data communications stations.” *Id.*, 7:28-35. Those parameters identify the CCR (made up of the parameter pair (n, k)) for the FEC coding scheme used for transmitting data on a communication channel. A POSITA would understand that specifying the parameter pair serves to identify Reed-Solomon FEC coding scheme. *See id.*, 6:16-39; 7:42-62. Cooper explains that the receiver (specifically, a

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<sup>7</sup> I assume for the sake of clarity that this claim limitation is missing a comma: “. . . via the channel[, ] the control signal specifying. . . .” However, this does not change my analysis as discussed herein.

microcontroller in the receiver) implements the illustrated method of FIG. 2 for “dynamically establishing the forward error correction parameters” – i.e., the Reed-Solomon parameters and communicates the FEC coding scheme and parameters “to the transmitter so that both units [the receiver and the transmitter] are operating with the same forward error correction parameters.” *Id.*, 7:58-61; 11:31-46. Because both the transmitter and receiver must know the FEC coding scheme and the applicable parameters for use, once a device determines the FEC coding parameters to be utilized for transmitting data, both the receiver and transmitter must be informed about what FEC coding scheme and parameters are to be used. *Id.*, 1:35-39, 4:64-66. Cooper explains that a transmitter “operates” with the FEC scheme and parameters in the transmitted signal by encoding transmitted data using the FEC coding parameters. A POSTIA would understand that the receiver then uses information identifying the FEC coding scheme and parameters to decode the transmitted data, at least in part by identifying what portion of each received code word is payload data bytes, and what portion is parity (error correcting) data bytes.

197. A signal used to communicate Cooper’s FEC parameters is a “control signal specifying the CCR and the FEC coding scheme” as used in claim 14 of the ’669 Patent. As discussed in the ’669 Patent, the control signal is used by the FEC coder of the transmitter to “adjust[] the CCR in response to the CCR adjustment control signal.” Ex. 1001, 14:58-59. Cooper provides an identical signal that

provides the same functionality to the transmitter. A POSITA would understand that this is identical to Cooper's description of a transmitter "operating" with the FEC parameters that are transmitted to it by using those parameters with the applicable FEC coding scheme to transmit data according to the FEC coding scheme and parameters.

198. Cooper does not explicitly state that a "DSL modem" transmits data, but Cooper discloses "high-speed data application[s]" and that the communications medium may be a "twisted pair copper wire." *Id.*, 4:11-15, 10:1-15. A POSITA would have known that data communications over "twisted pair copper wire," particularly for a "high-speed data application," require DSL modems to enable communication. *Id.*, 4:11-15. Therefore, a POSITA would understand that Cooper alone teaches "transmitting data from a DSL modem via the channel" as recited in 14[b].

199. Even if Cooper is found not to teach a DSL modem, Li explicitly discloses that a DSL modem transmits data according to the FEC coding parameters over twisted pair wire. Ex. 1008, [0039] ("The ADSL modem 600 includes a processor 602 and a memory 604. The memory 604 stores various data such as the parameters G, B, n and r, and the data to be transmitted....The processor 602 may also code the data to be transmitted according to the resulting preferred set of parameters and may generate code words 100 corresponding thereto."). Therefore, a POSITA would recognize that when implementing Cooper's dynamic FEC coding

scheme in a DSL communication system, the receiver and transmitter would encompass DSL modems and the FEC coding scheme parameters are communicated to a DSL modem that operates as a transmitter for transmitting data via the communication channel (e.g., twisted pair copper wire) according to the specified FEC coding scheme parameters.

***d. Element 14[c]: (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;***

200. Cooper teaches Element 14[c].

201. Cooper describes a process for “dynamically establishing the forward error correction parameters, in particular, the code word length (in bytes) and the check byte length (also in bytes)” as illustrated in Cooper’s FIG. 2. Ex. 1006, 11:31-35. As illustrated below, this process includes determining a calculated bit error rate<sup>8</sup> at step 206 based on the number of uncorrected errors in a received transmission. *Id.*, 11:66-67.

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<sup>8</sup> As recited in dependent claim 26, the ’669 Patent explicitly indicates that the MEV may be based on “a Bit Error Rate (BER),” and therefore Cooper’s disclosure of calculating a bit error rate explicitly maps to a claimed embodiment of acquiring an MEV. *See infra*, Section X.A.9.

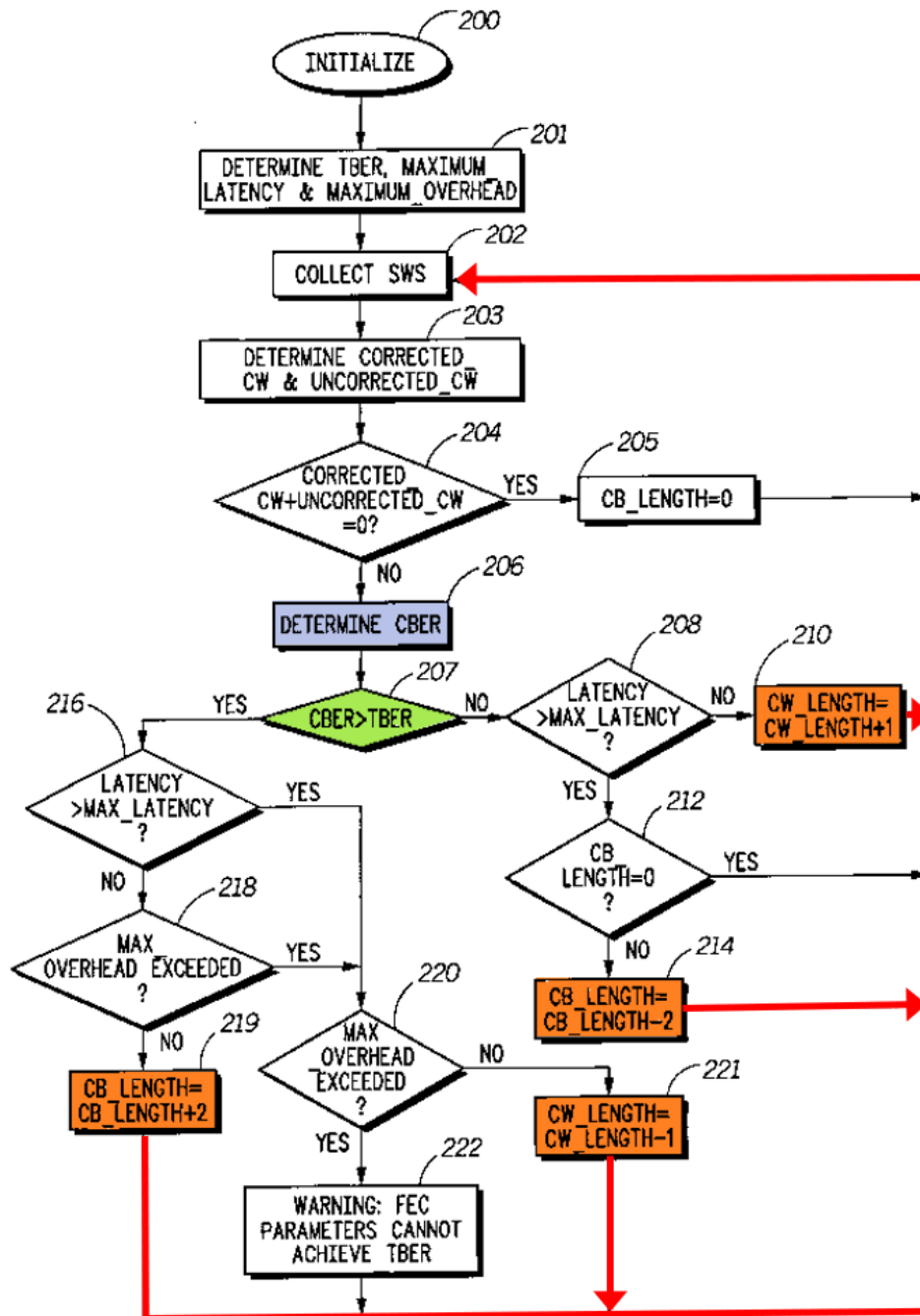


**FIG. 2**

*Id.*, Figure 2 (annotated).

202. Cooper explains that other calculated performance metrics representing the number of measured or calculated errors within a transmission may be used in

place of the calculated bit error rate, including “packet error rate, burst error rate, block error rate, or frame error rate.” *Id.*, 7:63-8:14; 13:65-14:6 (“In addition to using the calculated bit error rate as determined at the step 206 to determine whether to increase or decrease the forward error correcting power, in other embodiments a packet error rate or frame error rate can also be utilized.”). These “calculated or measured error parameter[s]” are measured during transmissions when several noise types—including impulse noise events (which could also be referred to as “burst” errors using Cooper’s terminology (*see e.g., id.*, 8:1-3)) that “disrupt the channel on a random and unpredictable basis” (*Id.*, 2:66-3:3; 5:52-65) would occur, after a DSL modem is trained and initialized to communicate with other DSL modems via the communication medium. *Id.* Accordingly, these calculated or measured error parameters would reflect the impact of impulse noise events, among other types of noise occurring during transmission. Moreover, Cooper’s FIG. 2 illustrates that the step for determining the calculated bit error rate (Step 206) occurs *after* an “initialize” step 200, *after* initial user-provided parameters are determined (step 201), and *after* data samples are collected during normal data transmission (step 202). *Id.*, 11:31-46.

203. Cooper also explains that determining a bit error rate *after* initialization and training is different from determining a bit error rate as a part of the initialization and training process; otherwise, “if the communications channel conditions were

known *a priori* and these conditions did not change during the communications interval, then the forward error correction parameters could simply be set to achieve the desired performance characteristics.” *Id.* By monitoring MEVs (specifically, bit error rates) after initialization and training of a modem, Cooper’s method enables dynamic adjustment of the FEC coding scheme to address errors (including burst errors, also known as impulse errors) occurring while the modem is transmitting data. Cooper points out that “[m]ost commercially available integrated circuits that are used to provide forward error correction through the use of well-known algorithms (such as Reed-Solomon) provide certain forward error correction statistics, such as the number of uncorrectable block errors received, number of received blocks which were corrected, and the total number of FEC blocks received.” *Id.*, 8:36-42. In short, Cooper explains that the process of Element 14[d] is a known feature of many commercially available integrated circuits for Reed-Solomon coding.

204. Cooper recognizes that communication systems “may be susceptible to interference from multiple noise sources” (*Id.*, 5:53-55), and so the measured error parameters can reflect noise levels that vary with time, including noise impulses that can “disrupt the channel on a random and unpredictable basis.” *Id.*, 2:66-3:3; 5:52-65. A POSTIA would understand that this matches the ’669 Patent’s characterization of impulse errors – which are described as “isolated” (Ex. 1001, 10:47-53) or “time-

varying intermittent noises” (Ex. 1001, 12:10-16). Therefore, Cooper’s discussion of monitoring a bit error rate (*see* Ex. 1006, 7:63-8:5) that represents burst errors satisfies Element 14[c]’s indication that MEVs represent impulse noise events detected on a channel after training and initialization of a modem.

205. As reflected in Cooper’s FIG. 2, shown above, the entire process is repeated over time, including step 206 for determining a calculated bit error rate (or other measured error parameter). *See* Ex. 1006, 12:25-30 (“[O]nce the forward error correcting power is changed ... processing always returns to the step 202 for the collection of additional samples, a recalculation of the calculated bit error rate, and comparison with the target bit error rate.”).

***e. Element 14[d]: (d) analyzing the acquired MEVs relative to a Target transmission Error Value (TEV); and***

206. Cooper teaches Element 14[d].

207. At step 207 of Cooper’s FIG. 2, “the calculated bit error rate is compared with the target bit error rate.” Ex. 1006, 12:10-30. Specifically, Cooper determines whether the calculated bit error rate is higher or lower than the target bit error rate, to determine whether to increase or decrease the forward error correcting power. *Id.*; *see also id.*, 13:65-14:6 (if a packet error rate or frame error rate are used in place of the bit error rate, then “decision step 207 would then involve comparing the target frame or packet error rates with the corresponding calculated value.”);

14:55-56 (limitation (c) of Cooper's claim 1 recites "comparing the monitored parameter with the threshold value.").

***f. Element 14[e]: (e) adjusting the CCR when the MEV differs sufficiently from the TEV.***

208. Cooper teaches Element 14[e].

209. Cooper describes "a technique for changing the forward error correction parameters in a communications channel between two or more data communications stations based on predetermined channel performance metrics including bit error rate, FEC corrected code words, FEC uncorrectable code words, latency, and percent utilization of the communication channel." Ex. 1006, 7:28-35. This is also illustrated in Blocks 210, 212, 214, 219, and 221 of FIG. 2, shown below. *Id.*, 12:31-13:64.

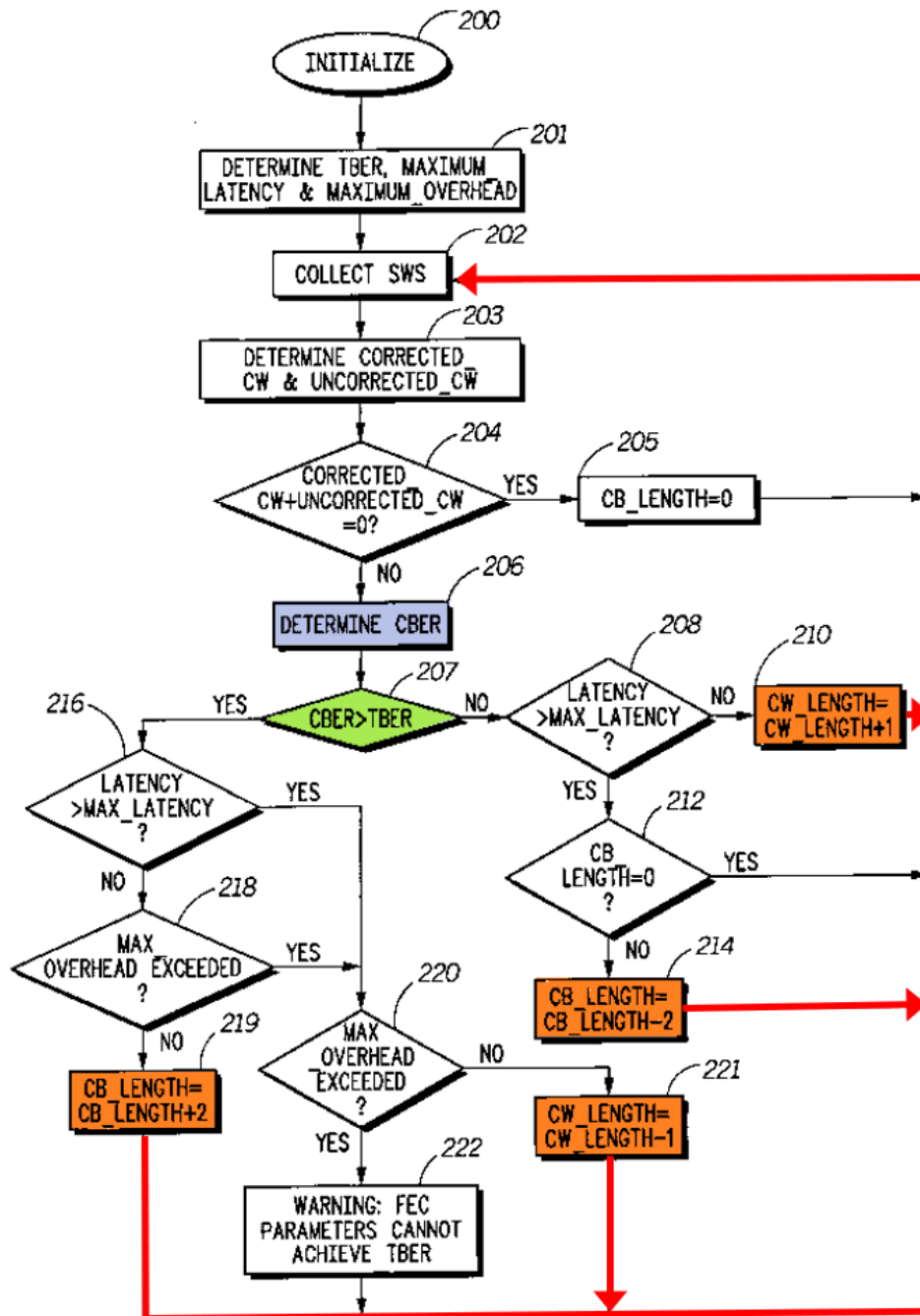


**FIG. 2**

*Id.*, Figure 2 (annotated).

210. As explained in Cooper, those “parameters” include “the code word length or the check byte length” (also referred to by their variables *n* and *k*). *Id.*,

6:16-39; 7:43-62. Specifically, if the calculated bit error rate is less than the target bit error rate, then the codeword length can be increased or the check byte length can be decreased (consequently increasing the payload data length). *Id.*, 12:31-13:5. If the calculated bit error rate is greater than the target bit error rate, then the check byte length can be increased (thereby decreasing the payload data length) or the codeword length can be decreased. *Id.*, 13:6-48.

211. As discussed above in reference to Element 14[a], those two components constitute the content of the CCR, as defined by the '669 Patent. *See* Ex. 1001, 9:8-28. Therefore, adjusting either or both of Cooper's code word length or check byte length will change the CCR—the ratio between the payload data bytes and the total number of bytes in a codeword.

**3. Dependent Claim 15: The method of claim 14 wherein repeatedly acquiring the MEVs comprises at least one of the following: directly measuring a characteristic of the DSL modem; collecting a value from an element management system; or computing the MEVs from collected data.**

212. Cooper or Cooper in view of Li teaches dependent claim 15.

213. As discussed in reference to Element 14[c], Cooper explains that most commercially available integrated circuits that are used to provide FEC can provide FEC statistics, including the number of uncorrectable block errors received and the number of received blocks that were corrected. Ex. 1006, 8:36-42. Cooper further explains that the receiver can perform the functions of FIG. 2 (including step 206 for

calculating or recalculating a bit error rate as a type of MEV), specifically using “a dedicated microprocessor or a microprocessor with multiple functions in the receiver where the FEC process is performed.” Ex. 1006 11:31-38; *see also id.*, 8:36-42 (explaining that commercially available integrated circuits can provide FEC statistics, including the number of uncorrectable block errors received and the number of received blocks that were corrected). The receiver is also configured to “process the bit stream from the demodulator according to the FEC algorithm and correct the erred bytes as necessary.” *Id.*, 9:35-52. Accordingly, Cooper’s receiver thereby directly measures a bit error rate, such as using an integrated circuit (or microcontroller) that also corrects errored bytes as necessary. The receiver also dynamically establishes FEC parameters according to the functions of FIG. 2, and accordingly the receiver directly measures the MEV (specifically, the bit error rate).

214. As discussed in reference to claim 14, a POSITA would have recognized that Cooper’s receiver would be embodied as a DSL modem (Ex. 1006, 4:3-15) or, in the alternative a POSITA would have utilized a DSL modem as discussed in Li, as the receiver of Cooper’s communication system. Ex. 1008, [0002]-[0004]. I have discussed a motivation to combine Cooper and Li in Section X.A.1, above.

**4. Dependent Claim 16: The method of claim 14 wherein steps (b) through (e) are repeated.**

215. Cooper teaches dependent claim 16. As discussed in reference to Element 14[c], Cooper describes that the process “for dynamically establishing the forward error correction parameters” as shown in FIG. 2 is repeated. *Id.*, 11:30-35; 12:25-30 (“[O]nce the forward error correcting power is changed, as will be discussed further in conjunction with the remaining steps of FIG. 2, processing always returns to the step 202 for the collection of additional samples, a recalculation of the calculated bit error rate, and comparison with the target bit error rate.”). The repeated steps include communicating a change in the codeword length and/or check byte length (and consequently the payload byte length) to the transmitter as discussed in reference to Element 14[b] (*supra*, Section X.A.2.b; *Ex. 1006*, 6:6-16; 7:58-61); repeatedly calculating the bit error rate (as shown in step 206 of Cooper’s FIG. 2), as discussed in reference to Element 14[c] (*supra*, Section X.A.2.d; *Ex. 1006*, 11:31-35); comparing the calculated bit error rate against a target bit error rate as shown in Step 207 of Cooper’s FIG. 2, as discussed in reference to Element 14[d] (*supra*, Section X.A.2.e; *Ex. 1006*, 12:10-30); and adjusting the forward error correction parameters that constitute a CCR as discussed in reference to Element 14[e] (*supra*, Section X.A.2.f; *Ex. 1006*, 12:31-13:64).

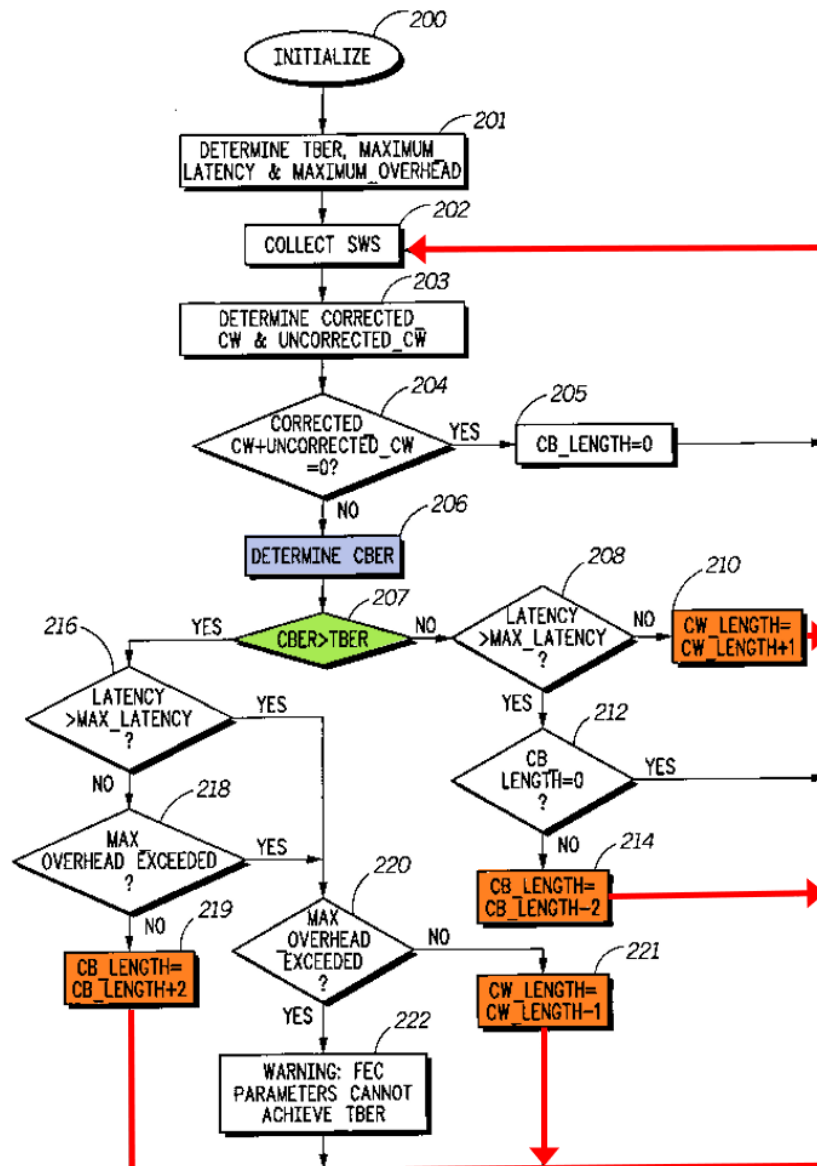


**FIG. 2**

*Id.*, Figure 2 (annotated).

**5. Dependent Claim 17: The method of claim 14 wherein the method is performed by a controller.**

216. Cooper teaches dependent claim 17.

217. As discussed in reference to Element 14[b], Cooper explains that the receiver, specifically a microcontroller of the receiver, performs the process of

Cooper's FIG. 2 (*Id.*, 9:31-46), and further communicates changes in FEC parameters to the transmitter (*Id.*, 7:58-62). The receiver thereby operates as a controller. Cooper also explains that other equipment may operate as a controller, such as "controlling, receiving and transmitting equipment" that may reside at a central location (referred to as a "head end") for some communications network. *Id.*, 1:35-39. For example, "processors control the various functions associated with the primary station 101." *Id.*, 4:64-66.

218. Alternatively, a POSITA would have found it obvious to perform the method using a controller based on the disclosure of Cooper. Again, Cooper indicates that controlling equipment may be present at a central location, and so a POSITA would recognize that steps for controlling the operation of the communications system (including the transmitter and receiver) could be beneficially performed by this controlling equipment. A POSITA would have been motivated to use a controller (such as the controlling equipment in Cooper) to perform the claimed method because a standalone controller may include more memory and/or processing power than a DSL modem, and the additional memory and/or processing power would enable the controller to more quickly calculate FEC coding changes. *See* Ex. 1028, Ex. 1029. Because Cooper's method addresses changes in noise levels detected on the communications channel in real-time or near real-time, the additional processing speed that would be provided by a standalone controller (which could be located at

a CO or elsewhere) would enable faster changes in FEC coding parameters, thereby improving the real-time performance of the dynamic FEC coding algorithm disclosed in Cooper. *Id.* The Applicant of the '669 Patent identified similar benefits to using a controller in the office action response dated March 21, 2008, stating “[u]nlike Locke’s AGWN, or stationary noise, ‘impulse noise events’ occur as random and unpredictable events on the channel, and therefore are detected over a period of hours, days, or weeks, *making collecting and storing such information impracticable for Locke’s modems.*” Ex. 1004, 187 (*emphasis added*).

219. Moreover, a POSITA would have had a reasonable expectation of success in using a controller to perform the recited method, as a controller including processors and memory are capable of controlling various functions of devices, including the devices of a primary station as disclosed in Cooper. Ex. 1006, 4:55-66. To control devices, those processors execute algorithms such as FEC coding algorithms as disclosed in Cooper.

**6. Dependent Claim 19: The method of claim 17 wherein the controller is in a Central Office (CO).**

220. Cooper teaches dependent claim 19.

221. As discussed in reference to claim 17, Cooper explains that the receiver performs the process of Cooper’s FIG. 2 (*Id.*, 9:31-46), and further communicates changes in FEC parameters to the transmitter (*Id.*, 7:58-62). The receiver thereby operates as a controller. Cooper also explains that other equipment may operate as a

controller, such as “controlling, receiving and transmitting equipment” that may reside at a central location (referred to as a “head end”) for some communications network. *Id.*, 1:35-39. For example, “processors control the various functions associated with the primary station 101.” *Id.*, 4:64-66. Although Cooper does not explicitly state that the controlling equipment at a central location performs the method steps, a POSITA would have been motivated to use a controller located at a central location to perform the described functions. *See supra*, Section X.A.1.

222. A POSITA would understand that Cooper’s “primary station 101” is a Central Office as the term is used in the ’669 Patent. Specifically, the ’669 Patent explains that a DSL central office can house the transmitters and a controller. Ex. 1001, 6:23-27; *see also* Ex. 1001, FIG. 7 (showing a controller as optionally located in the same location as a transmitter); Ex. 1011, 10 (describing a transceiver at a Central Office in the 992.1 standards).

223. While Cooper’s reference to controlling equipment located at a central location is discussed in reference to “coaxial cables [that] are further connected to fiber optical cables terminating at a central location,” Cooper explains that the described methodology can be performed on alternative communication mediums, including “twisted pair copper wires” that are commonly used to connect equipment at a Central Office to secondary locations, including households on a DSL system. *See* Ex. 1006, 1:27-46; 4:3-26. As discussed in reference to claim 14, Li confirms

that DSL uses twisted pairs of copper wire. *See* Ex. 1008, [0002] (“DSL uses an infrastructure that already exists; namely, copper twisted pair lines typically used for telephone communication.”).

**7. Dependent Claim 20: The method of claim 17 wherein the controller is outside a Central Office (CO).**

224. Cooper teaches dependent claim 20. As discussed in reference to Element 14[b], Cooper explains that a receiver can include a microcontroller that performs the described method. *See supra*, Section X.A.2.c; Ex. 1006, 11:31-46. The receiver (and included microcontroller) may be located at a secondary station (e.g., in a household), and away from the primary station that is equivalent to a Central Office. Ex. 1006, 4:3-26.

225. As further discussed in reference to dependent claim 17, a POSITA would have alternatively been motivated to utilize a separate controller for performing the method disclosed in Cooper. *See supra*, Section X.A.5. A POSITA would have been motivated to locate this controller “outside of a Central Office (CO),” such as at another internet connected location, to provide control operations to multiple transmitters (or multiple central offices containing one or more transmitters) and one or more receivers. *See* Ex. 1028, 1029. As discussed in reference to dependent claim 17, a standalone controller would provide additional processing power and memory over controllers integrated into a modem to enable

real-time determination of FEC parameters, and locating the controller outside of a central office would enable the controller to be used. *Id.*

226. A POSITA would have had a reasonable expectation of success in locating the controller outside of a central office. For example, a POSITA would recognize that internet-connected processors and memories execute algorithms for controlling DSL modems (e.g., the algorithms of Cooper), and those controllers may be located at a primary station, central office, or elsewhere. *See* Ex. 1028, 117 (Figure 2 shows an “Advanced DSL manager” that communicates with Automated test equipment in a CO, with DSL modems, with a DSL database, and a network operations center); Ex. 1029, 103 (Figure 1 shows a spectrum management center (SMC) located outside of a central office).

**8. Dependent Claim 23: The method of claim 14 wherein the CCR is  $K/N$ , wherein  $K$ =a total number of payload bytes in the codeword and  $N$ =a total number of bytes in the codeword.**

227. Cooper teaches dependent claim 23. As discussed in element 14[a], Cooper teaches that the method includes selecting a “parameter pair  $(n, k)$ , where ‘ $n$ ’ is the code word size and ‘ $k$ ’ is the block size (i.e., the number of information bytes).” Ex. 1006, 6:17-20. As explained in Cooper, an “ $n$ -byte codeword therefore consists of  $k$  information bytes plus  $(n-k)$  error correcting code bytes.” *Id.*, 6:26-28. Comparing these two parameters (such as by calculating a ratio between  $n$  and  $k$  as recited in claim 23 of the ’669 patent) is a description of how much of a codeword

consists of payload bytes—the remainder being parity bytes. Moreover, a POSITA would recognize that providing a “CCR” would entail providing values for K and N to allow the transmitter and receiver to know what codeword length should be used and what payload length should be used. Providing a single value representing a “CCR” would not provide a transmitter or receiver with sufficient information to encode data into codewords according to the FEC scheme. As an explanatory example, a CCR value of 0.5 does not indicate a size of the codeword – a codeword could be any length and still satisfy the 0.5 CCR value, so long as half of its length was reserved for payload data. Therefore, a POSITA would recognize that a “CCR” as recited in claim 23 would encompass providing values of both K and N, which would be included in a transmitted “control signal,” as recited in Element 14[b]. Therefore, Cooper’s selection of a “parameter pair (n, k), where ‘n’ is the code word size and ‘k’ is the block size” and Cooper’s discussion of comparing the parameters n and k by calculating an “overhead” teaches dependent claim 23.

228. Cooper likewise describes a relationship for balancing the amount of payload bytes (and error correcting bytes) against the total codeword length. *Id.*, 10:19-40 (Equation 2 shows a ratio between n-k and n as “Overhead= $f_o = CB\_LENGTH / CW\_LENGTH$ ”). Cooper’s “overhead” formula, like the K/N ratio recited in claim 23 as a CCR, describe a relationship between the number of payload bytes in a code word versus the total code word length. Although

the terminology is different between claim 23 and Cooper, the effect of describing the percentage of a code word that constitutes payload data is the same. And a POSITA would recognize that providing a value of “k/n” (instead of a value of “(n-k)/n”) would be an obvious modification of “overhead” as discussed in Cooper.

**9. Dependent Claim 26: The method of claim 14 wherein the MEV is based on at least one of the following: a Bit Error Rate (BER); errored seconds; errored minutes; code violations over a fixed period of time; a Signal-to-Noise Ratio (SNR) measured at the receiver; or Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.**

229. Cooper teaches dependent claim 26. As discussed in reference to Element 14[c], Cooper teaches determining a calculated bit error rate as a measured error parameter in step 206 of FIG. 2. *Id.*, 11:66-67.

**10. Dependent Claim 27: The method of claim 14 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented in computer readable program code.**

230. Cooper teaches dependent claim 27. As discussed above with respect to claim 14, Cooper teaches each of (a) repeatedly acquiring the MEVs, (b) analyzing the repeated MEVs relative to the TEV, and (c) adjusting the CCR. *See supra*, Section X.A.2. Cooper also discloses that each of these steps can be implemented in “[a] computer program product comprising a computer-usable medium having a computer-readable code therein for providing adaptive forward error correction.” Ex. 1006, 17:17-18:37 (Claim 18, steps (a), (c), and (e)-(l)).

**11. Dependent Claim 28: The method of claim 14 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented in hardware.**

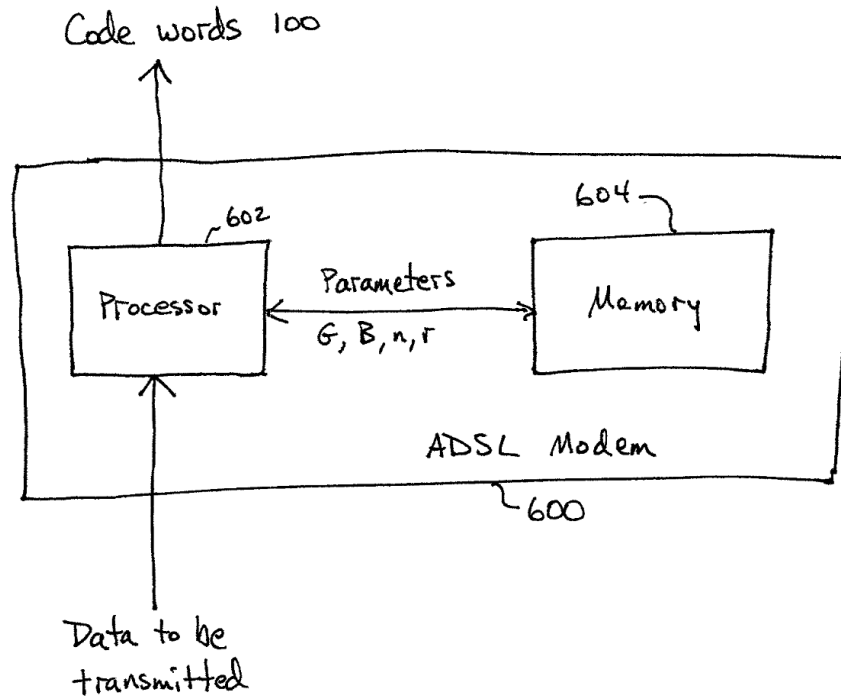
231. Cooper teaches dependent claim 28. As discussed above with respect to claim 14, Cooper teaches each of (a) repeatedly acquiring the MEVs, (b) analyzing the repeated MEVs relative to the TEV, and (c) adjusting the CCR. *See supra*, Section X.A.2. Moreover, Cooper states that these steps (which are reflected as a part of the method illustrated in FIG. 2) can be implemented in hardware, specifically “by a dedicated microprocessor or a microprocessor with multiple functions in the receiver where the FEC process is performed.” Ex. 1006, 11:31-46.

**12. Dependent Claim 29: The method of claim 14 wherein the DSL modem is an Asymmetric Digital Subscriber Line (ADSL) system operable in compatibility with an ADSL2 standard and farther wherein adjusting the CCR comprises adjusting at least one of the following: Impulse Noise Protection (INP); or maximum interleaving delay.**

232. Cooper in view of Li teaches dependent claim 29. As discussed above, Cooper teaches that the described dynamic FEC coding scheme can be implemented on a communication system using “twisted pair copper wires” as the communication medium, which is commonly known as the communication medium used with DSL systems. *See* Ex. 1006, 4:3-15.

233. Although Cooper does not explicitly discuss DSL modems (or the standards applicable to DSL modems), Li does. Specifically, Li discloses an ADSL

modem (as illustrated in FIG. 6, reproduced below) for dynamically determining parameters for a FEC coding scheme. Ex. 1008, [0008], [0039].



*Id.*, Figure 6.

234. Li explains that the modems may be compliant with applicable standards, such as the G.992.1 and G.992.2 standards that were in effect at the time of Li's filing date (October 26, 2001). *Id.*, [0025]. Although these standards are commonly known to refer to ADSL1 or ADSL-Lite standards (*see e.g.*, Ex. 1001, 6:60-7:8), a POSITA reviewing Cooper and Li would have been familiar with updated ADSL standards, and would have implemented the teachings of Cooper with current ADSL standards which, at the time of the '669 Patent filing, encompassed G.992.3/4/5 ADSL2 standards, to maintain compatibility with other ADSL2 modems in existence. *See* Ex. 1001, 2:39-45 (discussing ADSL1 and ADSL2 in

background), Ex. 1011-1016). A POSITA would have had a reasonable expectation of success in using an ADSL2 modem because a POSITA familiar with ADSL standards would have understood the features and requirements of an ADSL2 compatible modem. *See* Ex. 1013.

235. Moreover, Li also discloses that adjusting FEC parameters (including Reed-Solomon parameter pairs) includes adjusting the FEC parameters based on impulse noise protection (INP) requirements and/or a delay. Ex. 1008, [0028]. As explained in Li, parameters (including the number of symbols or bytes per codeword, or the number of redundancy/parity bytes within the codeword) can be adjusted based on the specified INP or delay requirements. *Id.* The INP and delay are related to the Reed-Solomon parameters using the formula below (recited in Li). Ex. 1008, [0028]. Therefore, a POSITA would recognize that Cooper's dynamic FEC coding scheme could be updated, thereby changing the CCR, to consider INP or delay requirements using Li's formula (reproduced below) for a maximum latency of  $L_{\max}$  ms. *See id.*

$$x + \frac{(S - 1)}{4} + \frac{S \cdot D}{4} < L_{\max}$$

where x is a constant system delay in milliseconds. Modifications of this nature in the selection of S and r are known, and their use in the present invention will be apparent to a person skilled in the art.

236. Table 7-7 of the G.992.3 standard also includes a formula demonstrating a relationship between INP and the parameters of S and D, as shown below, further demonstrating that those of skill in the art recognized a relationship between INP and the codeword parameters. Ex. 1013, 32.

$$INP_p = \left(\frac{1}{2}\right) \times (S \times D) \times \left(\frac{R}{N_{FEC}}\right)$$

237. Moreover, a POSTIA would recognize that ADSL standards (including ADSL-Lite and ADSL2) discuss INP and delay parameters (*see* Ex. 1008, [0026]-[0028]; *see also* Ex. 1013, 32-46 (describing that selection of FEC parameters must satisfy a requirement of meeting a minimum impulse noise protection)), and accordingly a POSITA would implement the dynamic FEC coding scheme of Cooper using an ADSL compatible modem that ensures compliance with INP and/or delay requirements.

### **13.Independent Claim 1**

***a. Element 1[pre]: A controller for an adaptive Forward Error Correction (FEC) coder using a Codeword Composition Ratio (CCR), wherein the FEC coder is used in a Digital Subscriber Line (DSL) modem in which a transmitter sends data via a channel using FEC coding and interleaving according to an original transmission latency, wherein the controller comprises***

238. Cooper alone or Cooper in view of Li discloses this limitation for the same reasons I explain for claim 14, limitations 14[pre], 14[a], and claim 17. Specifically, like limitation 14[pre], which claims “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,” limitation 1[pre] claims “an adaptive Forward Error Correction (FEC) coder” wherein “the FEC coder is used in a Digital Subscriber Line (DSL) modem in which a transmitter sends data via a channel.” Similarly, like limitation 14[a], which claims “a Codeword Composition Ratio (CCR),” limitation 1[pre] claims “using a Codeword Composition Ratio (CCR).” Finally, like claim 17, which claims a method “performed by a controller,” limitation 1[pre] claims “[a] controller” to enact the remainder of the limitation.

239. Though none of limitations 14[pre], 14[a], or 17 expressly identifies using “FEC coding *and interleaving* according to an original transmission latency,” Li discloses this portion of 1[pre]. Li discloses considering factors such as “delay” or “impulse noise protection” in selecting parameters, wherein one of those parameters is the “interleaver depth” (known as D). Ex. 1008, [0028]. Li explains that these parameters affect latency, and defines the relationship between the latency of the system and the FEC and interleaving parameters. *Id.* A POSITA would have known that data would be sent using FEC coding and interleaving at an original latency, which the ’669 patent suggests is the data transmission latency along a channel before the CCR is changed. Ex. 1001, 14:59-66.

***b. Element 1[a]: means for 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, wherein the means is coupled with the DSL modem;***

240. Cooper alone or Cooper in view of Li discloses this limitation for the same reasons I explained with respect to claim 14, limitation 14[c]. Limitation 1[a] is a means-plus-function limitation that recites a function analogous to that discussed in limitation 14[c], which claims “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.” Limitation 1[a] recites a function of “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.” Moreover, the ’669 patent specification discusses the structure of the “means” as a “transmission error value monitor” capable of “receiving an input signal 505 that is representative of the value being sought.” *Id.*, 13:18-23. Cooper discloses that “the primary station 101 includes a plurality of processors, memory units, receivers and transmitters for bidirectionally communicating with each of the secondary stations 110, 112, 114, and 116 to provide differentiated signals in both the upstream and downstream directions.” Ex. 1006, 4:55-61. The bidirectional communication capability of Cooper’s primary station 101 matches the structure and functionality of the “means”

discussed in the '669 patent specification. To the extent that limitation 1[a] recites “wherein the means is coupled with the DSL modem,” a POSITA would have understood that Cooper’s bidirectional communication capability serves to “couple” all of the processors, memory units, receivers, and transmitters (which a POSITA would recognize as a DSL modem based on Cooper alone or based on Cooper in view of Li, as discussed in reference to claim 14).

***c. Element 1[b] means for analyzing the acquired MEVs relative to a Target transmission Error Value (TEV), wherein the analyzing means is coupled with the acquiring means; and***

241. Cooper alone or Cooper in view of Li discloses this limitation for the same reasons explained with respect to claim 14, limitation 14[d]. Specifically, limitation 1[b] is a means-plus-function limitation that recites a function analogous to that discussed in limitation 14[d], which claims “analyzing the acquired MEVs relative to a Target transmission Error Value (TEV).” Limitation 1[b] recites a function of “analyzing the acquired MEVs relative to a Target transmission Error Value (TEV).” The '669 patent specification states that the “means for analyzing one or more MEV(s)...can comprise software, hardware or a combination of the two.” Ex. 1001, 13:50-52. As discussed in reference to claims 17 and 27, above, Cooper describes the structure that performs this function as a hardware microcontroller or a computer program product, and therefore Cooper describes the same structure and functionality for analyzing MEVs as the '669 patent. Ex. 1006, 9:31-46, 17:17-

18:37. Although limitation 1[b] recites “wherein the analyzing means is coupled with the acquiring means,” as with limitation 1[a], a POSITA would have understood all the elements of the system described by Cooper to be coupled. Ex. 1006, 4:55-61.

***d. Element 1[c] means for generating a CCR adjustment control signal during normal operation of the DSL modem (“SHOWTIME”) responsive to the means for analyzing, and transmitting the same to the DSL modem, wherein the generating means is coupled with the analyzing means.***

242. Cooper alone or Cooper in view of Li discloses this limitation for the same reasons I explained with respect to claim 14, limitations 14[b] and 14[e]. Specifically, limitation 1[c] is a means-plus-function limitation that recites a function analogous to those discussed in limitation 14[b], which claims “transmitting a control signal for transmitting data from the DSL modem,” and limitation 14[e], which claims “adjusting the CCR when the MEV differs sufficiently from the TEV.” Limitation 1[c] recites a function of “generating a CCR adjustment control signal during normal operation of the DSL modem (“SHOWTIME”) responsive to the means for analyzing, and transmitting the same to the DSL modem.” Here, limitation 1[c] specifically recites “SHOWTIME”—but the claim itself makes clear that is just in normal operation of the DSL modem. Moreover, the ’669 patent specification describes the structure that performs this function for generating a CCR (530) “can be implemented using software, hardware and/or a combination thereof.” Ex. 1001,

14:1-5. As discussed above in reference to element 1[b], Cooper provides the same level of detail specifying that the recited functionality can be performed by analogous hardware or software. A POSITA would have understood the embodiments of Cooper to be in normal operation. Although limitation 1[b] recites “wherein the generating means is coupled with the analyzing means,” as with limitation 1[a], a POSITA would have understood all the elements of the system described by Cooper to be coupled. Ex. 1006, 4:55-61.

**14. Dependent Claim 2: The controller of claim 1 wherein the MEVs are based on at least one of the following: a bit error rate; errored seconds; errored minutes; code violations over a fixed period of time; a Signal-to-Noise Ratio (SNR) measured at the receiver; or Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.**

243. Cooper alone or Cooper in view of Li discloses this claim for the same reasons with respect to claim 26, which is identical to claim 2 except that it is a “controller” rather than a method.

**15. Dependent Claim 3: The controller of claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as computer readable program code.**

244. Cooper alone or Cooper in view of Li discloses this claim for the same reasons with respect to claim 27. Both claims 27 and 3 recites that the method (and the correlating “means”) is “implemented” as “computer readable program code.”

**16. Dependent Claim 4: The controller of claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as hardware.**

245. Cooper alone or Cooper in view of Li discloses this claim for the same reasons with respect to claim 28. Both claims 28 and 4 recites that the method (and the correlating “means”) is “implemented” as “hardware.”

**17. Dependent Claim 11: The controller of claim 1 wherein the DSL modem is an Asymmetric Digital Subscriber Line (ADSL) modem operable in compatibility with an ADSL2 standard and further wherein the CCR adjustment control signal adjusts at least one of the following: Impulse Noise Protection (INP); or maximum interleaving delay.**

246. Cooper in view of Li discloses this claim for the same reasons with respect to claim 29, which is identical to claim 11 except that it is a “controller” rather than a method.

**B. Ground 2: Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 are rendered obvious by Klayman and Li.**

247. Klayman or Klayman in view of Li teaches all of the limitations of Claims 1-4, 11, 14-17, 19-20, 23, and 26-29.

### **1. Motivation to Combine Klayman and Li**

248. A POSITA would have been motivated to modify Klayman with the teachings of Li to perform dynamic FEC coding in real-time using a DSL modem that complies with ADSL standards, including the G.992.1 and G.992.2 standards disclosed in Li and using the FEC parameters discussed in Li.

249. Klayman and Li are analogous art, at least because both references discuss FEC coding for error correction in data transmission systems, including for

data transmitted over twisted pair wires. *See e.g.*, Ex. 1007, *Abstract*, 3:3-8; Ex. 1008, [0001]-[0006], [0017].

250. Klayman states that the described dynamic FEC coding scheme is usable with a communication system using “twisted pair wires” as a communication medium (Ex. 1007, 3:3-8), which a POSITA would recognize as a DSL communication medium. *See* Ex. 1008, [0002] (“DSL uses an infrastructure that already exists; namely, copper twisted pair lines typically used for telephone communication.”).

251. A POSITA would have understood that use of the twisted pair wires disclosed by Klayman would require a DSL modem. A POSITA would have recognized benefits of using DSL modems that are compliant with current ADSL standards, such as the G.992.1 and G.992.2 standards disclosed in Li and the more recent G.992.3/4/5 standards discussed in background of the ’669 patent, with the system disclosed in Klayman. Ex. 1008, [0025], Ex. 1001, 2:39-56; *see also* Ex. 1011, 1012, 1013, 1014, 1015. Those standards include consideration of external factors “such as a delay or impulse noise protection requirements” when determining Reed-Solomon coding scheme pairs. *See* Ex. 1013, 32. At the time of filing of the ’669 Patent, those standards included G.992.3/4/5. Ex. 1001, 3:29-60; *see also* Ex. 1013, 1014, 1015. Indeed, the ’669 Patent explains in background “ADSL standards prescribe some latencies....In ADSL2 and ADSL2+ (G.992.5), the available

latencies are set by the operator between 2 ms and 20 ms using the element management system (a data acquisition system, described in detail in G.997.1, *that allows a service provider to implement control parameters such as the INP value and maximum interleaving delay*), which conveys the preference to the line's modems, including the downstream receiver (ATU-R).” *Id.* Although not explicitly discussed in Li, a POSITA would have been motivated to maintain compliance with the most up-to-date ADSL standards when developing a DSL system in compliance with Klayman and Li to maintain compatibility with commercially available DSL modems.

252. Using a DSL modem (as discussed in Li) at both the primary station (which may be a CO for a DSL communication system) and at the secondary station(s) would enable Klayman’s system to use the twisted pair wire communication medium for DSL data transmission. The DSL modems encode and decode communications to be passed along the twisted pair copper wire using a Discrete Multi-Tone (DMT) scheme as is well-known for DSL communications and as discussed in Li. Ex. 1008, [0001]-[0003].

253. More generally, a POSITA would recognize benefits of using Klayman’s dynamic FEC coding scheme with DSL modems that are compliant with ADSL standards so that the DSL modem located at the primary station can communicate with the DSL modem at the secondary station. *See* Ex. 1008, [0003]

(“ADSL is the most widely implemented form of DSL technology”), [0025] (discussing G.992.1 and G.992.2 compliant modems). Both modems must have an understanding of the communication scheme used (and the FEC coding scheme used), and so ensuring that those modems are compliant with ADSL standards—including the use of parameters defined by those standards for setting an FEC coding scheme (e.g., setting INP or maximum interleaving delay), would ensure that modems at each location in the communication system can communicate with one another. Ex. 1007, 5:12-35 (discussing that both the transmitter and receiver must know what FEC parameters are being used so that the receiver can decode received data).

254. Moreover, Klayman and Li discuss methods for determining FEC coding parameters that can be used for transmitting code words across the twisted pair copper wires. Klayman focuses on dynamic determinations of FEC coding parameters using a master controller. Ex. 1007, 3:44-57, 7:8-10. Li discusses determinations of FEC coding parameters for implementation on a DSL system (Ex. 1008, [0020]-[0028]) would have led a POSITA to extend Klayman’s dynamic FEC coding scheme to a DSL communication system as disclosed in Li. Moreover, a POSITA would have recognized that the location of a controller for determining FEC coding parameters (e.g., the master controller discussed in Klayman) could be located inside or outside of a central office, so long as the controller can

communicate determined FEC coding parameters to the transmitter and receiver. *See* Ex. 1028, 1029.

255. A POSITA would have had a reasonable expectation of success in combining Klayman and Li because Klayman discusses that the described dynamic FEC coding scheme can be used with twisted pair copper wires that are used for DSL communications. Ex. 1007, 3:3-8; Ex. 1008, [0002]-[0006]. A POSITA would have recognized that DSL modems such as those described in Li would have been integrated into Klayman's communication system to enable use of the twisted pair copper wires that Klayman discusses as an eligible communication medium. Moreover, a POSITA would have understood that FEC coding parameters (and other communication parameters) can be determined by a controller based on characteristics of a DSL communication line (*see e.g.*, Ex. 1028, 1029), and therefore a POSITA would have recognized that the FEC coding parameters determined in accordance with Klayman could be distributed to both a transmitting DSL modem and a receiving DSL modem for use of the determined FEC coding parameters during a DSL data transmission, as discussed in Li.

## **2. Independent Claim 14<sup>9</sup>**

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<sup>9</sup> As with Ground 1, I address claims 14-17, 19-20, 23, and 26-29 before claims 1, 2, 3, 4, and 11.

256. Like Ground 1, it is easy to see a substantial overlap in disclosure between Klayman’s Abstract and claim 14 of the ’669 patent. I created a color-coded comparison between the two disclosures to demonstrate how each limitation in claim 14 of the ’669 patent is mentioned in Klayman’s Abstract.

| Claim 14, ’669 Patent                                                                                                                                                                                           | Klayman                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14. 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, the method comprising: | An apparatus (101, 110) and method for adaptive forward error correction in a data communication system (100) provides for dynamically changing forward error correction parameters based upon communication channel conditions, such as noise levels or error rates. In the method embodiment of the invention, data having a current degree of forward error correction is received (305), and a channel parameter is monitored (310), such as packet or bit error rates. A threshold level for the channel parameter is determined (315), and the monitored channel parameter is compared to the threshold level (320). When the channel parameter is not within a predetermined or adaptive variance of the threshold level, a revised forward error correction parameter having a greater or lesser degree of forward error correction capability is selected (330, 340, 350, 360), and the revised forward error correction parameter is transmitted (370). The device receiving the revised forward error correction parameter, such as a secondary station (110), then transmits data encoded utilizing the revised error correction parameter (425). |
| (a) selecting a Codeword Composition Ratio (CCR) representing a relation between payload and parity bytes in an FEC coding scheme;                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| (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;                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| (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.                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

*a. Element 14[pre]: 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, the method comprising:*

257. Klayman alone or Klayman in view of Li teaches the preamble of Claim 1, to the extent it is determined to be limiting. Klayman discloses a method of “dynamically changing forward error correction parameters based upon communication channel conditions, such as noise levels or error rates.” Ex. 1007, Abstract. The described method “provid[es] sufficient error correction for accurate data reception, and also provid[es] for overhead minimization for increased data

throughput.” *Id.*, 2:52-62. The method thereby allows FEC parameters to be adjusted to reduce the FEC error correction capability when a channel is performing with minimal error levels and to increase the FEC error correction capability when higher error levels are detected on the channel. *Id.*, 6:65-7:7. This capability to “utilize precisely enough error correction to compensate for the existing noise level, and no more or less” maximizes throughput of user data while minimizing overhead. *Id.*, 6:25-38.

258. Klayman’s dynamic FEC protocol is applied to communications over a communication medium between a primary station and a secondary station. *Id.*, 2:63-3:19. For upstream communications, the secondary station functions as a transmitter and the primary station functions as a receiver. For downstream communications, the primary station functions as a transmitter and the secondary station functions as a receiver. *Id.* The communications medium connecting the primary station and secondary station can be “twisted pair wires” (*Id.*, 3:3-8), which a POSITA would recognize as being the communications medium utilized for DSL data transmission that utilize DSL modems at the transmitter and receiver for encoding and decoding of data.

259. Klayman, like Cooper, focuses on the FEC coding scheme and a POSITA would understand that DSL modems are a necessity when implementing this coding scheme for DSL communications over “twisted pair wires.”

Nevertheless, in the event that Klayman is found not to teach DSL modems, Li discloses DSL modems that are capable of implementing dynamically-determined FEC coding parameters for optimizing data transmission in a specific environment. Ex. 1008, [0008]. Therefore, Li's DSL modems are capable of implementing FEC coding that has been adjusted in accordance with Klayman's disclosure. Because Klayman discloses that the disclosed adaptive and dynamic FEC scheme can be implemented for a "twisted pair wires" communication medium, a POSITA would recognize that a DSL modem (such as the DSL modems disclosed in Li) would be usable to implement Klayman's dynamic FEC coding scheme in a DSL communication system.

***b. Element 14[a]: (a) selecting a Codeword Composition Ratio (CCR) representing a relation between payload and parity bytes in an FEC coding scheme;***

260. Klayman teaches Element 14[a].

261. As discussed in Ground 1, above, the '669 patent defines a CCR as any quantity or value that "represents the relation between the payload and parity bytes in the applicable FEC coding scheme" – specifically a "Reed-Solomon" FEC technique which is "made up of K data or information bytes (the user's payload data) and R parity bytes, totaling N bytes in each codeword (that is,  $K+R=N$ )."

Ex. 1001, 2:6-19. Specifically, the '669 Patent defines an example CCR as:

$$\text{CCR} = \frac{\text{Payload data bytes}}{\text{Total data bytes}} \text{ OR } (\text{Payload bytes}) : (\text{Total bytes})$$

See Ex. 1001, 9:8-28.

262. The “Payload data bytes” is equivalent to the variable K: “Number of payload data bytes in each mux data frame” and the “total data bytes” is equivalent to the variable N “total number of bytes (combined payload data and parity/redundancy) per codeword.” *Id.*, 6:36-50. The above CCR formula yields a value reflecting what percentage of a total codeword length are characterized by payload bytes. The remainder of the total codeword length is the number of parity bytes.

263. Klayman discusses adjusting the percentage of a codeword that is attributed to payload versus parity bytes. Specifically, Klayman teaches selecting a CCR by selecting a parameter pair from a Reed Solomon FEC coding scheme (i.e., an FEC coding scheme), “such as (n, k) parameters (e.g., 128, 122), (200, 196), or (128, 124), from inclusion of different types of error correcting codes, such as concatenation of codes or inclusion of interleaving (with a specified depth), and by specification of any parameters associated with such codes.” Ex. 1007, 17-23. Klayman specifies that the parameter pair is used to define a Reed-Solomon code, “in which ‘n’ is the code word size and ‘k’ is the block size, such that an n-byte code word consists of k data bytes and (n-k) redundancy bytes (which represent the error

correcting code information).” *Id.*, 5:55-65. These “[f]orward error correction parameters . . . illustrate a balance between the amount of overhead added by the error correcting code itself (which utilizes space which could have been used for data and therefore decreases data throughput), on the one hand, and the amount of error correction needed due to channel conditions (which may serve to increase data throughput through avoidance of retransmission), on the other hand.” *Id.*, 6:19-26. Klayman then continues by explaining that “to maximize throughput of user data over a given communications channel, the optimal error correcting methodology would utilize precisely enough error correction to compensate for the existing noise level, and no more or less.” *Id.*, 6:26-30. Klayman thus teaches an optimal ratio of error correcting bytes ( $n-k$ ) to the total bytes ( $n$ ) is achieved by balancing the overhead (reflecting the length of the codeword dedicated to error correcting bytes) to the amount of error correction needed. As such, Klayman’s “ $n$ ” and “ $k$ ” parameters (and the ratio creating a balance therebetween) define the CCR as the term is used in 14[a].

***c. Element 14[b]: (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;***

264. Klayman or Klayman in view of Li teaches Element 14[b].

265. Klayman teaches an algorithm for “changing the forward error correction parameters (typically used on an upstream channel), based upon variable channel quality, such as variable noise or error levels.” Ex. 1007, 6:66-7:3. Those parameters identify the CCR (made up of the parameter pair  $(n, k)$ ) for the FEC coding scheme used for transmitting data on a communication channel. A POSITA would understand that specifying the parameter pair serves to identify a Reed-Solomon FEC coding scheme for transmitting data from a transmitter to a receiver on a communication channel. *Id.*, 5:55-65. Klayman explains that a master controller and/or other “various components” of a primary station function to perform the process of FIG. 4 for “channel monitoring and forward error correction parameter adjustment.” *Id.*, 3:44-44 (describing the components of the primary station 101 to include a master controller, and indicating that the function of these various components are explained in reference to FIGS. 4 and 5); 7:8-10 (“FIG. 4 is a flow chart illustrating channel monitoring and forward error correction parameter adjustment in accordance with the present invention.”). Regardless of the device that determines the FEC coding parameters (e.g., the values of  $n$  and  $k$  for a Reed-Solomon code pair  $(n, k)$ ), both the transmitter and receiver must know what FEC coding scheme is used and what parameters are used for the coding scheme so that the receiver can decode data using the same coding scheme used by the transmitter to encode the data. *See id.*, 7:23-27 (establishing an initial degree of FEC “during an

initial registration process, when a secondary station establishes a communication link with a primary station.”). Klayman further states that once an FEC coding parameter is determined (e.g., after it is adjusted and before repeating the process of FIG. 4 for monitoring and adjusting FEC coding parameters), a forward error correction parameter is transmitted (step 370 in Klayman’s FIG. 4, shown below), for example, to a secondary station. *Id.*, 8:39-47. A POSITA would understand that transmitting the FEC parameter is equivalent to transmitting a “control signal specifying the CCR and FEC coding scheme” as recited in claim 14 of the ’669 Patent. As discussed in the ’669 Patent, the control signal is used by the FEC coder of the transmitter to “adjust[] the CCR in response to the CCR adjustment control signal.” Ex. 1001, 14:58-59. By transmitting the FEC parameter to a secondary station (and/or a primary station, if another device determines the FEC coding parameter), both the transmitter and receiver are informed of the FEC coding scheme and associated parameters used for data transmission, which enables the transmitter to use those FEC coding parameters when transmitting data and enables the receiver to decode transmitted data based on the used FEC coding scheme and associated parameters once the data is received. A POSITA would understand that the receiver uses information identifying the FEC coding scheme and parameters used by the transmitter to decode the transmitted data, at least in part by identifying what portion

of each received code word is payload data bytes, and what portion is parity (error correcting) data bytes.

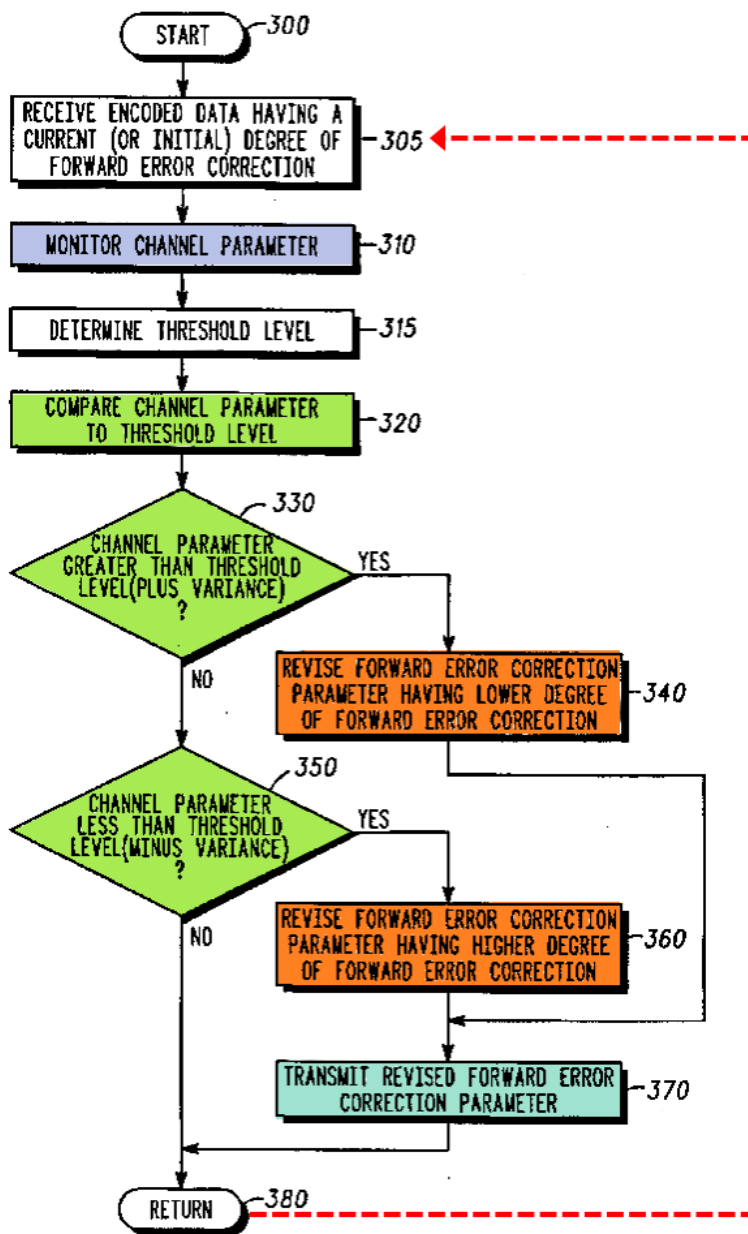


**FIG. 4**

Ex. 1007, Figure 4 (annotated).

266. Even if Klayman is found not to teach a DSL modem, Li explicitly discloses that a DSL modem transmits data according to the FEC coding parameters.

Ex. 1008, [0039] (“The ADSL modem 600 includes a processor 602 and a memory 604. The memory 604 stores various data such as the parameters G, B, n and r, and the data to be transmitted....The processor 602 may also code the data to be transmitted according to the resulting preferred set of parameters and may generate code words 100 corresponding thereto.”). Therefore, when implementing Klayman’s dynamic FEC coding scheme in a DSL communication system, the FEC coding scheme parameters are communicated to a DSL modem that operates as a transmitter for transmitting data from the DSL modem via the communication channel (e.g., twisted pair wires) according to the specified FEC coding scheme and associated parameters.

***d. Element 14[c]: (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***

267. Klayman teaches Element 14[c].

268. Klayman describes a process for “channel monitoring and forward error correction parameter adjustment” as illustrated in Klayman’s FIG. 4. Ex. 1008, 7:8-10. As illustrated below, this process includes monitoring a channel parameter (step 310, shown in light purple), which Klayman describes as “monitoring packet error rates, bit error rates, noise levels (such as levels of impulse noise or ingress noise), other interference, or other parameters or factors which could be correlated with channel quality, error rates, and a desired or necessary degree of error correction

capability.” *Id.*, 7:37-45.<sup>10</sup> Unpredictable disruptions to a channel, such as impulse noise events, contribute to degradation of channel quality, and therefore a POSITA would understand that the bit error rates or other “noise levels” monitored by Klayman would reflect the impact of impulse noise events, among other types of noise occurring during transmission on the communication channel occurring after training and initialization is complete so that the primary station and secondary station can communicate. Moreover, Klayman explains that the bit error rates are monitored *after* an initial startup step reflected by step 300 in FIG. 4, and *after* “the method proceeds to receive encoded data having a first or initial degree of forward error correction,” which “may be established during an initial registration process, when a secondary station establishes a communication link with a primary station.” *Id.*, 7:8-36. In short, step 310 for monitoring a channel parameter, of Klayman’s FIG. 4 occurs during a steady-state data transmission stage, occurring after the connected modems start-up and go through initialization and training steps necessary to enable the modems to communicate with one another. *See* Ex. 1001, 3:45-50 (explaining in

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<sup>10</sup> As recited in dependent claim 26, the ’669 Patent explicitly indicates that the MEV may be based “a Bit Error Rate (BER),” and therefore Klayman’s disclosure of calculating a bit error rate (Ex. 1007, 7:37-50) explicitly maps to a claimed embodiment of acquiring an MEV. *See infra*, Section X.B.9.

background that initialization occurs before data transmission, so that if values such as maximum interleaving delay and INP values are not known during initialization “there is no way to know any error measurements before data transmission.”).

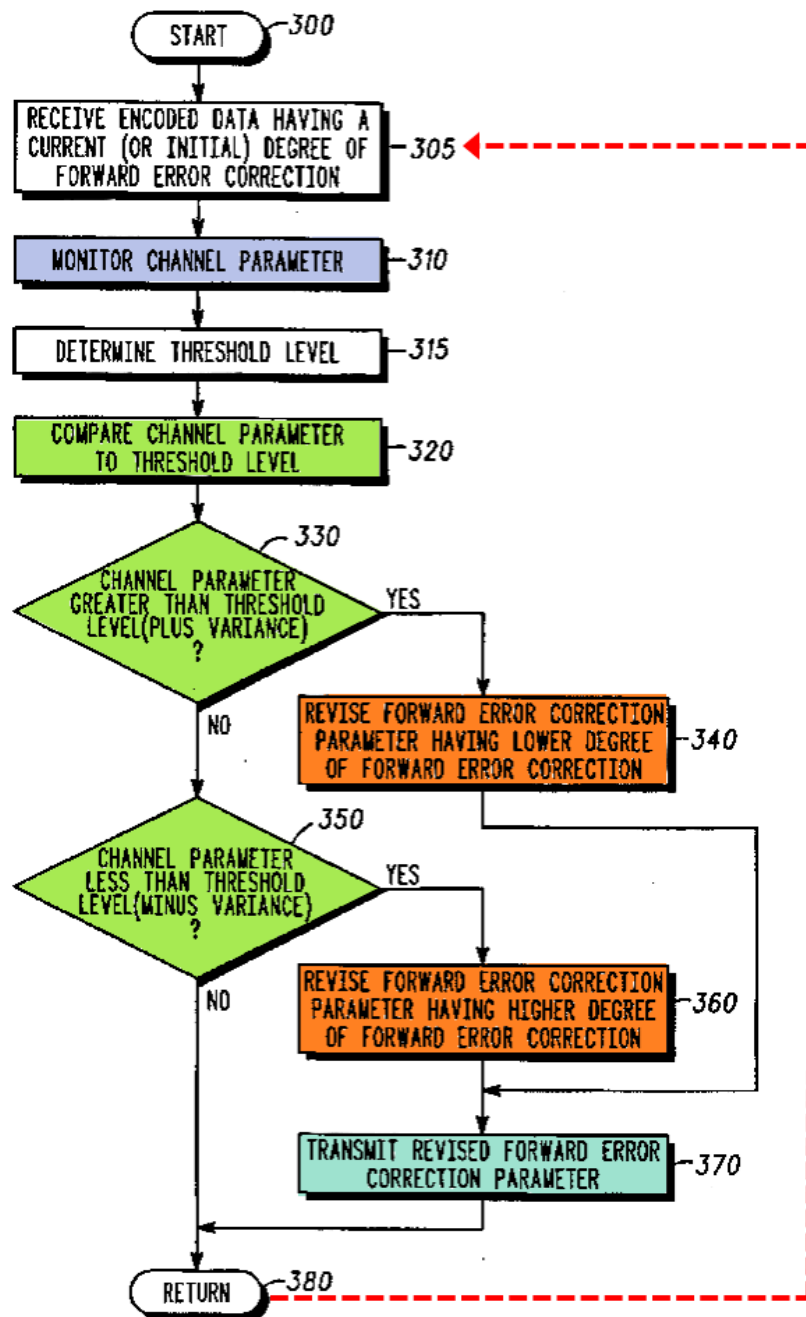


**FIG. 4**

Ex. 1007, Figure 4 (annotated).

269. Klayman continues by describing an example in which “monitoring an error rate may comprise monitoring a set of error rate parameters of a plurality of sets of error rate parameters in which the plurality of sets of error rate parameters consist of any of a plurality of combinations of a bit error rate, a packet error rate, a burst error rate, a block error rate, and a frame error rate.” *Id.*, 7:45-50.

270. Klayman also states that block error correcting codes (such as Reed-Solomon error correcting codes) are configured to correct “burst errors.” *Id.*, 5:37-60. These burst errors are isolated error instances, such that an interleaving technique may further improve error correction of these burst errors by spreading the burst error out over multiple blocks so that each block code has a higher probability of correcting a small portion of a large burst error. *Id.*, 5:46-54. These errors are identical to the impulse errors discussed in the ’669 Patent, which describes impulse errors as “isolated” (Ex. 1001, 10:47-53) or “time-varying intermittent noises” (Ex. 1001, 12:10-16). Therefore, Klayman’s discussion of monitoring impulse errors, and discussion of a bit error rate that represents burst errors satisfies Element 14[c]’s indication that MEVs represent impulse noise events detected on a channel.

271. Klayman states that the process of FIG. 4 may be repeated over time (as conditions vary) so that different revised forward error correction parameters will be determined and transmitted over time. Ex. 1007, 8:42-47.

***e. Element 14[d]: (d) analyzing the acquired MEVs relative to a Target transmission Error Value (TEV); and***

272. Klayman teaches Element 14[d]. *See supra*, §X.B.2.a.

273. At step 320 in Klayman's FIG. 4, "the channel parameter (monitored in step 310) is compared to the threshold level, step 320, such that if the channel parameter is not within a predetermined or adaptive tolerance or variance of the threshold level (i.e., is not equal to the threshold level plus or minus an allowable tolerance (or variance)), then the degree of forward error correction utilized will be revised." Ex. 1007, 7:60-66. Specifically, Klayman determines if the bit error rate (or other monitored channel parameter) is greater than the threshold level or lower than the target threshold level to determine whether to increase or decrease the degree of forward error correction capability. *Id.*, 8:2-38.

***f. Element 14[e]: (e) adjusting the CCR when the MEV differs sufficiently from the TEV.***

274. Klayman teaches Element 14[e].

275. Klayman describes a method for "channel monitoring and forward error correction parameter adjustment." Ex. 1007, 7:8-10. The steps for adjusting the forward error correction parameters are reflected in steps 340 and 360 of FIG. 4, shown below in orange. *Id.*, 8:2-38.

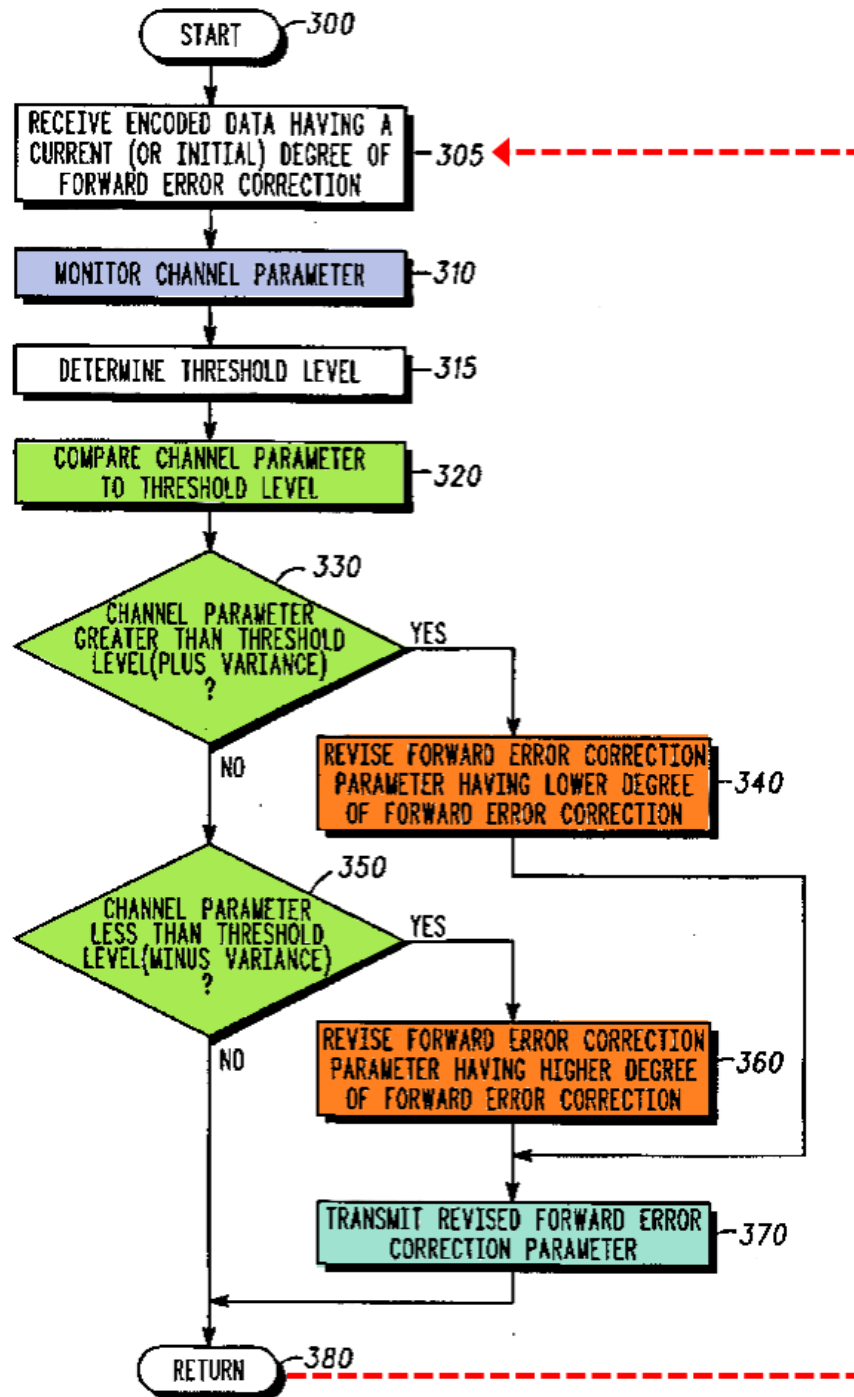


**FIG. 4**

Ex. 1007, Figure 4 (annotated).

276. Klayman states that when a monitored channel parameter (e.g., bit error rate) indicates that the channel has a comparatively high quality “and is causing

fewer errors than are capable of being corrected by the current error correcting code, then a revised forward error correcting parameter is selected which has a lower degree of forward error correction capability, i.e., is capable of correcting fewer errors, step 340.” *Id.*, 8:2-16. This decreases the overhead because a high error correcting capability is unnecessary, thereby increasing payload data throughput. *Id.*

277. Conversely, when a monitored channel parameter (e.g., bit error rate) indicates that the channel has a low quality according to Klayman’s method “and is causing more errors than are capable of being corrected by the current error correcting code, then a revised forward error correcting parameter is selected which has a higher degree of forward error correction capability, i.e., is capable of correcting more errors, step 360.” *Id.*, 8:16-30. This increases the error correcting capability so that more errors can be corrected without requiring retransmission of data. *Id.*

278. As discussed above in reference to Element 14[a], the “forward error correcting parameters” discussed in Klayman are Reed-Solomon parameter pairs ( $n$ ,  $k$ ), which represent the content of the CCR, as defined by the ’669 Patent. *See* Ex. 1001, 9:8-28. Therefore, adjusting Klayman’s FEC parameters will result in a change in the CCR—the ratio between the payload data bytes and the total number of bytes in a codeword.

**3. Dependent Claim 15: The method of claim 14 wherein repeatedly acquiring the MEVs comprises at least one of the following: directly**

**measuring a characteristic of the DSL modem; collecting a value from an element management system; or computing the MEVs from collected data.**

279. Klayman teaches dependent claim 15.

280. As discussed in reference to Element 14[c], Klayman explains that a master controller of the primary station performs the process of FIG. 4, which includes monitoring packet error rates, bit error rates, noise levels or other interference or parameters. Ex. 1007, 4:42-44; 7:37-45. In order for the master controller of the primary station to monitor these parameters (e.g., bit error rates), the primary station must obtain data reflecting these parameters. For upstream communications (where the primary station is the receiver), these parameters are directly measured at the receiver (which, when the communication medium is a twisted pair wire, the receiver is a DSL modem). For downstream communications, the master controller must receive collected data (e.g., from the secondary station) to compute the bit error rate or other parameters that constitute MEVs.

281. As discussed in reference to claim 14, a POSITA would have recognized that Klayman's receiver would be embodied as a DSL modem or, in the alternative a POSITA would have utilized a DSL modem as discussed in Li, as the receiver of Cooper's communication system. Ex. 1008, [0002]-[0004]. I have discussed a motivation to combine Klayman and Li in Section X. B.1, above.

**4. Dependent Claim 16: The method of claim 14 wherein steps (b) through (e) are repeated.**

282. Klayman teaches dependent claim 16. As discussed in reference to Element 14[c], Klayman describes that the process for “channel monitoring and forward error correction parameter adjustment” is repeated over time (as conditions may vary) as different revised forward error correction parameters are determined over time. *Id.*, 8:42-47. This is reflected by the dashed red line in the annotated version of Klayman’s FIG. 4, below.

283. The repeated steps include communicating a revised forward error correction parameter to a secondary station as discussed in reference to Element 14[b] (*supra*, Section X.B.2.c; Ex. 1007, 8:39-42); repeatedly calculating the bit error rate (as shown in step 310 of Klayman’s FIG. 4), as discussed in reference to Element 14[c] (*supra*, Section X.B.2.d, Ex. 1007, 7:37-50); comparing the calculated bit error rate against a threshold level as shown in step 320 of Klayman’s FIG. 2, as discussed in reference to Element 14[d] (*supra*, Section X.B.2.e; Ex. 1007, 7:50-8:2); and adjusting the forward error correction parameters that constitute a CCR as discussed in reference to Element 14[e] (*supra*, Section X.B.2.f; Ex. 1007, 8:2-30).

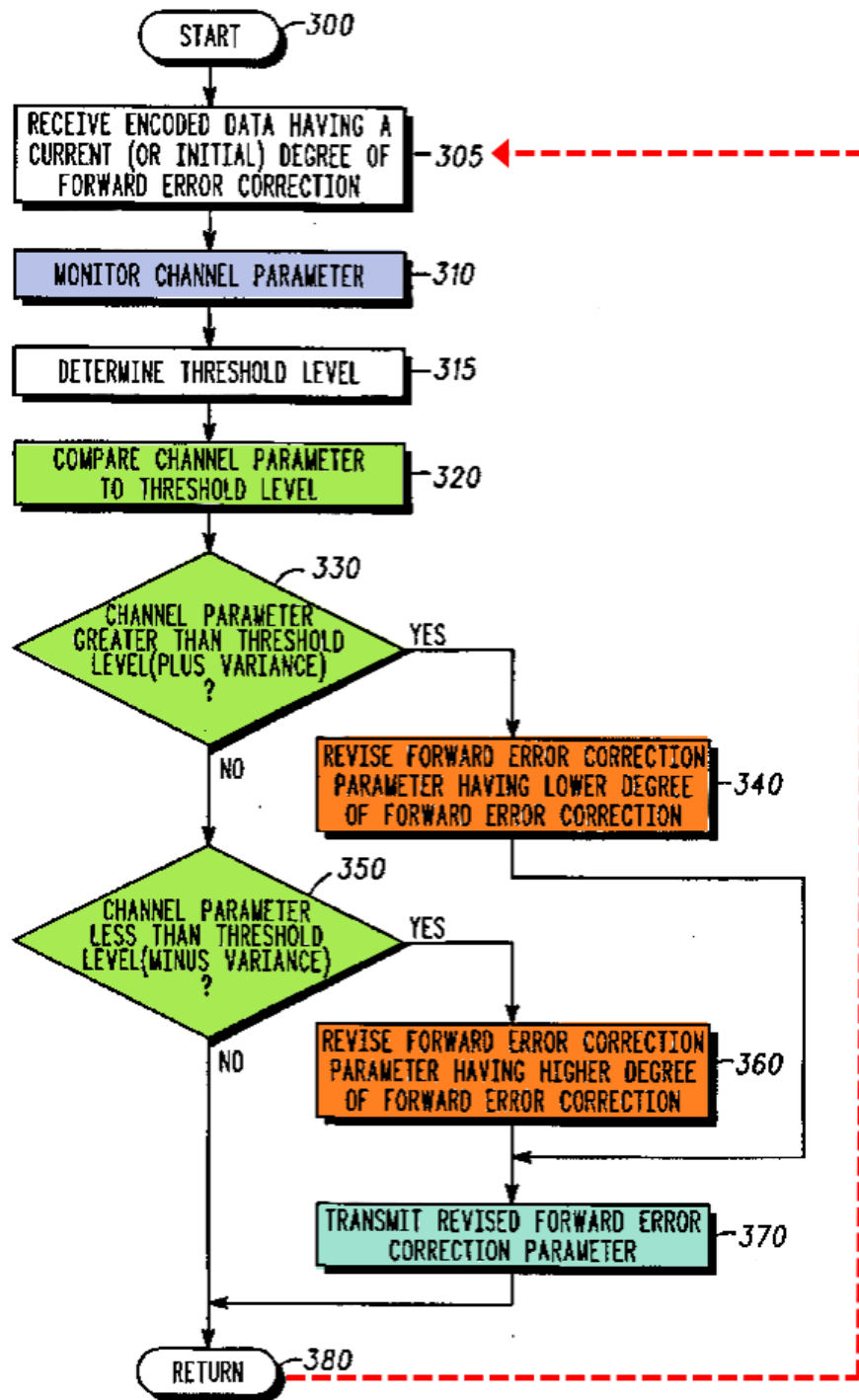


**FIG. 4**

Ex. 1007, Figure 4 (annotated).

5. Dependent Claim 17: The method of claim 14 wherein the method is performed by a controller.

284. Klayman teaches dependent claim 17.

285. As discussed in reference to Element 14[b], Klayman explains that a “master controller” of the primary station performs the process of FIG. 4 (which encompasses the steps recited in claim 14 of the ’669 Patent). *Id.*, 3:44-57 (explaining the primary station includes a master controller); *id.*, 4:41-44 (the components of the primary station, including the master controller, performs the steps of FIG. 4); *id.*, 7:8-10 (explaining FIG. 4 illustrates a channel monitoring and forward error correction parameter adjustment method).

286. Alternatively, a POSITA would have found it obvious to perform the method using a controller based on the disclosure of Klayman. Again, Klayman indicates that the master controller is at a primary station, and so a POSITA would recognize that steps for controlling the operation of the communications system (including transmitter and receiver) could be beneficially performed by a controller. A POSITA would have been motivated to use a controller to perform the claimed method because a standalone controller may include more memory and/or processing power than a DSL modem, and the additional memory and/or processing power would enable the controller to more quickly calculate FEC coding changes. Because Klayman’s method addresses changes in noise levels detected on the communications channel in real-time or near real-time, the additional processing speed that would be provided by a standalone controller would enable faster changes

in FEC coding parameters, thereby improving the real-time performance of the dynamic FEC coding algorithm disclosed in Cooper. The Applicant of the application that matured into the '669 Patent identified similar benefits to using a controller in the office action response dated March 21, 2008, stating “[u]nlike Locke’s AGWN, or stationary noise, ‘impulse noise events’ occur as random and unpredictable events on the channel, and therefore are detected over a period of hours, days, or weeks, *making collecting and storing such information impracticable for Locke’s modems.*” Ex. 1004, 187 (*emphasis added*).

287. Moreover, a POSITA would have had a reasonable expectation of success in using a controller to perform the recited method, as a controller including processors and memory are capable of controlling various functions of devices, such as the master controller that is a part of the primary station in Klayman. Ex. 1007, 3:44-4:44. To control devices, those processors execute algorithms such as FEC coding algorithms as disclosed in Klayman.

**6. Dependent Claim 19: The method of claim 17 wherein the controller is in a Central Office (CO).**

288. Klayman teaches dependent claim 19.

289. As discussed in reference to claim 17, Klayman explains that a primary station includes a “master controller,” which can perform the steps for FIG. 4 *See supra*, Section X.B.5. A POSITA would understand that Klayman’s “primary station 101” is equivalent to a Central Office as the term is used in the '669 Patent. Klayman

explains that the described method can be performed on a communication medium used for DSL communication (specifically, “twisted pair wires,” Ex. 1007, 3:3-8), which extends between a central office (“primary station 101”) and a secondary station. Specifically, the ’669 Patent explains that a DSL central office can house the transmitters and a controller. Ex. 1001, 6:23-27; *see also* Ex. 1001, FIG. 7 (showing a controller as optionally located in the same location as a transmitter); Ex. 1011, 10 (describing a transceiver at a Central Office in the 992.1 standards).

**7. Dependent Claim 20: The method of claim 17 wherein the controller is outside a Central Office (CO).**

290. Klayman teaches dependent claim 20.

291. Klayman explains that a “secondary station” includes a processor coupled to memory, such as a part of a commercially available integrated circuit. Ex. 1007, 4:45-65. The components of the secondary station can perform functions including forward error correction encoding and decoding. *Id.* Specifically, Klayman explains that the secondary station components can perform the same functions as the master controller and other components of the primary station, including the functions that are described in detail with respect to FIG. 4 *Id.*, 5:7-10. Therefore, Klayman explains that the controller can be located at the location of a secondary station, which is outside of the central office (primary station 101).

292. As further discussed in reference to dependent claim 17, a POSITA would have alternatively been motivated to utilize a separate controller for

performing the method disclosed in Klayman. *See supra*, Section X.B.5. A POSITA would have been motivated to locate this controller “outside of a Central Office (CO),” such as at another internet connected location, to provide control operations to multiple transmitters (or multiple central offices containing one or more transmitters) and one or more receivers. *See* Ex. 1028, 1029. As discussed in reference to dependent claim 17, a standalone controller would provide additional processing power and memory over controllers integrated into a modem, and so expanding the benefits of the standalone controller to multiple central offices would provide the same benefits to systems that encompass multiple central office locations to enable real-time determination of FEC parameters, and locating the controller outside of a central office would enable the controller to be used. *Id.*

293. A POSITA would have had a reasonable expectation of success in locating the controller outside of a central office. For example, a POSITA would recognize that internet-connected processors and memories execute algorithms for controlling DSL modems (e.g., the algorithms of Klayman), and those controllers may be located at a primary station, central office, or elsewhere. *See* Ex. 1028, 117 (Figure 2 shows an “Advanced DSL manager” that communicates with Automated test equipment in a CO, with DSL modems, with a DSL database, and a network operations center); Ex. 1029, 103 (Figure 1 shows a spectrum management center (SMC) located outside of a central office).

**8. Dependent Claim 23: The method of claim 14 wherein the CCR is  $K/N$ , wherein  $K$ =a total number of payload bytes in the codeword and  $N$ =a total number of bytes in the codeword.**

294. Klayman teaches dependent claim 23. As discussed in Element 14[a], Klayman teaches that the method includes revising Reed-Solomon parameters, including the  $n$  and/or  $k$  parameters in the parameter pair  $(n, k)$ , where “ $n$ ” is the codeword size and “ $k$ ” is the block size. Ex. 1007, 5:55-65; 7:17-23. Comparing these two parameters (such as by calculating a ratio between  $n$  and  $k$ ) is a manner of describing how much of a codeword consists of payload bytes—the balance being parity bytes. As discussed in Ground 1, a POSITA would recognize that providing a “CCR” would entail providing values for  $K$  and  $N$  to allow the transmitter and receiver to know what codeword length should be used and what payload length should be used. Providing a single value representing a “CCR” would not provide a transmitter or receiver with sufficient information to encode data into codewords according to the FEC scheme. As an explanatory example, a CCR value of 0.5 does not indicate a size of the codeword – a codeword could be any length and still satisfy the 0.5 CCR value, so long as half of its length was reserved for payload data. Therefore, a POSITA would recognize that a “CCR” as recited in claim 23 would encompass providing values of both  $K$  and  $N$ , which would be included in a transmitted “control signal,” as recited in Element 14[b]. Therefore, Klayman’s selection of parameters  $(n, k)$ , where “ $n$ ” is the code word size and “ $k$ ” is the block

size and Klayman's discussion of comparing the parameters  $n$  and  $k$  teaches dependent claim 23.

295. Klayman also describes a relationship for balancing the amount of payload bytes (and error correcting bytes) against the total codeword length. *Id.*, 6:19-26. Regardless of the ratio used to compare the values of " $k$ " and " $n$ " (e.g.,  $K/N$ ,  $(N-K)/N$ , or otherwise) the effect of describing the percentage of a code word that constitutes payload data is the same. And a POSTIA would understand that providing a value of " $k/n$ " would be an obvious manner of describing the balance between the number of payload bytes against the total codeword length, as discussed in Klayman.

**9. Dependent Claim 26: The method of claim 14 wherein the MEV is based on at least one of the following: a Bit Error Rate (BER); errored seconds; errored minutes; code violations over a fixed period of time; a Signal-to-Noise Ratio (SNR) measured at the receiver; or Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.**

296. Klayman teaches dependent claim 26. As discussed in reference to Element 14[c], Klayman teaches determining a calculated bit error rate as a measured error parameter in step 310 of FIG. 4. *Id.*, 7:37-45.

**10. Dependent Claim 27: The method of claim 14 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented in computer readable program code.**

297. Klayman in view of Li teaches dependent claim 27.

298. As discussed above with respect to claim 14, Klayman teaches each of (a) repeatedly acquiring the MEVs, (b) analyzing the repeated MEVs relative to the TEV, and (c) adjusting the CCR. *See supra*, Section X.B.2. These steps are performed by processors in communication with memory and in connection with “a computer, a workstation, or other data terminal equipment (“DTE”). Ex. 1007, 4:45-56. A POSITA would recognize that in order to perform the method steps of FIG. 4, the processor would execute software, specifically computer readable program code stored in the memory and/or at the connected computer, workstation, or other DTE, to instruct the processor on the steps for performance.

299. Moreover, Li explains that the method for generating Reed-Solomon codes can be performed by a process “implemented as a more general device that executes a computer program, microcode, or other software in order to perform the above-described processes. In such a case, the computer program may be stored in the memory 604 or on some other computer-readable medium such as a floppy disk, hard drive or CD-ROM.” Ex. 1008, [0040].

**11. Dependent Claim 28: The method of claim 14 wherein repeatedly acquiring the MEVs, analyzing the repeated MEVs relative to the TEV, and adjusting the CCR are implemented in hardware.**

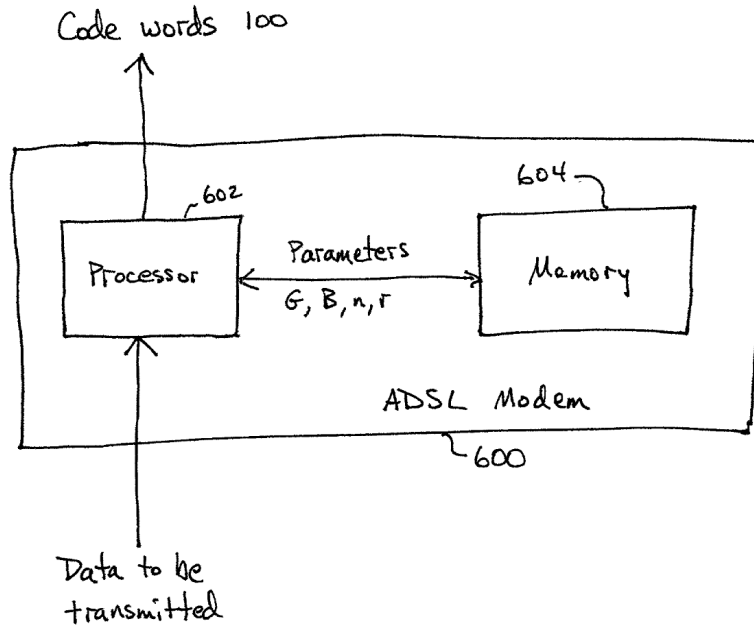
300. Klayman teaches dependent claim 28. As discussed above with respect to claim 14, Klayman teaches each of (a) repeatedly acquiring the MEVs, (b) analyzing the repeated MEVs relative to the TEV, and (c) adjusting the CCR. *See*

*supra*, Section X.B.2. Moreover, Cooper states that these steps (which are reflected as a part of the method illustrated in FIG. 4) can be implemented in hardware, specifically by a primary station including a commercially available integrated circuit that performs such functions as forward error correction encoding and decoding. Ex. 1007, 4:45-65.

**12. Dependent Claim 29: The method of claim 14 wherein the DSL modem is an Asymmetric Digital Subscriber Line (ADSL) system operable in compatibility with an ADSL2 standard and farther wherein adjusting the CCR comprises adjusting at least one of the following: Impulse Noise Protection (INP); or maximum interleaving delay.**

301. Klayman in view of Li teaches dependent claim 29. As discussed above, Klayman teaches that the described dynamic FEC coding scheme can be implemented on a communication system using “twisted pair wires” as the communication medium, which is commonly known as the communication medium used with DSL systems. Ex. 1007, 3:3-8.

302. Although Klayman does not explicitly discuss DSL modems (or the standards applicable to DSL modems), Li does. Specifically, Li discloses an ADSL modem (as illustrated in FIG. 6, reproduced below) for dynamically determining parameters for a FEC coding scheme. Ex. 1008, [0008], [0039].



*Id.*, Figure 6.

303. Li explains that the modems may be compliant with applicable standards, such as the G.992.1 and G.992.2 standards that were in effect at the time of Li's filing date (October 26, 2001). *Id.*, [0025]. Although these standards are commonly known to refer to ADSL1 or ADSL-Lite standards (*see e.g.*, Ex. 1001, 6:60-7:8), a POSITA reviewing Klayman and Li would have been familiar with updated ADSL standards, and would have implemented the teachings of Klayman with current ADSL standards (which, at the time of the '669 Patent filing, encompassed G.992.3/4/5 ADSL2 standards) so as to maintain compatibility with other ADSL2 modems in existence. A POSITA would have had a reasonable expectation of success in using an ADSL2 modem because a POSITA familiar with ADSL standards would have understood the features and requirements of an ADSL2 compatible modem.

304. Moreover, Li also discloses adjusting FEC parameters (including Reed-Solomon parameter pairs includes adjusting the FEC parameters based on impulse noise protection (INP) requirements and/or a delay. Ex. 1008, [0028]. As explained in Li, parameters (including the number of symbols or bytes per codeword, or the number of redundancy/parity bytes within the codeword) can be adjusted based on the specified INP or delay requirements. *Id.* The INP and delay are related to the Reed-Solomon parameters using a formula as specified in Li (and in G.992.3), and therefore a POSITA would recognize that Cooper's dynamic FEC coding scheme could be updated to consider INP or delay requirements using Li's formula. *See* Ex. 1008, [0028]; *see also* Ex. 1013, 32. Moreover, a POSTIA would recognize that ADSL standards (including ADSL-Lite and ADSL2) discuss INP and delay parameters (*see* Ex. 1008, [0026]-[0028]; *see also* Ex. 1013, 32-46 (describing that selection of FEC parameters must satisfy a requirement of meeting a minimum impulse noise protection)), and accordingly a POSITA would implement the dynamic FEC coding scheme of Klayman using an ADSL compatible modem that ensures compliance with INP and/or delay requirements.

### **13.Independent Claim 1**

305. Ground 1, above, discusses the function and structure of the "means-plus-function" elements recited in independent claim 1. Klayman's teachings include at least the same level of detail as the specification of the '669 patent with respect to

each recited “means-plus-function” in claim 1, and those structures of Klayman are discussed in reference to claims 14, 17, and 27, above.

***a. Element 1[pre]: A controller for an adaptive Forward Error Correction (FEC) coder using a Codeword Composition Ratio (CCR), wherein the FEC coder is used in a Digital Subscriber Line (DSL) modem in which a transmitter sends data via a channel using FEC coding and interleaving according to an original transmission latency, wherein the controller comprises***

306. Klayman alone or Klayman in view of Li discloses this limitation for the same reasons explained with respect to claim 14, limitations 14[pre], 14[a], and claim 17.

307. Though none of limitations 14[pre], 14[a], or 17 expressly identifies using “FEC coding ***and interleaving*** according to an original transmission latency,” Li discloses this portion of 1[pre]. Li discloses considering factors such as “delay” or “impulse noise protection” in selecting parameters, wherein one of those parameters is the “interleaver depth” (known as D). Ex. 1008, [0028]. Li explains that these parameters affect latency, and defines the relationship between the latency of the system and the FEC and interleaving parameters. *Id.* A POSITA would have known that data would be sent using FEC coding and interleaving at an original latency, which the ’669 patent suggests is the data transmission latency along a channel before the CCR is changed. Ex. 1001, 14:59-66.

***b. Element 1[a]: means for 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, wherein the means is coupled with the DSL modem;***

308. Klayman alone or Klayman in view of Li discloses this limitation for the same reasons I explained with respect to claim 14, limitation 14[c]. Limitation 1[a] is a means-plus-function limitation that recites a function analogous to that discussed in limitation 14[c], which claims “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.” Limitation 1[a] recites a function of “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.” As discussed in Ground 1, the ’669 patent specification discusses the structure of the “means” as a “transmission error value monitor” capable of “receiving an input signal 505 that is representative of the value being sought.” Ex. 1001, 13:18-23. The one difference in claim language is that limitation 1[a] recites “wherein the means is coupled with the DSL modem.” Klayman discloses that “the primary station includes a processor arrangement 120 which is connected to a plurality of channel interfaces, channel interface 125a through channel interface 125n, for communication over the communication medium 114.” Ex. 1007, 3:44-57. This structure for

“communication” over the communication medium matches the structure and functionality of the “means” discussed in the ’669 patent specification. To the extent that limitation 1[a] recites “wherein the means is coupled with the DSL modem,” a POSITA would have understood that Klayman’s communication structure serves to “couple” the processor arrangement and channel interfaces (which a POSITA would recognize includes a DSL modem based on Klayman alone or Klay in view of Li, as discussed in reference to claim 14).

***c. Element 1[b] means for analyzing the acquired MEVs relative to a Target transmission Error Value (TEV), wherein the analyzing means is coupled with the acquiring means; and***

309. Klayman alone or Klayman in view of Li discloses this limitation for the same reasons I explained with respect to claim 14, limitation 14[d]. Specifically, limitation 1[b] is a means-plus-function limitation that recites a function analogous to that discussed in limitation 14[d], which claims “analyzing the acquired MEVs relative to a Target transmission Error Value (TEV).” Limitation 1[b] recites a function of “analyzing the acquired MEVs relative to a Target transmission Error Value (TEV).” The ’669 patent specification states that the “means for analyzing one or more MEV(s)...can comprise software, hardware or a combination of the two.” Ex. 1001, 13:50-52. As discussed in reference to claims 17 and 27, above, Klayman describes the structure that performs this function as a “master controller,” and a POSITA would have recognized that the master controller executes software to

instruct the master controller to perform the recited steps. Ex. 1007, 3:44-57. Although limitation 1[b] recites “wherein the analyzing means is coupled with the acquiring means,” as with limitation 1[a], a POSITA would have understood all the elements of the system described by Klayman to be coupled. Ex. 1007, 3:43-57.

***d. Element 1[c] means for generating a CCR adjustment control signal during normal operation of the DSL modem (“SHOWTIME”) responsive to the means for analyzing, and transmitting the same to the DSL modem, wherein the generating means is coupled with the analyzing means.***

310. Klayman alone or Klayman in view of Li discloses this limitation for the same reasons I explained with respect to claim 14, limitations 14[b] and 14[e]. Specifically, limitation 1[c] is a means-plus-function limitation that recites a function analogous to those discussed in limitation 14[b], which claims “transmitting a control signal for transmitting data from the DSL modem,” and limitation 14[e], which claims “adjusting the CCR when the MEV differs sufficiently from the TEV.” Limitation 1[c] recites a function of “generating a CCR adjustment control signal during normal operation of the DSL modem (“SHOWTIME”) responsive to the means for analyzing, and transmitting the same to the DSL modem.” Moreover, the ’669 patent specification describes the structure that performs this function for generating a CCR (530) “can be implemented using software, hardware and/or a combination thereof.” Ex. 1001, 14:1-5. As discussed above in reference to element 1[b], Klayman provides the same level of detail specifying that the recited

functionality can be performed by analogous hardware or software. A POSITA would have understood the embodiments of Klayman to be in normal operation. Although limitation 1[b] recites “wherein the generating means is coupled with the analyzing means,” as with limitation 1[a], a POSITA would have understood all the elements of the system described by Klayman to be coupled. Ex. 1007, 3:43-57.

**14. Dependent Claim 2: The controller of claim 1 wherein the MEVs are based on at least one of the following: a bit error rate; errored seconds; errored minutes; code violations over a fixed period of time; a Signal-to-Noise Ratio (SNR) measured at the receiver; or Transmission Control Protocol and Internet Protocol (TCP/IP) throughput.**

311. Klayman alone or Klayman in view of Li discloses this claim for the same reasons I discussed with respect to claim 26, which is identical to claim 2 except that it is a “controller” rather than a method.

**15. Dependent Claim 3: The controller of claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as computer readable program code.**

312. Klayman alone or Klayman in view of Li discloses this claim for the same reasons I discussed with respect to claim 27. Both claims 27 and 3 recites that the method (and the correlating “means”) is “implemented” as “computer readable program code.”

**16. Dependent Claim 4: The controller of claim 1 wherein the acquiring means, the analyzing means and the generating means are implemented as hardware.**

313. Klayman alone or Klayman in view of Li discloses this claim for the same reasons I discussed with respect to claim 28. Both claims 28 and 4 recites that the method (and the correlating “means”) is “implemented” as “hardware.”

**17. Dependent Claim 11: The controller of claim 1 wherein the DSL modem is an Asymmetric Digital Subscriber Line (ADSL) modem operable in compatibility with an ADSL2 standard and further wherein the CCR adjustment control signal adjusts at least one of the following: Impulse Noise Protection (INP); or maximum interleaving delay.**

314. Klayman in view of Li discloses this claim for the same reasons I discussed with respect to claim 29, which is identical to claim 11 except that it is a “controller” rather than a method.

## **XI. REVISION OR SUPPLEMENTATION**

315. In this report, I have presented my opinions regarding the invalidity of the challenged claims of the 669 Patent based on the information available to me. My opinions are subject to change in view of opinions provided by the Patent Owner or its expert, or any additional information that I receive. I reserve the right to supplement my opinions accordingly.

## **XII. CONCLUSION**

316. The opinions and conclusions expressed in this Declaration represent my current opinions and conclusions, and the bases thereof. They may be revised and/or supplemented should additional information or insights become available to me.

317. As discussed above, it is my opinion that Claims 1-4, 11, 14-17, 19-20, 23, and 26-29 of the '669 Patent are obvious and should be canceled as unpatentable over the prior art.

318. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 or Title 18 of the United States Code.

Executed this 31<sup>st</sup> day of December, 2024.



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Richard D. Gitlin