

Declaration of Dr. Wilson in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 7,529,305 B1

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NINTENDO CO., LTD., and
NINTENDO OF AMERICA INC.,
Petitioners

v.

MALIKIE INNOVATIONS LTD.,
Patent Owner

U.S. Patent No. 7,529,305 B1
Issue Date: May 5, 2009

Title: COMBINATION OF SPACE-TIME CODING AND SPATIAL MULTIPLEXING, AND
THE USE OF ORTHOGONAL TRANSFORMATION IN SPACE-TIME CODING

DECLARATION OF SARAH KATE WILSON, PH.D.

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I, Sarah Kate Wilson, Ph.D., declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

1. I have been retained by Nintendo Co. Ltd. and Nintendo of America Inc., (“Petitioner”) as an independent expert for purposes of proceedings before the United States Patent and Trademark Office (“USPTO”).

2. I am being billed out at a rate of \$975/hour for my services in this proceeding.

3. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony or this declaration, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

A. Qualifications and Experience

4. I am an independent consultant. All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in wireless communication.

5. I am over 18 years of age and reside in Menlo Park, California. If I am called upon to do so, I would be competent to testify as to the matters set forth herein.

6. In this section, I provide information regarding my background, qualifications, and experience relevant to the issues in this litigation. A copy of my

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current curriculum vitae, which details my education and professional and academic experience, is included as EX1002¹ with this declaration. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

7. I have extensive experience in the field of wireless communications through my education, my research work, and my teaching. I earned a Bachelor of Arts in mathematics with honors from Bryn Mawr College in 1979. After working in industry for several years, I went to graduate school and earned my M.S. in Electrical Engineering from Stanford University in 1987. In 1989, I returned to Stanford to work on my Ph.D. in Electrical Engineering in wireless communications; my thesis was on Orthogonal Frequency Division Multiplexing (OFDM). I received my Ph.D. in 1994.

8. Since graduating from Stanford with my Ph.D., I have published over 60 journal and conference papers in digital communications, two book chapters, and edited one book on transmission techniques for wireless communications. My research has focused mainly on OFDM and has spanned the areas of cellular communications, wireless LANs, digital subscriber lines (DSL), LiFi and underwater communications.

¹ Throughout this declaration, I will refer to exhibits using the abbreviation EX####.

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9. I have researched communications and taught both undergraduate and graduate courses in digital and wireless communications at universities in the United States (Stanford University, Purdue University, and Santa Clara University) and Sweden (Lulea University of Technology and the Royal Institute of Technology).

10. I also have significant experience in the wireless communications industry. For example, I worked at ArrayComm, a smart antenna company and consulted for multiple companies, including Texas Instruments where I worked on modeling the physical and link layer of LTE and handover schemes.

11. From 2006 to 2023 when I retired, I taught at Santa Clara University in the Electrical and Computer Engineering Department where I was a full professor.

12. My community has acknowledged my work through awards. I became an IEEE Fellow in 2014 “for contributions to OFDM.” I received the IEEE Communications Society Joseph LoCicero Award “For sustained and innovative contributions to Publications” in 2017 from the IEEE Communications Society. In 2018 I was awarded the IEEE Education Society Harriett B. Rigas award for “for excellence in communications engineering, education and promoting equity.”

B. Materials Considered

13. The analysis that I provide in this declaration is based on my education, research, and experience, as well as the documents I have considered. In forming

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my opinions, I have read and considered U.S. Patent No. 7,529,305 B1 (“305 patent”) (EX1001) and its prosecution history (EX1013). I have considered the following documents in my analysis below, most of which are cited in this declaration:

Exhibit No.	Description of Exhibit
1001	U.S. Patent No. 7,529,305 B1 to Wen Tong, Michail G. Bakulin, Vitaly B. Kreyndelin, Alexander M. Shloma, Yuriy S. Shinakov (Issued May 5, 2009)
1002	Curriculum Vitae of Sarah Kate Wilson, Ph.D.
1003	Tarokh, Vahid, et al., “Space-Time Codes for High Data Rate Wireless Communication: Performance Criterion and Code Construction,” <i>IEEE Transactions on Information Theory</i> , Vol. 44, No. 2, (March 1998)
1004	Naguib, Ayman F., et al., “A Space-Time Coding Modem for High-Data-Rate Wireless Communications,” <i>IEEE Journal on Selected Areas in Communications</i> 16.8, (1998)
1005	Bevan, D.D.N., et al., “Space-Time Coding for Capacity Enhancement in Future-Generation Wireless Communications Networks,” Nortel Networks, (2000)
1006	Alamouti, Siavash M., Vahid Tarokh, and Patrick Poon, “Trellis-Coded Modulation and Transmit Diversity: Design Criteria and Performance Evaluation,” <i>ICUPC’98, IEEE 1998 International Conference on Universal Personal Communications</i> , Conference Proceedings (Cat. No. 98TH8384). Vol. 1. IEEE, (1998)
1007	Li, Ye, et al., “Transmitter Diversity for OFDM Systems and Its Impact on High-Rate Data Wireless Networks,” <i>IEEE Journal on Selected Areas in Communications</i> , Vol. 17.7, (1999)
1008	Calderbank, A. Robert, “The art of signaling: Fifty Years of Coding Theory,” <i>IEEE transactions on Information Theory</i> , Vol. 44.6 (1998)

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Exhibit No.	Description of Exhibit
1009	Gaspa, Roger, and Javier R. Fonollosa, “Space-Time Coding for UMTS. Performance Evaluation in Combination with Convolutional and Turbo Coding,” IEEE, (2000)
1010	Gaspa, Roger, and Javier R. Fonollosa, “Comparison of Different Transmit Diversity Space- Time Code Algorithms,” (2000)
1011	Papadias, Constantinos, “On the Spectral Efficiency of Space-Time Spreading Schemes for Multiple Antenna CDMA Systems,” Proc. 33rd Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, IEEE, (1999)
1012	Mitra, Urbashi, <i>New Robust Estimation/Detection Techniques With Applications to Wireless CDMA Communications</i> , No. AFRL-SR-BL-TR-000286, (1999)
1013	File History for U.S. Patent No. 7,529,305 B1
1014	<i>Malikie, et al. v. Nintendo, et al.</i> , No. 2:24-cv-01490-JLR, D.I. 50, LPR 132 Joint Claim Construction and Prehearing Statement (Amended), (W.D. Wash.) (Filed 09/24/2025)
1015	U.S. Patent No. 6,377,632
1016	U.S. Patent No. 6,628,702
1017	U.S. Patent No. 5,241,544
1018	U.S. Patent No. 5,410,538
1019	<i>Malikie, et al. v. Nintendo, et al.</i> , No. 2:24-cv-01490-JLR, Plaintiffs’ Infringement Contentions Cover Document and Exhibit E (Claim Chart for ’305 Patent), (W.D. Wash.)
1020	Lee, Donghoon, and Kyungwhoon Cheun, “A New Symbol Timing Recovery Algorithm for OFDM Systems,” <i>IEEE Transactions on Consumer Electronics</i> , Vol. 43.3, (1997)
1021	U.S. Patent No. 6,421,401

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Exhibit No.	Description of Exhibit
1022	Kim, Yun Hee, et al., “An efficient frequency offset estimator for OFDM systems and its performance characteristics,” <i>IEEE Transactions on Vehicular Technology</i> , Vol. 50.5, (2001)
1023	Wu, Yiyan, and William Y. Zou, “Orthogonal frequency division multiplexing: A multi-carrier modulation scheme,” <i>IEEE Transactions on Consumer Electronics</i> , Vol. 41.3, (1995)
1024	Dabak, A. G., et al., “A comparison of the open loop transmit diversity schemes for third generation wireless systems,” <i>2000 IEEE Wireless Communications and Networking Conference</i> , 441
1025	Yong, Wang, et al, “Multiuser Detector with Transmit Diversity in the Convolutionally Coded DS/CDMA Systems,” <i>VTC2000-Spring. 2000 IEEE 51st Vehicular Technology Conference Proceedings</i> (Cat. No. 00CH37026). Vol. 1. IEEE, 2000
1026	U.S. Patent No. 6,128,330
1027	U.S. Patent No. 6,952,454
1028	Salmasi, Allen, and Klein S. Gilhousen, “On the system design aspects of code division multiple access (CDMA) applied to digital cellular and personal communications networks,” <i>Proc. VTC</i> , Vol. 91, (1991)
1030	Damen, M. Oussama, Karim Abed-Meraim, and Teng Joon Lim, “Transmit Diversity as a Combination of Spatial and Delay Diversity,” <i>2000 IEEE Sixth International Symposium on Spread Spectrum Techniques and Applications. ISSTA 2000. Proceedings</i> (Cat. No. 00TH8536). Vol. 1. IEEE, 2000.
1031	U.S. Patent Appl. Publ. No. 2004/0013211 A1
1032	U.S. Patent No. 6,542,556
1033	U.S. Patent No. 6,351,499
1034	Rappaport, Theodore S., “Wireless Communications—Principles and Practice, Second Edition,” Prentice-Hall (2002)

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Exhibit No.	Description of Exhibit
1035	Sampath, He., and A. Paulraj, “Space-Time Processing TDMA Wireless Testbed,” <i>1999 IEEE International Conference on Acoustics, Speech, and Signal Processing. Proceedings</i> , ICASSP99 (Cat. No. 99CH36258). Vol. 4. IEEE, 1999
1036	Varshney and Vetter, “Emerging Mobile and Wireless Networks,” <i>Communications of the ACM</i> , Vol. 43, No. 6, June 2000
1037	Erceg et al. “A Model for Multipath Delay Profile of Fixed Wireless Channels,” <i>IEEE Journal on Selected Areas in Communications</i> , Vol. 17, No. 3, March 1999
1038	Rappaport, Theodore S., Scott Y. Seidel, and Rajendra Singh, “900-MHz multipath propagation measurements for US digital cellular radiotelephone,” <i>IEEE Transactions on Vehicular Technology</i> 39.2 (1990): 132-139
1039	Cox, Donald, “Delay Doppler characteristics of multipath propagation at 910 MHz in a suburban mobile radio environment,” <i>IEEE Transactions on Antennas and Propagation</i> , Vol. AP-20, No. 5 (September 1972): 625-635
1040	Cox, Donald, “910 MHz urban mobile radio propagation: Multipath characteristics in New York City,” <i>IEEE Transactions on Communications</i> 21.11 (1973): 1188-1194
1041	Cox, Donald and Robert Leck, “Distributions of Multipath Delay Spread and Average Excess Delay for 910-MHz Urban Mobile Radio Paths,” <i>IEEE Transactions on Antennas and Propagation</i> , Vol AP-23, No. 2 (March 1975)
1042	Malikie 07/28/2025 Email Confirming Malikie Position that “mth” and “m-1” Limitations are Satisfied “for any value of m from 1 to M”
1043	<i>Malikie, et al. v. Nintendo, et al.</i> , No. 2:24-cv-01490-JLR, Report of Matthew B. Shoemake, Ph.D., Regarding Claim Construction, (W.D. Wash.) (Signed 08-06-2025)

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Exhibit No.	Description of Exhibit
1044	Zeng, Mao, A. Annamalai, and Vijay K. Bhargava, “Harmonization of global third-generation mobile systems,” <i>IEEE Communications Magazine</i> 38.12 (2000): 94-104
1045	3GPP TS 25.213 V2.2.0 (1999-8), TSGR1#7 (99)c71
1046	<i>BlackBerry Limited v. Nokia Corporation</i> , No. 1-17-cv-00155, D.I. 1 (Complaint), (D. Del.) (filed Feb. 14, 2017)

II. PERSON OF ORDINARY SKILL IN THE ART

14. I am informed by counsel that, under the patent laws in effect before the America Invents Act (“AIA”) of 2011, an assessment of claims of a patent filed before the AIA took effect should be undertaken from the perspective of a person of ordinary skill in the art as of the earliest claimed priority date (*i.e.*, the “time the invention was made”). I understand that the ’305 patent claims priority to PCT No. PCT/RU00/00426, which was filed on October 27, 2000. I understand that Patent Owner has alleged that October 27, 2000 is the earliest priority date (also referred to herein as “critical date”) for the ’305 patent. (EX1019, pp.002-03.)

15. I have been advised that to determine the appropriate level of a person having ordinary skill in the art, I may consider the following factors: (1) the types of problems encountered by those working in the field and prior art solutions thereto; (2) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (3) the educational level of active workers in the field;

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and (4) the educational level of the inventor. I am also informed that a person of ordinary skill in the art is presumed to be aware of all of the pertinent prior art.

16. The '305 patent purports to disclose “systems and methods for performing layered space-time coding for wireless channels.” ('305 patent, 1:8-9.)

17. In my opinion, and based on the subject matter of the '305 patent, a person of ordinary skill in the art at the time of the alleged invention would have had at least a bachelor's degree in electrical engineering, computer science, or a related field, and at least two years of practical experience and/or graduate level education with wireless communications, in particular transmission and reception of signals and methods to improve performance. Additional education could have substituted for professional experience, and significant work experience could have substituted for formal education. My opinion regarding the level of ordinary skill in the art appears to be largely consistent with the opinion of Patent Owner's expert, Dr. Shoemake, in the related district court litigation. (EX1043, ¶¶19-20.) Moreover, the opinions I have expressed throughout this declaration would be the same under Dr. Shoemake's description of the level of ordinary skill in the art.

18. My opinions regarding the level of ordinary skill in the art are based on, among other things, my more than 30 years of experience in the field of wireless communication, my understanding of the basic qualifications that would be relevant

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to an engineer or scientist tasked with investigating methods and systems in the relevant area, and my familiarity with the backgrounds of colleagues, co-workers, and students, both past and present.

19. Although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art defined above, I qualified as at least a person of ordinary skill in the art as of the alleged priority date of October 27, 2000, and, in my analysis below, I have adopted the perspective of one of ordinary skill in the art as of October 27, 2000. In addition to being at least a person of ordinary skill in the art, I have worked closely with many such persons over the course of my career. My opinions and analysis below would remain the same if a person of ordinary skill in the art were found to have somewhat more or less formal education and/or somewhat more or less work experience in the field.

III. STATEMENT OF LEGAL PRINCIPLES

A. Claim Construction

20. I understand that a purpose of claim construction is to determine what a person of ordinary skill in the art would have understood the claim terms to mean. Claim terms are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question as of the critical date (i.e., either the earliest claimed priority date (pre-AIA) or the

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effective filing date (AIA)).

21. I understand that the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. I understand that the patent specification, under the legal principles, has been described as the single best guide to the meaning of a claim term, and is thus highly relevant to the interpretation of claim terms. Also, I understand for terms that do not have a customary meaning within the art, the specification usually supplies the best context of understanding the meaning of those terms.

22. I further understand that other claims of the patent in question, both asserted and unasserted, can be valuable sources of information as to the meaning of a claim term. Because the claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

23. I understand that the prosecution history can further inform the meaning of the claim language by demonstrating how the inventors understood the invention and whether the inventors limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be. Extrinsic evidence, such as

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dictionaries, may also be consulted in construing the claim terms.

24. I understand that, in *Inter Partes* Review (IPR) proceedings, a claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in a U.S. district court (which I understand from counsel is called the “*Phillips*” claim construction standard), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the specification and prosecution history pertaining to the patent.

25. I have been instructed by counsel to apply the “*Phillips*” claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require an explicit construction. The description of the legal principles set forth above thus provides my understanding of the “*Phillips*” standard as provided to me by counsel. I have applied these principles and standards in my analysis below.

B. Obviousness

26. I understand that a patent claim is obvious if, as of the critical date (i.e., either the earliest claimed priority date (pre-AIA) or the effective filing date (AIA), it would have been obvious to a person having ordinary skill in the field of the technology (the “art”) to which the claimed subject matter belongs.

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27. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that certain other facts known as “secondary considerations” such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others may be utilized as indicia of nonobviousness. I understand, however, that secondary considerations should be connected, or have a “nexus,” with the invention claimed in the patent at issue.

28. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

29. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a

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motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid “hindsight bias” and ex post reasoning in performing an obviousness analysis. But this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

30. I understand that when determining whether a patent claim is obvious in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid.

31. I understand one way that a patent can be found obvious is if 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 understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide

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a reason to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to known methods, the combination is likely to be obvious when it does no more than yield predictable results. Thus, if a person of ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

32. I understand that obviousness may be shown by demonstrating that it

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would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the art, or from sources such as explicit statements in the prior art. I understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his skill to combine the known options in order to solve the problem.

33. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art:

- (1) Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;

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- (2) Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;
- (3) Combining prior art elements according to known methods to yield predictable results;
- (4) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;
- (5) Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- (6) Simple substitution of one known element for another to obtain predictable results; or
- (7) Use of a known technique to improve similar products, devices, or methods in the same way.

34. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether one 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 understand 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.

35. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. The test for obviousness, in other words, is not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

IV. TECHNOLOGY BACKGROUND

36. The concepts underlying the '305 patent have long been known to ordinary practitioners and scholars in the field of wireless communication.

A. Diversity

37. In relation to wireless communication, the term “diversity” is often used to refer to methods used to improve reliability and/or increase performance by using two or more communication channels. Multiple diversity techniques were well-known to those skilled in the art, including—but not limited to—time, frequency, and space diversity:

Time Diversity: Replicas of the transmitted signal are provided to the receiver in the form of redundancy in the time domain, such as by channel coding and interleaving.

Frequency Diversity: Replicas of the transmitted signal are provided to

the receiver in the form of redundancy in the frequency domain, such as by transmitting the same information on different frequencies.

Space Diversity: Replicas of the transmitted signal are provided to the receiver in the form of redundancy in the spatial domain, such as by transmitting the same information using multiple antennas.

(EX1003 (Tarokh 1998), p.001; EX1004 (Naguib 1998), pp.001-02.)

38. Those skilled in the art have long recognized the importance of diversity techniques to wireless communication. (EX1004 (Naguib 1998), p.001 (“Perhaps the single most important factor in providing reliable communications over wireless channels is diversity.”).) And the prior art specifically encouraged combining multiple diversity techniques in a single wireless communication system. (EX1003 (Tarokh 1998), pp.001-02 (“When possible, cellular systems should be designed to encompass all forms of diversity to ensure adequate performance [26].”).)

B. Space-Time Coding

39. Although there is not a universally agreed upon definition of what qualifies as space-time coding,² space-time coding generally refers to coding designs

² For example, some prior art authors described delay diversity as a special case of space-time coding. (EX1003 (Tarokh 1998), p.003 (“It is shown that the delay

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that exploit both spatial diversity and time diversity in a multiple transmitter system. (EX1005 (Bevan 2000), p.001 (space-time coding “exploits both the temporal and spatial dimensions for the construction of coding designs”); EX1004 (Naguib 1998), p.002 (“spatial and temporal properties of [space-time coded modulation] guarantee that diversity is achieved at the transmitter”).) In the late 1990s, some of the most well-known space-time coding designs encoded information in both space and time to achieve coding gain and/or diversity gain. (*See, e.g.*, EX1006 (Alamouti 1998), p.002 (describing space-time coding that provides “diversity order of $2M$ ” but no coding gain); EX1008 (Calderbank 1998), p.028 (“the space-time codes constructed by Tarokh, Seshadri, and Calderbank [209] provide both coding gain and diversity”).)

40. Prior to the priority date of the '305 patent, four common forms of space-time coding included Space-Time Block Coding (STBC), Space-Time Spreading (STS), Space-Time Trellis Coding (STTC), and layered space-time

diversity scheme of Seshadri and Winters [32] is a specific case of space-time coding.”.) While others appeared to view delay diversity as something distinct from space-time coding. (*See, e.g.*, EX1007 (Li 1999), pp.002-04 (describing delay diversity and space-time coding as different types of diversity).)

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coding, e.g. BLAST. (EX1009 (Gaspa 2000-Space-Time Coding for UMTS), p.001;
EX1011 (Papadias 1999), pp.002-03.)

41. STBC involves encoding the information to be transmitted using block codes and transmitting the encoded information over multiple antennas. (EX1009 (Gaspa 2000-Space-Time Coding for UMTS), pp.002-03.) The block codes used in STBC are often (although not required to be) orthogonal in order to prevent interference between the signals transmitted from each antenna. (*Id.*, p.004.) One well-known STBC design is an orthogonal code by Alamouti for a two antenna system. (EX1006 (Alamouti 1998), p.002.) STBC provides diversity gain but does not necessarily provide coding gain. (EX1010 (Gaspa 2000-Comparison of Different Transmit Diversity Space-Time Code Algorithms), pp.003-04.)

42. STS involves transmitting the same data over multiple antennas, but encoding the information for each antenna using different spreading codes. (EX1011 (Papadias 1999), pp.002-03; *see also* EX1012 (Mitra 1999), p.006 (describing STS as disclosed in EX1009 as an example of applying “space-time coding to DS-CDMA systems”).) STS can provide increased spectral efficiency for CDMA based systems. (EX1011 (Papadias 1999), Abstract.)

43. STTC involves encoding the information to be transmitted using trellis codes and transmitting the encoded information over multiple antennas. (EX1003

(Tarokh 1998), pp.003-04.) STTC provides both coding gain and diversity gain, but is typically viewed as having increased complexity as compared to STBC. (EX1010 (Gaspa 2000-Comparison of Different Transmit Diversity Space-Time Code Algorithms), p.004.)

44. Layered space-time coding is a diversity technique where information is demultiplexed into multiple substreams, encoded into symbols, and transmitted over multiple antennas. Layered space-time coding systems can “take[] advantage of the spatial dimension by transmitting and detecting a number of independent co-channel data streams (substreams) each one transmitted from a different antenna [[5]-[7]].” (EX1010 (Gaspa 2000-Comparison of Different Transmit Diversity Space-Time Code Algorithms), p.004.) Two layered space-time coding architectures that were well-known at the time were Vertical-BLAST and Diagonal-BLAST. D-BLAST was similar to STBC and STTC in that it introduced redundancy by having all bits transmitted from all antennas. (*Id.*, pp.004-05.)

V. THE '305 PATENT [EX1001]

A. Overview of the Specification

45. The '305 patent states that it “relates to systems and methods for performing layered space-time coding for wireless channels.” ('305 patent, 1:8-9.)

46. In the Background section, the '305 patent identifies certain layered

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space-time coding approaches where data is demultiplexed into separate substreams, which are “encoded and modulated separately,” and the resulting data symbols on each substream are then transmitted over separate antenna. (’305 patent, FIGS. 1-2, 1:24-2:37.) The problem with this approach, according to the ’305 patent, is that it fails to provide improvements in signal-to-noise ratio (SNR) because each data symbol (s_m) is transmitted only by one antenna:

That such a system has no improvement in SNR performance can be explained by noting that the data symbol s_m is transmitted only by one antenna, and in case of full cancellation of other transmit antennas, the model of such a system is shown in FIG. 3. In this case there is one transmit antenna and N receive antennas. Therefore, for symbol s_m there is no coding gain.

(’305 patent, 2:38-44.)

47. The ’305 patent describes two primary sets of embodiments related to the alleged invention. In FIGS. 4 and 5, the patent provides examples of “symbol level space-time encoding in the sense that the input to the space-time encoding process consists of symbols output by the encoder/modulator blocks.” (’305 patent, 5:1-4.) And in FIGS. 6-7, the patent describes an embodiment “in which bit-level space-time encoding is performed.” (’305 patent, 5:4-6 and 5:18-21.)

48. For the symbol level space-time coding embodiment in FIG. 4, the ’305 patent describes producing encoded substreams $s_1, s_2, \dots, s_M$ and performing an

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orthogonal transformation of each of the symbols $s_1, s_2, \dots, s_M$ to generate space-time coded symbol $x_1, x_2, \dots, x_M$ that are “a function of all the instantaneous inputs.” (’305 patent, 4:3-42.) Then, “to achieve [] separation in time” each space-time coded symbol is delayed by a different time period to create symbols $z_1, z_2, \dots, z_M$ that are each transmitted on their own respective antenna. (’305 patent, 4:43-51.)

49. For the symbol level space-time coding embodiment in FIG. 5, the ’305 patent provides the same architecture for producing encoded substreams $s_1, s_2, \dots, s_M$. In FIG. 5, however, the symbols $s_1, s_2, \dots, s_M$ are first subjected to time delays, then undergo scaling/complex multiplication, and finally are combined to create symbols $z_1, z_2, \dots, z_M$ that are each transmitted on their own respective antenna. (’305 patent, 4:42-62.) The ’305 patent describes FIG. 5 as “mathematically equivalent to the embodiment of FIG. 4 in that each output symbol z_m is again a function of all of the input symbols at a given instant, but at different times. Effectively, the delay block and the orthogonal transformation functions have been done in reverse order.” (’305 patent, 4:62-67.)

50. For the bit-level space-time encoding embodiment in FIG. 6, the ’305 patent describes generating bit substreams $u_1, \dots, u_M$ which are fed into delay elements, the bits output of which are fed to respective QAM symbol mapping functions. (’305 patent, 5:4-17.) Each QAM mapping function maps its M input

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bits to a corresponding output symbol z_m which is output by a corresponding antenna.

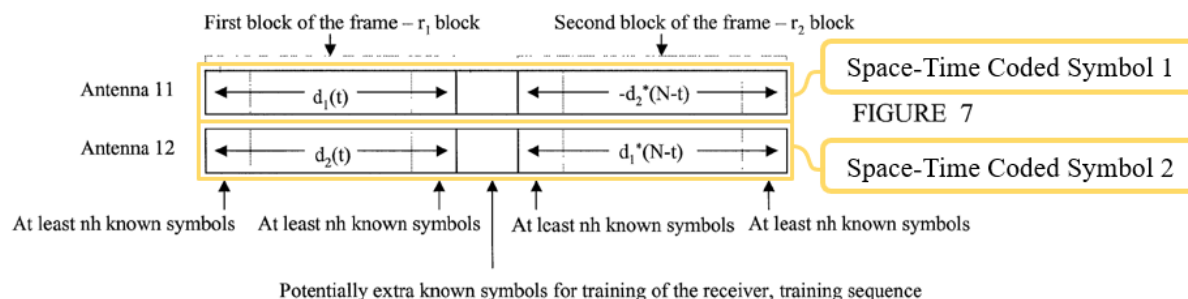
(*Id.*) FIG. 7 provides a “specific example of the embodiment of FIG. 6” in which the demultiplexer 59 is a 1:4 demultiplexer, the QAM mappings are 16 QAM, there is a single delay T , and two outputs for symbols z_1 , z_2 fed to respective transmit antennas. (’305 patent, 5:18-35.)

B. Prosecution History [EX1013]

51. I have been informed that the ’305 patent was filed as PCT No. PCT/RU00/00426 on October 27, 2000, which became national application No. 10/399,859. I understand that the earliest date to which the ’305 patent claims priority is October 27, 2000.

52. During prosecution of the ’305 patent, the application was rejected based on a number of different prior art references, including U.S. 2004/0013211A1 (“Lindskog” EX1031). (EX1013 (’305 FH), pp.265-79.) For the rejection based on Lindskog, the Examiner pointed to two series of symbols represented by $(d_1(t) - d_2^*(N-t))$ and $(d_2(t) - d_1^*(N-t))$ as shown in FIG. 7 as the “space-time coded symbols” recited in the claims. (See EX1013 (’305 FH), p.265.) As annotated below, each series of symbols the Examiner identified as the “space-time coded symbols” are comprised of two blocks, which include representations of symbol streams $d_1(t)$ and $d_2(t)$:

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(EX1031 (Lindskog), FIG. 7 (annotated); *id.*, [0021], [0024], [0075], [0092] (confirming $d_1(t)$ and $d_2(t)$ are “symbol streams”).)

53. The Applicant raised some initial arguments disputing that the series of symbols in Lindskog can be construed as a single space-time coded symbol. (See EX1013 ('305 FH), pp.297-300.) However, rather than amending the claims to clarify or limit the meaning of the word “symbol,” the Applicant instead amended the claims to recite that the “space-time coded symbols...are transmitted at different times” and then distinguished Lindskog because even under the Examiner’s construction of “symbol,” the symbols the Examiner identified are transmitted simultaneously:

Notwithstanding this, Applicant has amended claim 1 in the manner suggested by the Examiner to include the following limitation upon the symbols transmitted:

“such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times”.

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Using the Examiner's construction of "symbol", the entirety of Figure 7 that is transmitted on one antenna is a "single symbol". As such, the "symbol" transmitted on the first antenna that contains the representation of d_1 is transmitted simultaneously with the "symbol" transmitted on the second antenna containing a representation of d_1 .

(EX1013 ('305 FH), p.300.)

54. In response to Applicant's amendments, the Examiner initiated an interview in which the Examiner and Applicant discussed the prior art, the claims, and the pending rejection. (EX1013 ('305 FH), p.309.) In the interview summary, the Examiner noted that "[t]he attorney agrees to the proposed changes to [the] claims" but the Examiner did not indicate s/he agreed to Applicant's understanding of the prior art. (*Id.*) To the contrary, in the Notice of Allowance the Examiner continued to note that Lindskog discloses a similar space-time coding system and made clear that it was the amendments specifying that the space-time coded symbols are transmitted at different times that put the application in condition for allowance:

The closest prior art, Lindskog et al. (US 2004/0013211 A1) discloses a similar space time coding system but fail to disclose a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams, such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times. This distinct feature has been added to the independent claim 24, thus

rendering claims 24-30 allowable.

(EX1013 ('305 FH), p.316.)

55. The Applicant did not file any response to the Examiner's interview summary, or the Examiner's characterization of the basis for allowability in the Notice of Allowance.

C. The Challenged Claims

56. My declaration addresses independent claim 1 and dependent claims 2-3 and 6 of the '305 patent. Claim 1 recites:

- 1[p]** A transmitter adapted to process a plurality M of symbol substreams, the transmitter comprising:
 - 1[a.i]** a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols,
 - 1[a.ii]** each input set of M symbols comprising one symbol per symbol substream,
 - 1[a.iii]** each of the M space-time coded symbols being included in a respective one of M space-time coded streams,
- 1[b]** wherein each symbol of the M symbol substreams is represented in all M space-time coded streams,
- 1[c]** wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams,
- 1[d]** each space-time coded symbol comprising a representation of a

symbol of each of the M symbol substreams;

1[e] a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams,

1[f] such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.

('305 patent, 5:60-6:14 (Claim 1; bracketed notations (e.g., **[a.i]**) added).)

VI. CLAIM CONSTRUCTION

57. I understand that Petitioner and Patent Owner have raised certain claim construction positions related to the '305 Patent as summarized in the chart below.

Term	Petitioner's Construction	Patent Owner's Construction
M substreams	M symbol substreams	
the space-time coding function	the space-time coding block	
mth	(m=1,...,M)th where the claim is satisfied if the limitations are met for any single value of m	(m=1,...,M)th where the claim is satisfied if the limitations are met for all values of m
m-1	((m=1,...,M) – 1) where the claim is satisfied if the limitations are met for any single value of m	((m=1,...,M) – 1) where the claim is satisfied if the limitations are met for all values of m

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Term	Petitioner's Construction	Patent Owner's Construction
a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams		a time delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams
delay elements adapted to insert a delay in at least one of the M substreams		delay elements adapted to insert a time delay in at least one of the M symbol substreams

(See, e.g., EX1014; EX1042, EX1043.) As discussed below, the prior art invalidates the claims regardless of which construction is applied. Accordingly, I do not take a position on these claim constructions.

58. To the extent that I felt it was necessary to explain my understanding of the plain-and-ordinary meaning of a term, I have done so in my analysis below.

VII. APPLICATION OF THE PRIOR ART TO CHALLENGED CLAIMS

59. I have reviewed and analyzed the prior art references and materials listed in Part I.B. above. In my opinion the claims of the '305 patent are anticipated and/or rendered obvious based on the following prior art.

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Ground	Claims	Basis for Challenge
1	1-3, 6	Paulraj '632 (Anticipation and/or Obviousness)
2	2-3	Paulraj '632 in view of Jalali '454
3	2-3, 6	Paulraj '632 in view of Schilling '330
4	1-3, 6	Rowitch '702 in view of Paulraj '632
5	2-3	Rowitch '702 in view of Paulraj '632 and Jalali '454
6	2-3, 6	Rowitch '702 in view of Paulraj '632 and Schilling '330

60. For each of these identified invalidity grounds, a person of ordinary skill in the art would have considered the teachings of the identified references further in view of such a person's knowledge, skill, and experience in the art of wireless communication. In my opinions below, my discussion and analysis of the teachings of a particular reference or what was known by one of skill in the art is not meant to and should not be understood to be limited to the particular ground, claim, or claim element in which such discussion or analysis appears, but rather as relevant and applicable to any and all related or applicable grounds, claims, or claim elements.

61. I am informed by counsel that each of the references cited in the grounds above qualifies as prior art to the challenged claims because each reference was filed and/or published before the '305 patent critical date.

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A. Brief Summary of Prior Art

62. As discussed above, the '305 patent purports to relate to improvements to wireless communications, and in particular describes alleged improvements to cellular communications standards used for wireless Internet. ('305 patent, 1:13-45.) However, the concepts disclosed and claimed in the '305 patent were well known in wireless communication, including in cellular communications references. While I understand that Patent Owner is currently accusing the '305 patent against Wi-Fi technology, a prior patent owner represented that the '305 patent is related to cellular technology. (EX1046, ¶¶36, 65, 106-109, 163-170.) The following is a brief summary of the primary references addressed in this declaration.

1. Paulraj '632 [EX1015]

63. Paulraj '632, U.S. Patent No. 6,377,632, is titled "Wireless Communication System and Method Using Stochastic Space-Time/Frequency Division Multiplexing." (Paulraj '632.) Paulraj '632 "relates generally to wireless communication systems and adaptive methods of operating such systems in a multipath fading environment." (Paulraj '632, 1:8-10.) I am informed that Paulraj '632 qualifies as prior art to the '305 patent because it was filed on January 24, 2000, which is before the '305 patent's critical date.

64. Paulraj '632 discloses a transmitter as shown in FIG. 1 that includes

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multiple diversity branches for wireless communication. Paulraj '632 teaches "a bitstream 102 of information is fed to a modulation block 104, which generates an output symbol stream 106 Symbol stream 106 is then fed to a serial to parallel converter 108, which collects a set of N symbols into a frame.... The frame of symbols is fed to a coding block 110. Coding block 110 outputs are fed to P diversity branches 109," each with its own antenna. (Paulraj '632, 4:53-66.)

65. Paulraj '632 FIGS. 2-3 illustrate the operation of embodiments of coding block 110. In both figures, the "frame of complex symbols $\{S_1, \dots, S_N\}$ is fed to each diversity branch 109 (FIG. 1) in parallel" and, without a cyclic shift for FIG. 2 and after a cyclic shift for FIG. 3, then undergoes "matrix multiplication in the matrix multipliers 128. The controller 120 controls the action of the shift blocks 150." (Paulraj '632, 5:52-60.)

66. Following the coding block 110, the multi-datastream output is fed to transform blocks 130, "where each data frame is multiplied by a transform matrix. This transformation maps an input frame of N complex values into M values, where $M \geq N$." (Paulraj '632, 7:16-38.) Paulraj '632 discloses multiple transforms, including Walsh-Hadamard and IFFTs. (Paulraj '632, 7:21-34.) Paulraj '632 also teaches that when an IFFT transform matrix is used, then $M=N$. (Paulraj '632, 7:37-38.) "After the transformation of each datastream, the transformed coefficients are

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passed through a parallel-to-serial converter block 132 ... where a cyclic prefix equal in symbol length to $L-1$ can be added, where L corresponds to channel length and the delay introduced into the diversity branches.... The role of the prefix is to avoid interference between consecutive frames The resulting $M+L-1$ complex valued symbols of each diversity branch go through individual delays. The amount of delay can be controlled by coding block 110 based on the feedback regarding the channel length if available.” (Paulraj ’632, 7:47-61; *see also id.* 4:66-5:5 (“Each diversity branch 109 also has a unique delay (shown as delays $1-P$) that is controlled by the coding block 110. Each of the P delays imposes a particular, unique amount of delay on the symbols being transmitted.”).)

67. Additional details about Paulraj ’632 are provided in the analysis of the ’305 patent claim limitations.

2. Rowitch ’702 [EX1016]

68. Rowitch ’702, U.S. Patent No. 6,628,702, is titled “Method and Apparatus for Demodulating Signals Processed in a Transmit Diversity Mode.” (Rowitch ’702.) Rowitch ’702 relates generally to “data communications. More particularly, the present invention relates to method and apparatus for efficiently demodulating signals that have been processed and transmitted in a diversity mode.” (Rowitch ’702, 1:9-12.) I am informed that Rowitch ’702 qualifies as prior art to

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the '305 patent because it was filed on June 14, 2000 which is before the '305 patent's critical date.

69. Rowitch '702 discloses a transmitter 110 and receiver 130 in a communications system 100. (Rowitch '702, 4:32-64.) The transmitter 110 includes “modulator 116, which can be used to process a downlink data transmission in a Space-Time Spreading transmit diversity mode in accordance with the CDMA-2000 standard (hereinafter referred to as the STS mode).” (Rowitch '702, 5:43-47.) As shown in FIG. 2, in the modulator 116 data symbols Y are “demultiplexed into two complex symbol streams, Y_{even} and Y_{odd} , which are then provided to modulators 210a and 210b.” (Rowitch '702, 5:46-51.) Within each modulator 210a/b, the even and odd complex symbol streams, Y_{even} and Y_{odd} , are provided to symbol repeaters 212a/c and 212b/d, and then cover elements 214a/c and 214b/d, respectively, which cover the data symbols with a Walsh space-time spreading symbol (W_{STS} and $\bar{W}_{STS}$). (Rowitch '702, 5:43-6:21.) The complex symbols covered using Walsh symbol $\bar{W}_{STS}$ are provided to a complex conjugator 216a/b and then summed with the complex symbols covered by Walsh symbol W_{STS} . (*Id.*) The summed output is processed with a phase rotator 222a/b and a complex multiplier 224a/b to produce symbols S_1 and S_2 . (Rowitch '702, 6:34-57.)

70. Additional details about Rowitch '702 are provided beginning in the

analysis of the '305 patent claim limitations.

3. Jalali '454 [EX1027]

71. Jalali '454, U.S. Patent No. 6,952,454, is titled "Multiplexing of Real Time Services and Non-Real Time Services for OFDM Systems." (Jalali '454.) Jalali '454 "relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility." (Jalali '454, 1:24-28.) I am informed that Jalali '454 qualifies as prior art to the '305 patent because it was filed on July 12, 2000 which is before the '305 patent's critical date.

72. Jalali '454 discloses "[t]ransmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services." (Jalali '454, Abstract.) In FIG. 3, Jalali '454 discloses an embodiment where an aggregate input data stream is demultiplexed into a number of channel data streams which are then encoded by a respective encoder. (Jalali '454, FIG. 3, 16:23-58.) Jalali '454 discloses that transmit diversity may be used where a sub-channel is assigned to multiple antenna. (Jalali '454, 16:59-66.) And teaches that OFDM modulation can be used, including where symbols corresponding to multiple sub-channels are combined into an OFDM symbol. (Jalali '454, 17:11-50.)

4. Schilling '330 [EX1026]

73. Schilling '330, U.S. Patent No. 6,128,330, is titled "Efficient Shadow Reduction Antenna System for Spread Spectrum." (Schilling '330.) Schilling '330 relates generally to "reducing the effects of shadowing from a multipath environment, using space diversity and coding." (Schilling '330, 1:6-9.) I am informed that Schilling '330 qualifies as prior art to the '305 patent because it was filed on November 24, 1998 which is before the '305 patent's critical date.

74. Schilling '330 discloses multiple transmitter embodiments, and multiple alternative arrangements for each embodiment. For example, FIGS. 1-2 are equivalent alternatives of the same embodiment, where FIG. 1 encodes and then demultiplexes whereas FIG. 2 demultiplexes and then encodes. (Schilling '330, FIGS. 1-2, 6:1-62.) Likewise, FIGS. 4-5 are equivalent alternatives of the same embodiment, where FIG. 4 includes a delay after encoding and FIG. 5 includes the delay prior to encoding. (Schilling '330, FIGS. 4-5, 12:30-57.)

B. Grounds 1-3: Claims 1-3, and 6 Are Anticipated and/or Obvious Over Paulraj '632 (Ground 1); and/or Claims 2-3 are Obvious Over Paulraj '632 in View of Jalali '454 (Ground 2); and/or Claims 2-3, and 6 are Obvious Over Paulraj '632 in View of Schilling '330 (Ground 3)

75. As explained in greater detail below, claims 1-3 and 6 of the '305 patent are anticipated and/or rendered obvious by Paulraj '632 (Ground 1). To the extent

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certain limitations in claims 2-3 are not disclosed and/or rendered obvious by Paulraj '632, claims 2-3 are obvious over Paulraj '632 in view of Jalali '454 (Ground 2). Likewise, to the extent certain limitations in claims 2-3, and 6 are not disclosed and/or rendered obvious by Paulraj '632, claims 2-3 and 6 are obvious over Paulraj '632 in view of Schilling '330 (Ground 3).

1. Claim 1 (Independent)

76. As is explained below, claim 1 is anticipated by and/or rendered obvious by Paulraj '632. For reference, claim 1 recites (with bracketed notations to delineate its limitations):

- 1[p]** A transmitter adapted to process a plurality M of symbol substreams, the transmitter comprising:
 - 1[a.i]** a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols,
 - 1[a.ii]** each input set of M symbols comprising one symbol per symbol substream,
 - 1[a.iii]** each of the M space-time coded symbols being included in a respective one of M space-time coded streams,
- 1[b]** wherein each symbol of the M symbol substreams is represented in all M space-time coded streams,
- 1[c]** wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams,

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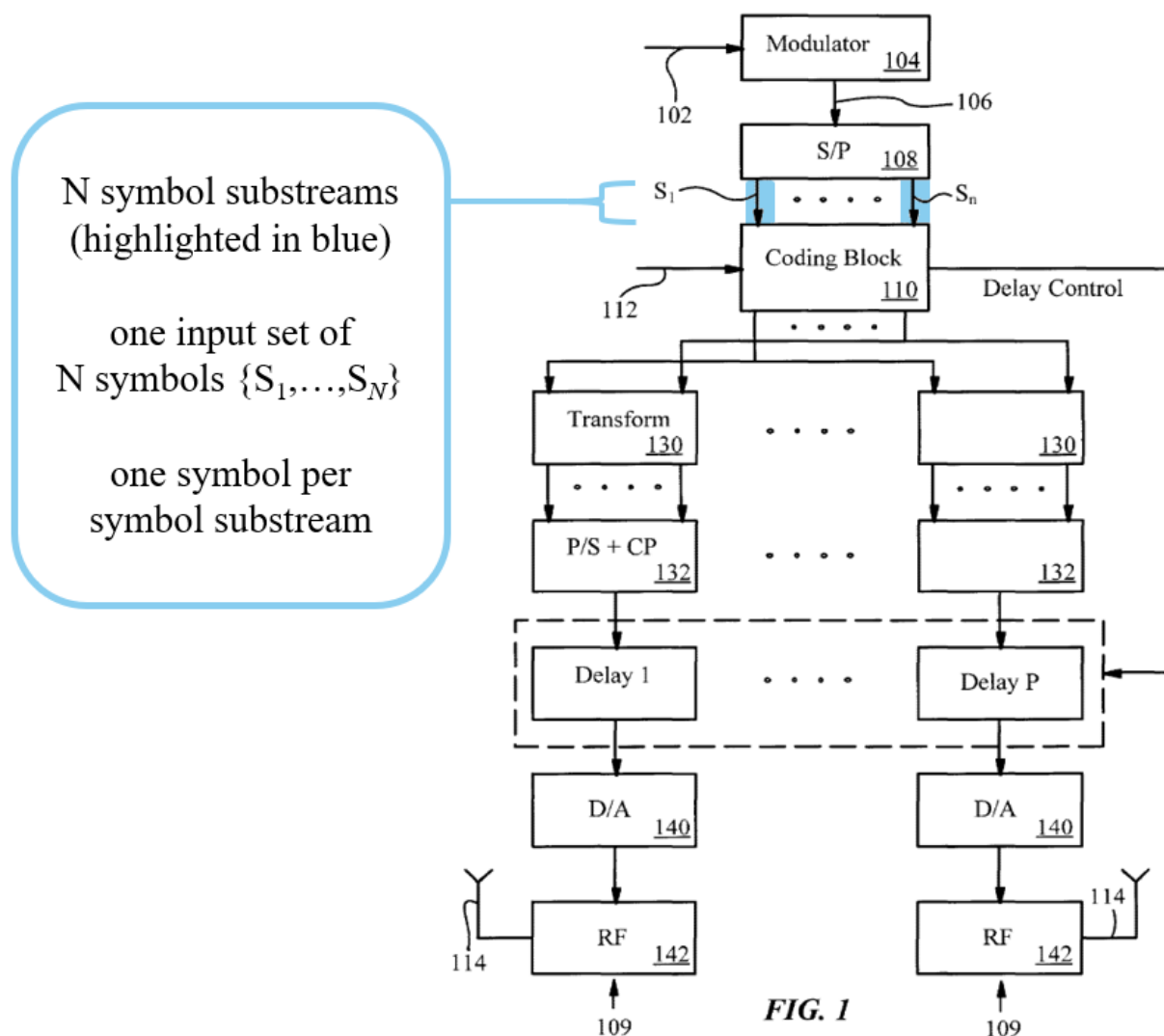
- 1[d] each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams;
- 1[e] a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams,
- 1[f] such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.

(’305 patent, 5:60-6:14 (Claim 1; bracketed notations (e.g., [a.i]) added).)

(a) **“A transmitter adapted to process a plurality M of symbol substreams, the transmitter comprising:”
(claim 1, preamble)**

77. To the extent the preamble is treated as limiting, Paulraj ’632 discloses and renders obvious “[a] transmitter adapted to process a plurality M of symbol substreams.”

78. Paulraj ’632 discloses “[a] method and apparatus for wireless transmission of a digital bit stream.” (Paulraj ’632, Abstract.) As shown in FIG. 1, Paulraj ’632 teaches a transmitter that generates a symbol stream 106 which is fed into a serial to parallel converter 108 that creates N symbol substreams corresponding to a frame of symbols $\{S_1, \dots, S_N\}$. Below I have annotated Paulraj ’632 FIG.1 to highlight the symbol substreams in blue:

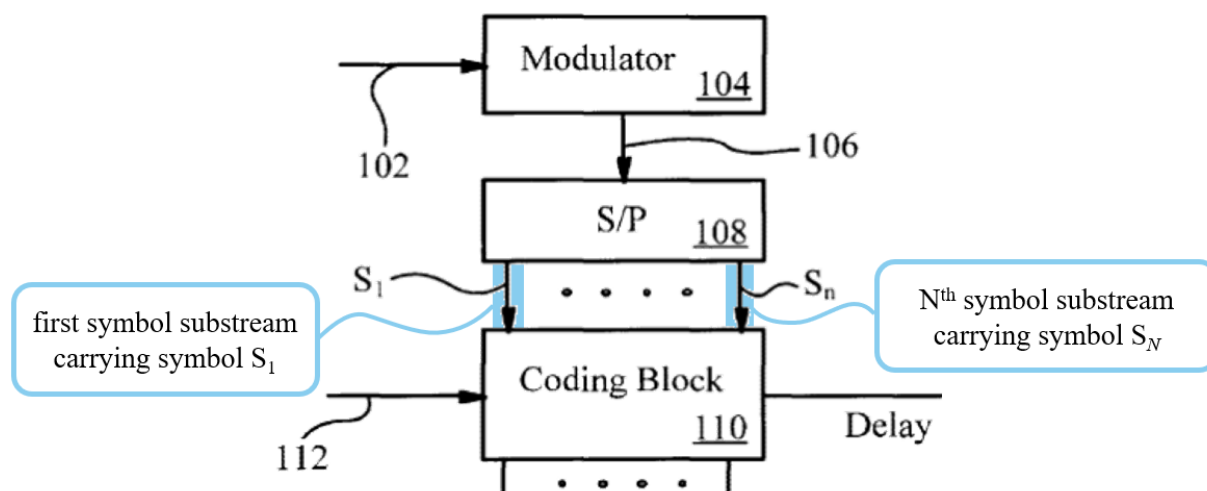


“FIG. 1 shows a block diagram of a transmit station in accordance with an embodiment of the present invention. After required coding and interleaving, a bitstream 102 of information is fed to a modulation block 104, which generates an output symbol stream 106 in response to bitstream 102. Symbol stream 106 is then fed to a serial to parallel converter 108, which collects a set of N symbols into a frame.”

(Paulraj '632, FIG. 1 (annotated), 4:53-60.) Note that while FIG. 1 labels the

symbols S_1 to S_n (using a lowercase “n”) the specification consistently discusses the symbols as S_1 to S_N (using an uppercase “N”). A person of skill in the art would understand that the symbols S_1 to S_n in FIG. 1 correspond to symbols S_1 to S_N in the specification. For purposes of this analysis, I will refer to the substream symbols as symbols S_1 to S_N .

79. A person of ordinary skill in the art would recognize that the output of the serial-to-parallel converter 108 in Paulraj '632 corresponds to a plurality N of symbol substreams. Indeed, Paulraj '632 illustrates the output (frame of symbols $\{S_1, \dots, S_N\}$) of the serial to parallel converter 108 as parallel substreams which each comprise a single substream symbol. Below I have annotated the outputs of the S/P 108 to show that each symbol substream (highlighted in blue) carries one symbol from the set ($S_1, \dots, S_n$):



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(Paulraj '632, FIG. 1 (excerpted and annotated).) And those skilled in the art at the time recognized that serial-to-parallel conversion takes a single symbol stream and converts it into multiple parallel symbol streams. (*See, e.g.*, EX1017 (U.S. Patent No. 5,241,544), 4:9-15 (“[A]n input symbol stream D^1 is provided by the serial-to-parallel converter (302). The serial-to-parallel converter (302) provides a symbol stream for each sub-channel simply by assigning a first data symbol to the first sub-channel, the subsequent data symbol to the second sub-channel, etc.”); EX1018 (U.S. Patent No. 5,410,538), 7:48-52 (“The symbol stream is received by a serial to parallel converter 315 which converts the single serial symbol stream from the mobile unit into a plurality of separate parallel symbol streams such that each stream transmits a single symbol at a time”).)

80. At a minimum, a person of skill in the art would consider it obvious to implement Paulraj '632 using a plurality N of symbol substreams. Paulraj '632 teaches creating a set of N symbols that must be fed into the coding block 110. As depicted by Paulraj '632 FIG. 1, and is well-understood by a person of skill in the art, one way to input a set of N symbols into the coding block is by simultaneously transmitting the symbols using parallel symbol substreams.

81. Paulraj '632 thus teaches and renders obvious a transmitter adapted to process a plurality M of symbol substreams (each stream for symbols $S_1, \dots, S_N$ is a

symbol substream, where the “plurality M of symbol substreams” recited in the claim are the same as the N symbol substreams disclosed in Paulraj ’632).

(b) “a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols,” (claim 1[a.i])

82. Paulraj ’632 discloses and renders obvious “a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols.”

83. Paulraj ’632 discloses a “Wireless Communication System and Method Using Stochastic Space-Time/Frequency Division Multiplexing,” the primary embodiment of which is shown in FIG. 1. (Paulraj ’632, Title.) A person of skill in the art would understand that in FIG. 1 the output of serial-to-parallel converter 108 is input into a series of blocks that convert the N symbol substreams into P space-time coded symbols.

84. Paulraj ’632 further discloses and renders obvious embodiments where the number of space-time coded symbols (P) is equal to the number of symbol substreams (N). For example, Paulraj ’632 discloses that the number of symbol streams for the input frame is any plural value (N), and further discloses that the number of diversity branches (P) is preferably at least two. (Paulraj ’632, 3:6-15.) A person of skill in the art would understand from Paulraj ’632’s disclosure that one embodiment (N=P=2) is to have two diversity branches and two symbol substreams.

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For example, Paulraj '632 expressly teaches “at least two diversity branches” ($P=2$). (Paulraj '632, 3:9-10, 3:34-35.)³ And while Paulraj '632 does not expressly state that $N=2$, a person of skill in the art would understand that $N=2$ is encompassed by Paulraj's disclosure that N can be any plurality (i.e., $N \geq 2$). (Paulraj '632, 3:32-34 (“a plurality of symbols grouped into a frame”), 4:59 (“a set of N symbols”), etc.)

85. Moreover, Paulraj '632 teaches an approach intended to work for “a

³ Paulraj '632 discloses that in transform blocks 130 the N symbols in the N symbol substreams are mapped into M values, where $M \geq N$. (Paulraj '632, 7:19-21, 7:37-38.) For claim 1, the value of M in Paulraj '632 is not relevant because the M values output from the transform blocks 130 are mapped onto P diversity branches—and as long as $N=P$ this discloses what is claimed. However, even if the value of M is relevant, Paulraj '632 expressly discloses that M can be equal to N , such as “[w]hen the transform is IFFT.” (*Id.*) Accordingly, when the transform is IFFT (or when the transform that is selected has $N=M$, such as a 2-dimensional Walsh-Hadamard transform for two substreams), references to $N=P$ or $N=P=2$ would be understood to refer to $N=M=P$ and $N=M=P=2$. However, to avoid confusion between the variable “ M ” in the claim language and variable “ M ” as used in Paulraj '632, I have not explicitly referenced the variable “ M ” as used in Paulraj '632 in each instance.

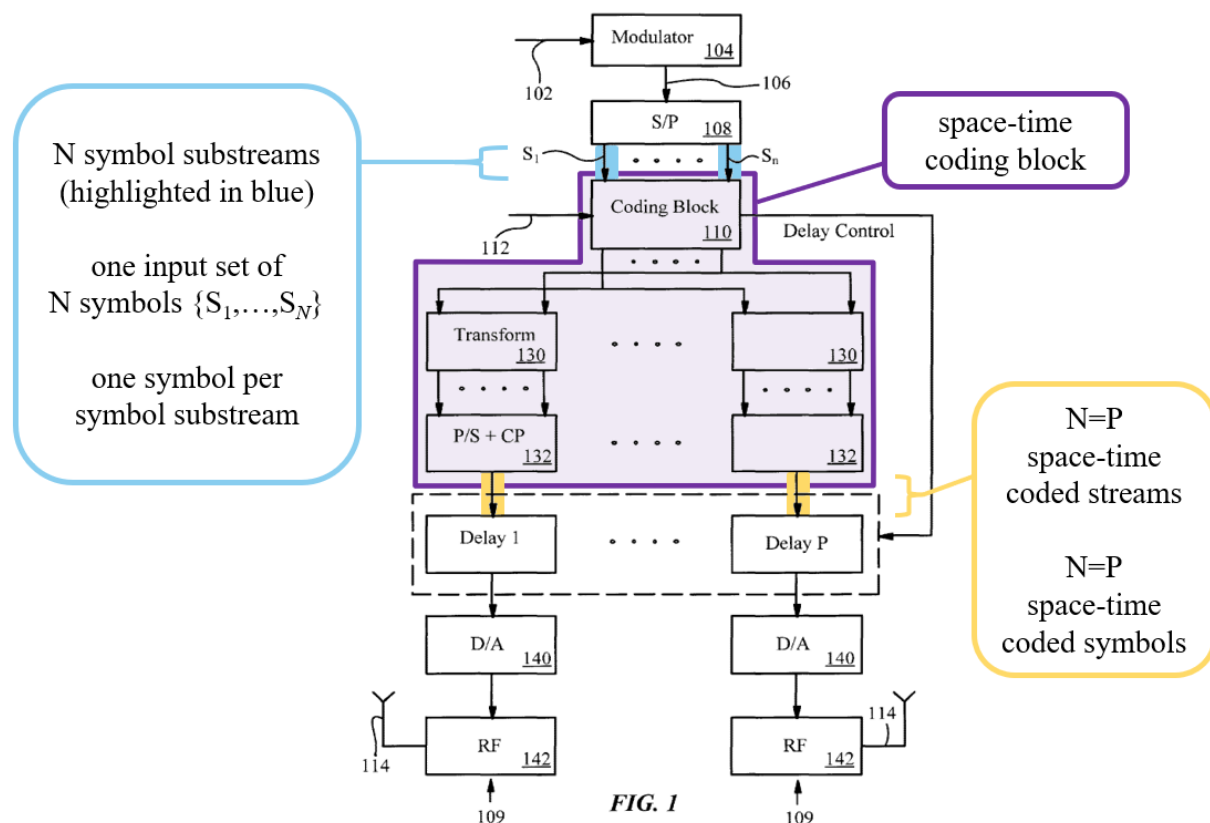
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multipath fading environment under varying channel conditions ranging from pure Rayleigh to pure Rician and varying delay spread.” (Paulraj ’632, 2:44-55.) A person of skill in the art would understand that Paulraj ’632 is teaching flexibility in the number of diversity branches to deal with various environments, which would include ranging from a low number of diversity branches (e.g., two) to a larger number of diversity branches.

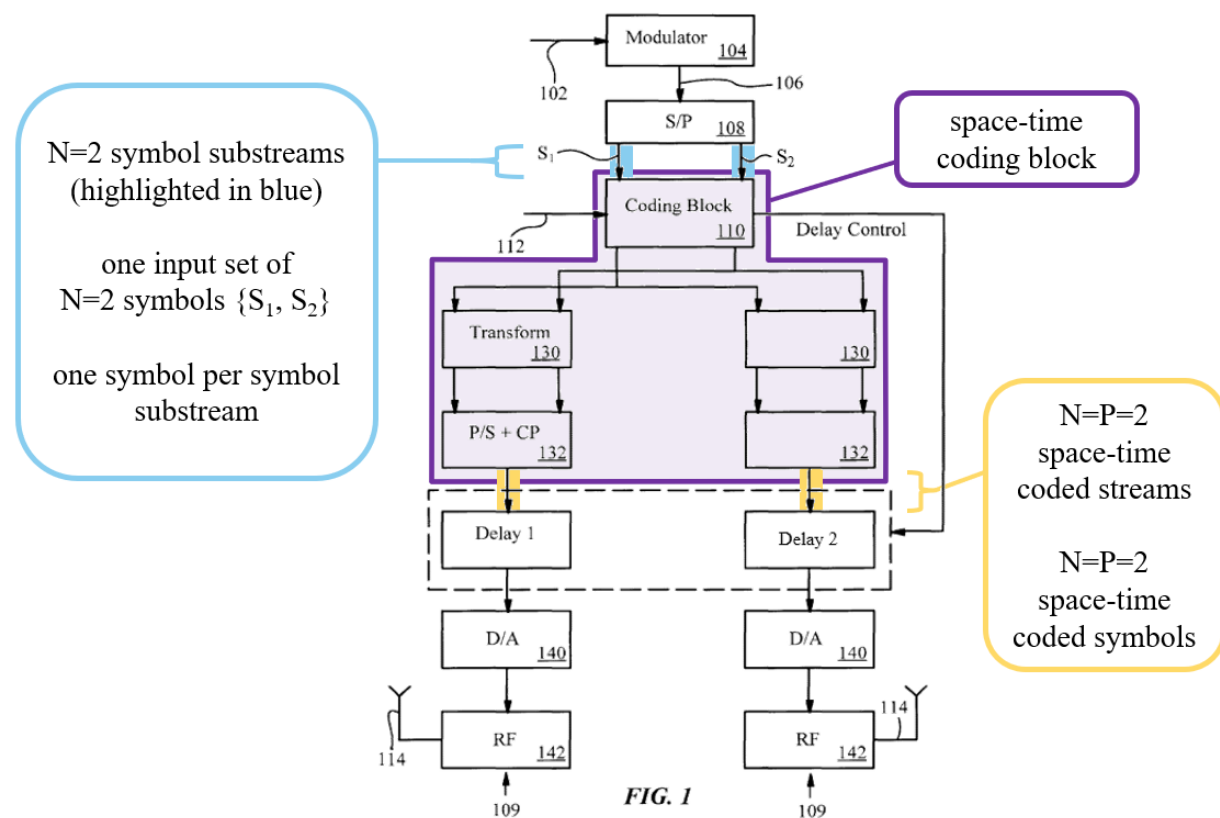
86. Selecting an embodiment where $N=P=2$ is not only encompassed and rendered obvious by Paulraj ’632, it is also a known design choice by those skilled in the art. For example, one of the well-known papers on diversity uses two antenna and two input symbols. (EX1006 (Alamouti 1998), p.002; EX1009 (Gaspas 2000-Space-Time Coding for UMTS), p.003 (“the Alamouti code maps two consecutive symbols to a 2×2 space-time matrix”).) Moreover, those skilled in the art specifically taught diversity approaches where the number of substreams matches the number of antenna. (EX1011 (Papadopoulos 1999), p.002 (“In transmit diversity, the information-bearing input signal $b(t)$ is demultiplexed in $s_m(t)$, $m = 1, \dots, M$, each of which is transmitted (after up-conversion) by the m -th antenna.”).) Following this approach for Paulraj ’632 results in a transmitter where the number of diversity branches P would be equal to the number of substreams N . And when $P=2$, this would mean that $N=P=2$.

87. Accordingly, using two symbol substreams and two diversity branches in Paulraj '632 would have been considered (i) encompassed by Paulraj '632's teachings (ii) an obvious option based on Paulraj '632's teachings, and (iii) an obvious option based on Paulraj '632 teachings and the knowledge of those skilled in the art.

88. Below, I have annotated Paulraj '632 FIG. 1 to show that for each input frame of N symbols ($\{S_1, \dots, S_N\}$) (highlighted in blue) the transmitter produces $N=P$ space-time coded symbols (highlighted in yellow):



(Paulraj '632, FIG. 1 (annotated).) As discussed above, a person of skill in the art would understand Paulraj '632 to disclose and render obvious the transmitter producing $N=P$ space-time coded symbols. For example, the case $N=P=2$ is encompassed by and rendered obvious by Paulraj '632. An annotated version of Paulraj '632 FIG. 1 for $N=P=2$ is shown below. In this example, there are $N=2$ symbol substreams (highlighted in blue) that input a set of $N=2$ symbols $\{S_1, S_2\}$ to the space-time coding block (highlighted in purple). For a system with $P=2$ diversity branches, the space-time coding block outputs $N=P=2$ space time coded streams (highlighted in yellow):



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(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated).)

89. A person of skill in the art would understand that there are multiple ways to draw a box around the transmitter components described and shown in Paulraj '632 that would satisfy the claim requirements for the space-time coding block. For purposes of simplicity of explanation, for the present analysis I will define the space-time coding block in Paulraj '632 to include coding block 110, transform block 130, and parallel-to-serial converter (P/S+CP) block 132. This is illustrated in purple in the figure above.

90. Using this example, the output of the space-time coding block in Paulraj '632 is the output of the set of P/S+CP blocks 132 across all the diversity branches. Paulraj '632 teaches that each P/S+CP block 132 in each diversity branch outputs “ $M+L-1$ complex valued symbols,” where the *collective “ $M+L-1$ complex valued symbols” output*⁴ is a function of the parallel outputs of the transform block 130.

⁴ As discussed herein, a person of skill in the art would understand that, in view of the '305 patent specification, the *collective “ $M+L-1$ complex valued symbols” output* corresponds to a single space-time coded symbol. In an attempt to help with readability, I have italicized and bolded *collective “ $M+L-1$ complex valued*

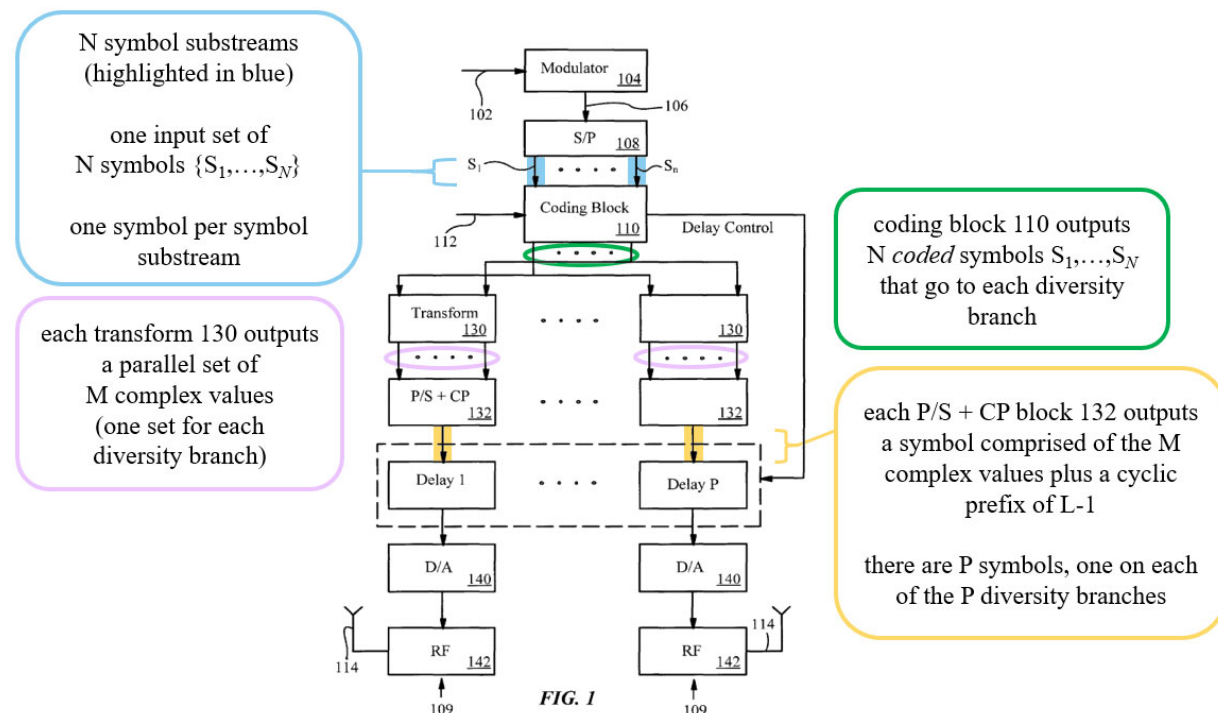
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(Paulraj '632, 7:47-59.) A person of ordinary skill in the art would understand that the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 corresponds to a “space-time coded symbol” as recited in the claim. Since Paulraj '632 teaches that (i) the P/S+CP block 132 in each diversity branch outputs “M+L-1 complex valued symbols” (a space-time coded symbol on each branch), and (ii) it was encompassed by, and obvious from, Paulraj '632 to have $P=N$ diversity branches, a person of skill in the art would understand that, in total, it was encompassed by, and obvious from, Paulraj that there would be $P=N$ blocks 132 that output $P=N$ space-time coded symbols.

91. The following figure provides an example showing how the N symbols on the N substreams correspond to the P space-time coded symbols in the P diversity channels. A set of N symbols $\{S_1, \dots, S_n\}$ are input to the coding block using N parallel symbol substreams (highlighted in blue). The coding block 110 outputs N coded symbols $S_1, \dots, S_n$ (circled in green) to each diversity branch. On each diversity branch, the N coded symbols $S_1, \dots, S_n$ are passed to transform 130 which outputs a parallel set of M complex values (circled in pink on each path). The P/S

symbols” output so that this collective output can more easily be understood to be referring to a single symbol.

+ CP block on each path then outputs a symbol comprised of the M complex values plus a cyclic prefix of L-1 on each space-time coded stream (highlighted in yellow):



(Paulraj '632, FIG. 1 (annotated).)

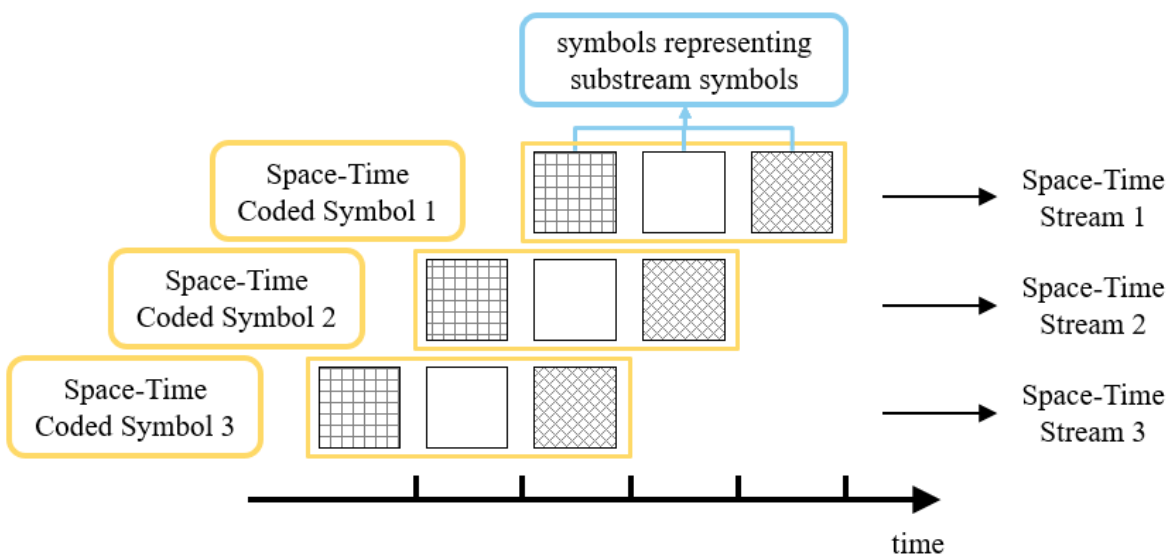
92. A person of skill in the art would understand that the ***collective “M+L-1 complex valued symbols” output*** from an individual P/S+CP block 132 is a space-time coded symbol. Paulraj '632 describes the ***collective “M+L-1 complex valued symbols” output*** from each P/S+CP block 132 as a function of:

- (i) M complex symbols formed by:
 - (a) coding the input frame of N symbols ($\{S_1, \dots, S_N\}$) (Paulraj '632, 5:21-7:13 (describing coding the symbols using

- matrix multiplication without cyclic shift (FIG. 2) and with cyclic shift (FIG. 3)), and
- (b) orthogonal transformation through IFFT or “any other transform which diagonalizes the matrix of channel coefficients” (Paulraj ’632, 7:16-47), and
 - (ii) a cyclic prefix of $L-1$ added to the serialized M complex symbols. (Paulraj ’632, 7:16-47.)

93. First, describing the *collective “ $M+L-1$ complex valued symbols”* **output** from each P/S+CP block 132 as a single “space-time coded symbol” is consistent with the use of “space-time coded symbol” in the ’305 patent claims. Limitation 1[c] recites that “for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams” and limitation 1[d] recites “each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams.” A person of skill in the art would understand that one way to implement limitations 1[c] and 1[d] would be for each symbol of the M symbol substreams to be represented at a different time in each space-time coded symbol. A person of skill in the art would further understand this would require that a space-time coded symbol must comprise a series of symbols (which represent the substream symbols). For example, the figure below demonstrates an example of

how each substream symbol can be represented at a different time in each space-time stream. In this example, the space-time coded symbol (boxed in yellow box) comprises a series of symbols (each symbol is square) in the time domain that represent the substream symbols:

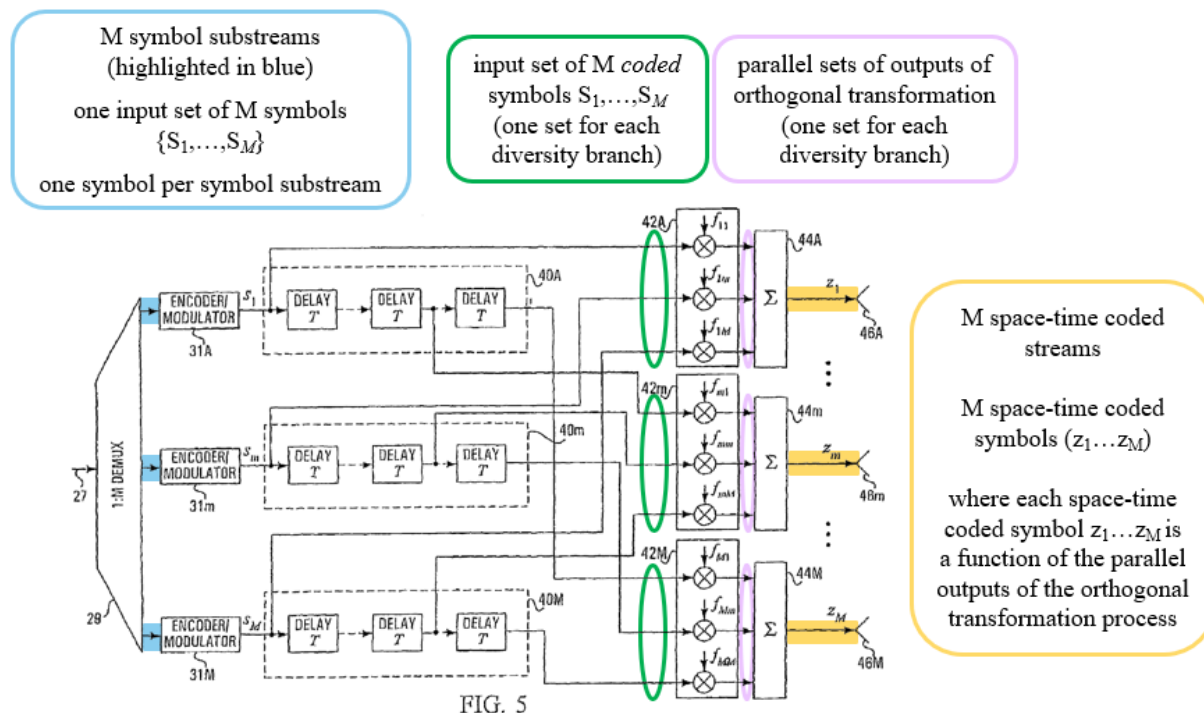


94. Second, describing the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 as a single “space-time coded symbol” is consistent with the ’305 patent specification. For example, in order to implement the “space-time coder” in FIGS. 4 and 5 of the ’305 patent, the ’305 patent specification describes the use of an orthogonal transformation process, and defines a single “symbol” created by the orthogonal transformation process as any “output of the orthogonal transformation [that is] a function of all the instantaneous inputs ... $x_1=f_1(s_1, s_2, \dots, s_M), \dots, x_m=f_m(s_1, s_2, \dots, s_M).$ ” (’305 patent, 4:1-67.) Since the

collective “M+L-1 complex valued symbols” output from an individual P/S+CP block 132 is the output of a function of all the instantaneous substream symbol inputs, the *collective “M+L-1 complex valued symbols” output* satisfies the description of a single space-time coded symbol in the ’305 patent. In particular, Paulraj ’632 specifically mentions orthogonal transformations such as IFFTs and Walsh-Hadamard codes. (Paulraj ’632, 7:30-39.) A person of ordinary skill in the art would understand that the transformations in the Paulraj ’632 patent encompasses orthogonal transformations.

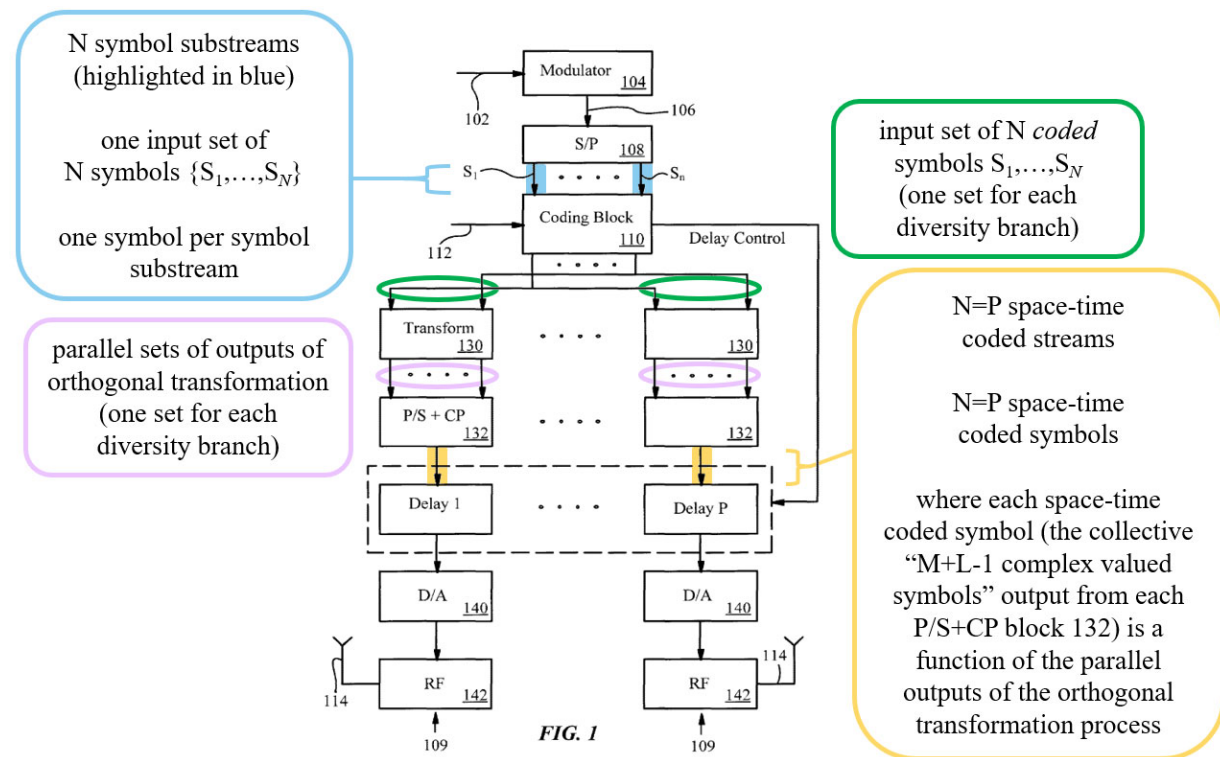
95. Comparing the systems and methods in FIG. 5 of the ’305 patent with FIG. 1 of Paulraj ’632 only further confirms that the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 can be considered a single space-time coded symbol. For FIG. 5, the ’305 patent teaches that a single output symbol z_m (each output is highlighted in yellow) is created by inputting a parallel group of coded symbols (circled in green) into the orthogonal transformation, outputting parallel outputs (circled in pink), and then combining the parallel outputs of the orthogonal transformation as a single function:

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(’305 patent, FIG. 5 (annotated).) Just as in FIG. 5 of the ’305 patent, in FIG. 1 of Paulraj ’632 the *collective “ $M+L-1$ complex valued symbols” output* (each output is highlighted in yellow) from each P/S+CP block 132 are created by inputting a parallel group of coded symbols (circled in green) into the orthogonal transformation, outputting parallel outputs (circled in pink), and then combining the parallel outputs of the orthogonal transformation as a single function:

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(Paulraj '632, FIG. 1 (annotated).)

96. The embodiment in FIG. 4 of the '305 patent also supports understanding that each *collective “ $M+L-1$ complex valued symbols” output* from each P/S+CP block 132 is a space-time coded symbol. For '305 patent FIG. 4, for example, each row of the matrix is described as a singled space-time coded symbol $(x_1, x_2, \dots, x_M)$. ('305 patent, 4:13-23 (defining a matrix X that is comprised of symbols $(x_1, x_2, \dots, x_M)$.) A person of skill in the art, however, would understand that each row $x_1, \dots, x_M$ of matrix X is comprised of a serial set of symbols corresponding to the symbols from the symbol substreams $(s_1, s_2, \dots, s_M)$. ('305 patent, 4:13-42.) Accordingly, the embodiment in FIG. 4 of the '305 patent supports the

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understanding that a serialized set of symbols—just like the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 in Paulraj ’632—can be considered as a single space-time coded symbol.

97. Third, describing the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 as a single “space-time coded symbol” is consistent with the ’305 patent file history. As discussed in Section V.B., during prosecution the Examiner argued that a “space-time coded symbol” as used in the claims could correspond to a series of symbols output by a space-time coding function. (See EX1013 (’305 FH), p.265.) The Applicant initially disputed this position, but ultimately failed to amend the claims to narrow the meaning of “space-time coded symbol” to exclude a series of symbols from being a “space-time coded symbol.” Instead, the Applicant amended the claims to distinguish Lindskog on other grounds and neglected to respond to the Examiner’s statements that the feature that distinguished Lindskog is the timing of the “space-time coded symbols” and not that each series of symbols in Lindskog should not be considered a “space-time coded symbol.” (EX1013 (’305 FH), pp.309, 316-17.)

98. Fourth, Patent Owner has argued that a sequence of symbols should be considered a symbol. For example, in its infringement contentions for this limitation, Patent Owner cites to the disclosure in IEEE 802.11(2012) reciting that

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“[t]he sequence of N_{ST} complex numbers...*constitutes an OFDM symbol*[.]”

(EX1019 (Malikie Infringement Contentions, Exhibit E, Page 16 of 26), p.024.)

Patent Owner’s purported reliance on an OFDM symbol (which is a sequence of symbols) as a “space-time coded symbol” confirms that Patent Owner also believes the plain-and-ordinary meaning of symbol includes a series of values. Moreover, the cited portion of the 802.11 Standard confirms that those skilled in the art understand that a sequence of symbols can correspond to a symbol.

99. Fifth, contemporaneous literature confirms that the serialized output described in Paulraj ’632 was commonly considered a single symbol. Indeed, when discussing a system that serializes the complex values (sometimes referred to as samples) that are output from an IFFT, those skilled in the art commonly referred to the serialized samples as a single symbol. (*See, e.g.*, EX1020 (Lee 1997), p.002 (“the serial OFDM samples $S_{n,m}$ composing the n th OFDM symbol”); EX1021 (U.S. Patent 6,421,401), 2:44-45 (“A parallel-to-serial converter 102 is used to generate an OFDM symbol, marked $s(k)$.”); EX1022 (Kim 2001), p.001 (“An OFDM symbol is denoted as $\{x_{N-G}, \dots, x_{N-1}, x_0, x_1, \dots, x_{N-1}\}$, of which the first G samples are guard samples to eliminate ISI.”); EX1023 (Wu 1995), p.002 (“The output of the IFFT forms an OFDM symbol, which is converted back to serial data for transmission. A guard interval is inserted between symbols to eliminate ISI caused by multipath

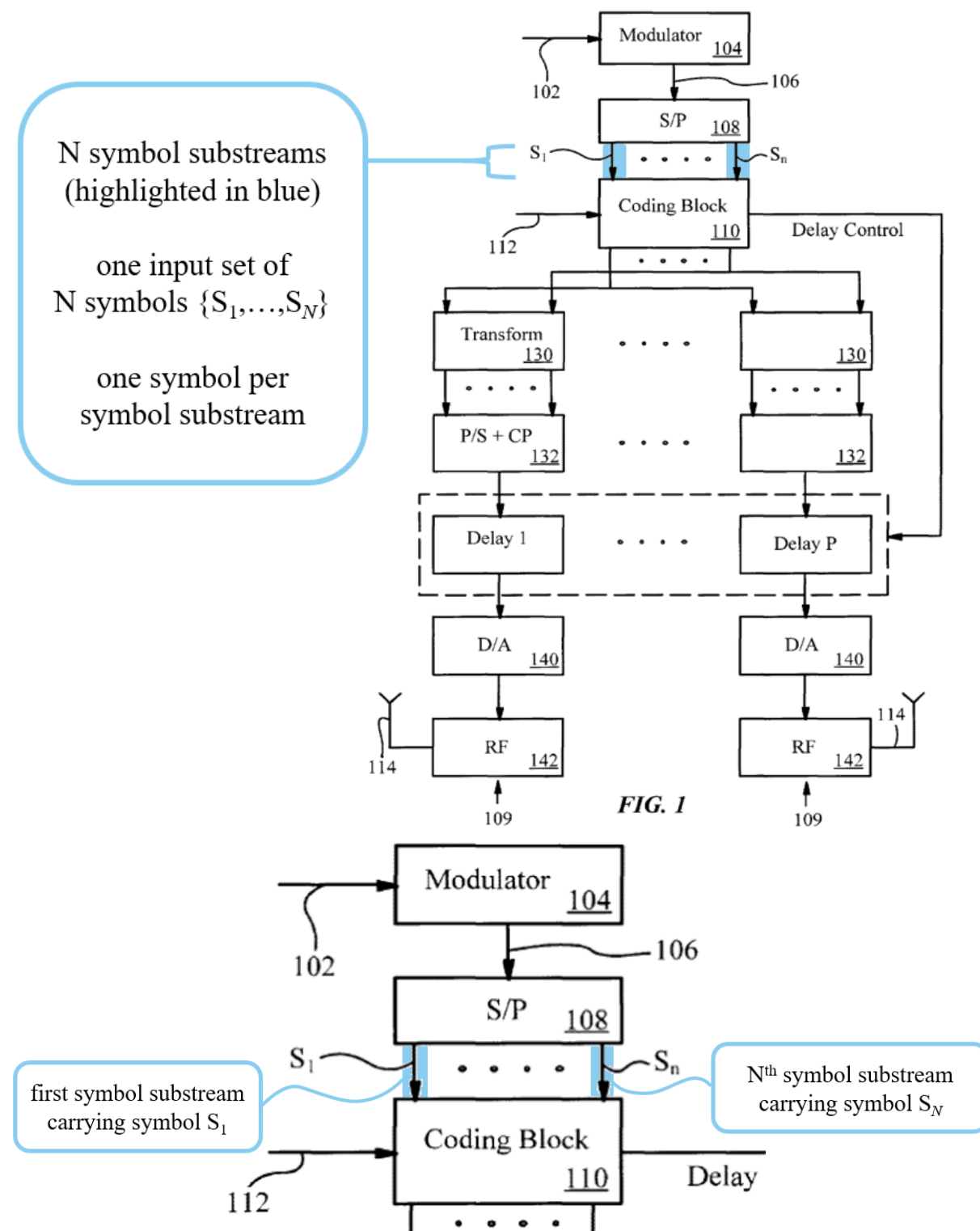
distortion.”.)

100. Paulraj '632 thus teaches and renders obvious a space-time coding block (coding block 110, transform 130, and P/S+CP block 132) adapted to produce M space-time coded symbols (the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 are space-time coded symbols) per input set of M symbols (per input frame of M=N symbols $\{S_1, \dots, S_N\}$).

(c) “each input set of M symbols comprising one symbol per symbol substream,” (claim 1[a.ii])

101. Paulraj '632 discloses “each input set of M symbols comprising one symbol per symbol substream.”

102. As discussed for the preamble, a person of skill in the art would recognize that the frame of symbols $\{S_1, \dots, S_N\}$ in Paulraj '632 corresponds to a plurality N of symbol substreams, where each symbol $S_1, \dots, S_N$ is on a separate substream:



(Paulraj '632, FIG. 1 (annotated).)

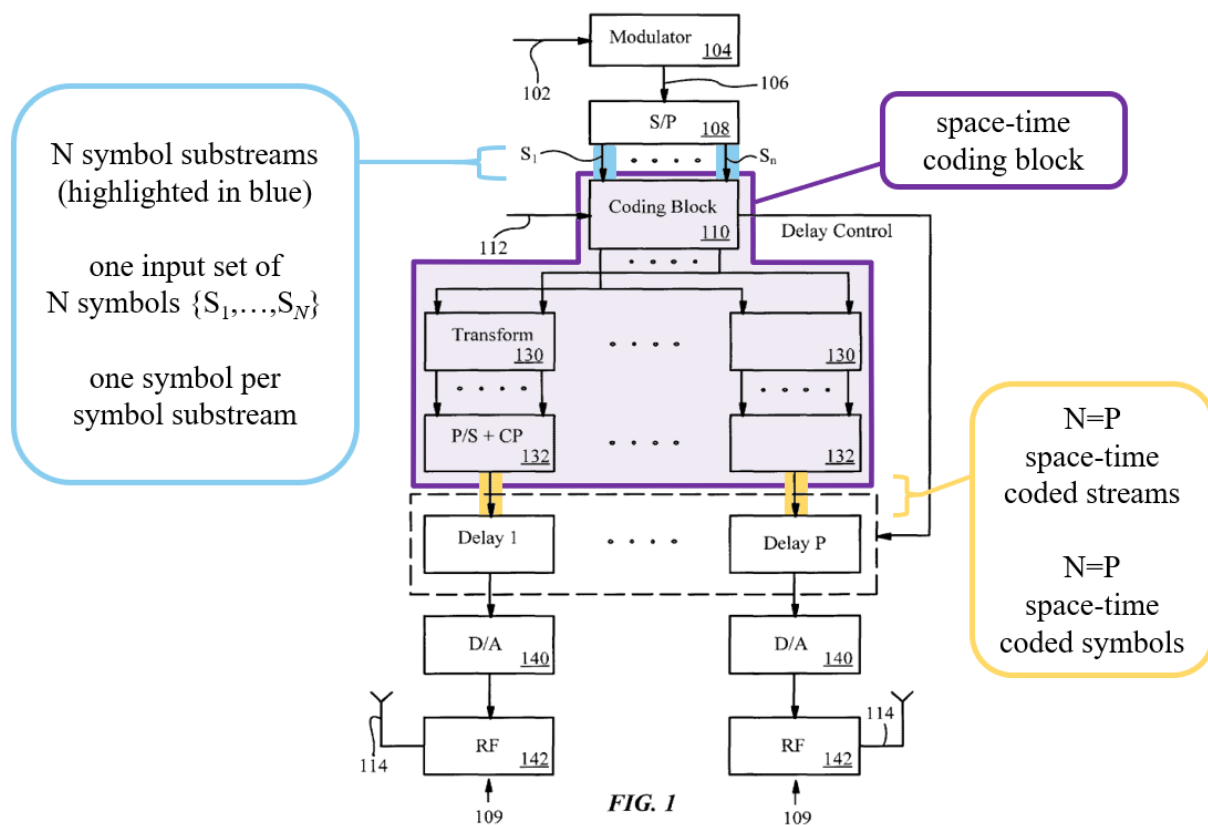
103. Paulraj '632 thus teaches each input set of M symbols (frame of symbols $\{S_1, \dots, S_N\}$) comprising one symbol per symbol substream (each symbol $S_1, \dots, S_N$ corresponds to a separate substream).

(d) **“each of the M space-time coded symbols being included in a respective one of M space-time coded streams,” (claim 1[a.iii])**

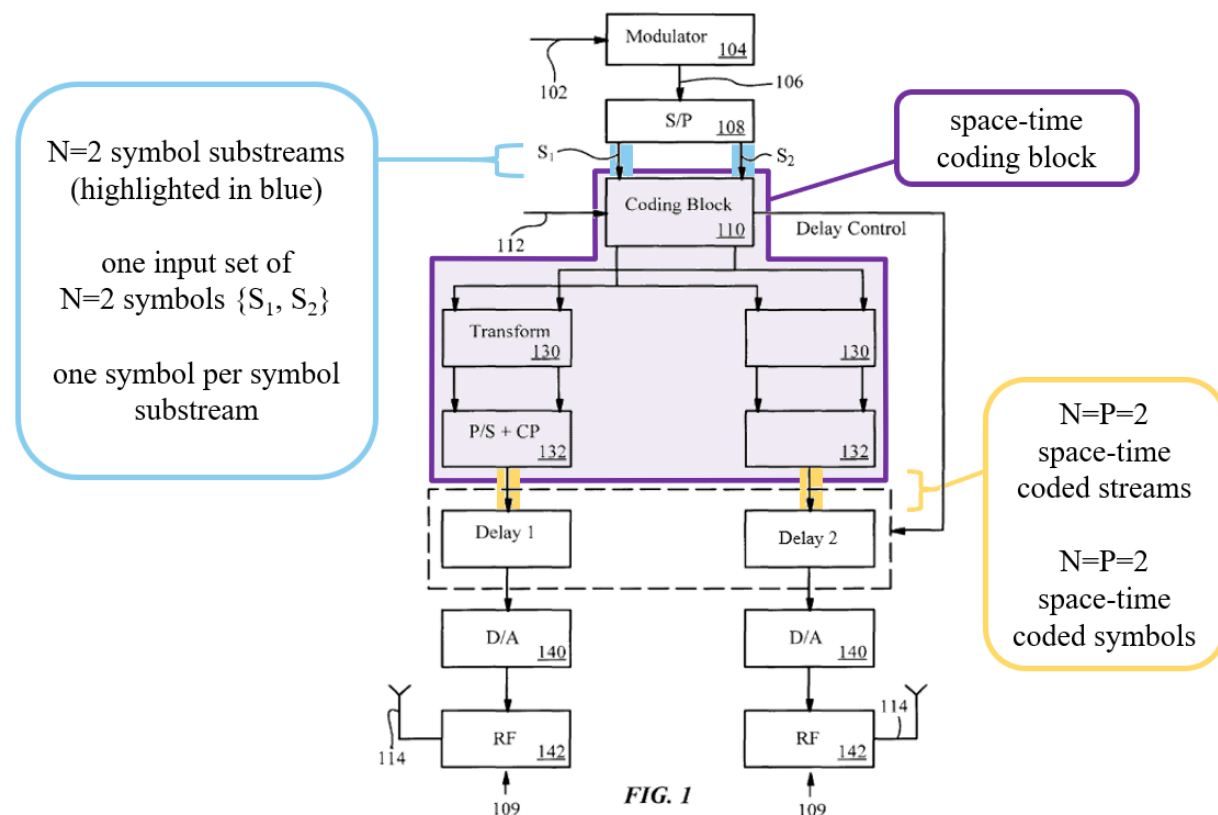
104. Paulraj '632 discloses and renders obvious “each of the M space-time coded symbols being included in a respective one of M space-time coded streams.”

105. As discussed above, Paulraj '632 teaches and renders obvious the ***collective “ $M+L-1$ complex valued symbols” output*** from each P/S+CP block 132 corresponds to the claimed space-time coded symbols. (Paulraj '632, 7:47-59 (“ $M+L-1$ complex valued symbols of each diversity branch”).) As shown in FIG. 1, and described in the specification, there is a P/S+CP block 132 for each diversity branch, and a person of skill in the art would understand that Paulraj '632 discloses and renders obvious a situation where the number of diversity branches is equal to the number of symbol substreams:

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(Paulraj '632, FIG. 1 (annotated).) In particular, as discussed above, a person of skill in the art would understand that Paulraj '632's disclosure encompasses and renders obvious $N=P=2$:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated).)

106. Paulraj '632 thus teaches and renders obvious each of the M space-time coded symbols (the *collective “ $M+L-1$ complex valued symbols” output* from each P/S+CP block 132) being included in a respective one of M space-time coded streams (diversity branch corresponding to its own antenna).

(e) “wherein each symbol of the M symbol substreams is represented in all M space-time coded streams,” (claim 1[b])

107. Paulraj '632 discloses and renders obvious “wherein each symbol of the M symbol substreams is represented in all M space-time coded streams.”

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108. Paulraj '632 teaches that it is preferable that symbols $(S_1, \dots, S_N)$ are transmitted from all the available diversity branches. (Paulraj '632, 3:6-40.) Paulraj '632 explains that the preference that the substream symbols $(S_1, \dots, S_N)$ be transmitted from all available diversity branches applies equally to when the substream symbols are grouped into a frame. (Paulraj '632, 3:32-40.)

109. Moreover, even to the extent Paulraj '632 recognizes that there may be situations when substream symbols $(S_1, \dots, S_N)$ are transmitted from less than the full set of diversity channels, a person of skill in the art would understand from Paulraj '632's express disclosure and general teachings that it is preferable that substream symbols are transmitted from the full set of diversity channels. (Paulraj '632, 3:14-15, 3:38-40.) Moreover, a person of skill in the art would consider it obvious that when the number of diversity branches are small (e.g., two diversity branches) that all substream symbols (S_1, S_2) would be transmitted from both diversity branches to achieve a diversity gain.

110. Paulraj '632 thus teaches and renders obvious each symbol of the M symbol substreams $(S_1, \dots, S_N)$ is represented in all M space-time coded streams (all diversity branches).

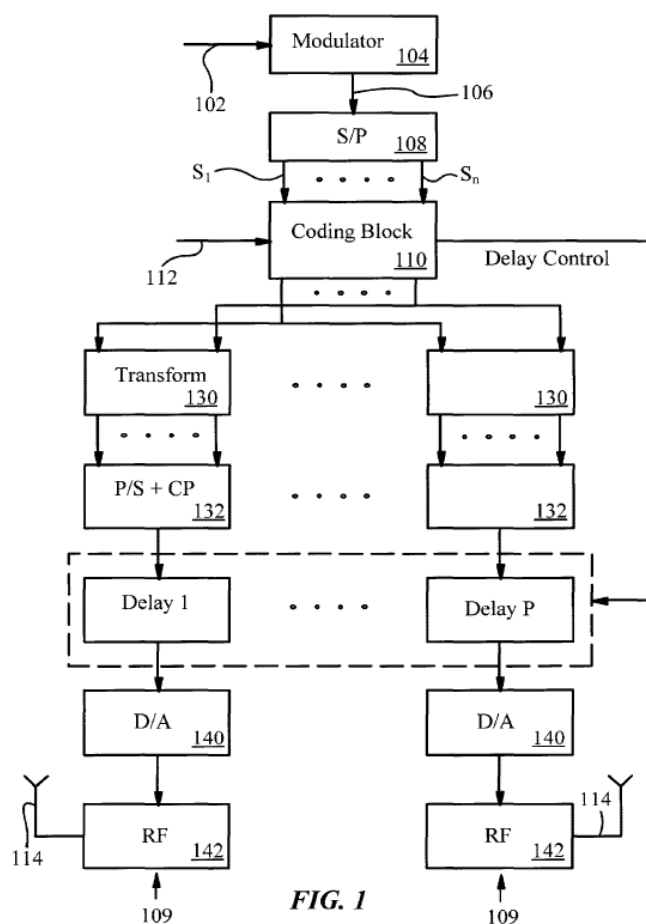
(f) “wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams,” (claim 1[c])

111. Paulraj ’632 discloses and renders obvious “wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams.”

112. I understand that Petitioner has argued that this limitation should be limited to “a time delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams.” (EX1014.) I further understand that Patent Owner has argued this limitation is broader and includes additional forms of delays such as phase delays. (EX1043, ¶39.) Paulraj ’632 discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies Patent Owner’s broader construction.

113. Paulraj ’632 teaches including a time delay in each diversity branch in order to “improve the effect of diversity as well as reduce the overhead resulting in a higher throughput.” (Paulraj ’632, 7:62-67.) Paulraj ’632 further teaches that it is beneficial to include delay diversity “when there is considerable fading (low K-

factor) and delay spread in the channel.” (Paulraj ’632, 2:29-31.) As shown in FIG. 1, Paulraj ’632 teaches adding a delay in each branch (Delay 1 in branch on left of figure and Delay P in branch on right of figure) that delays the space-time coded symbols from each branch (the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132) prior to digital-to-analog conversion:



(Paulraj ’632, FIG. 1.)

114. Paulraj ’632 teaches that “[e]ach of the P delays imposes a particular,

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unique amount of delay on the symbols being transmitted”:

Each diversity branch 109 has an antenna 114 for transmitting a signal. Each diversity branch 109 also has a unique delay (shown as delays 1–P) that is controlled by the coding block 110. Each of the P delays imposes a particular, unique amount of delay on the symbols being transmitted. The value of differential time delay between the diversity branches is preferably at least equal to the channel length (delay spread of the channel).

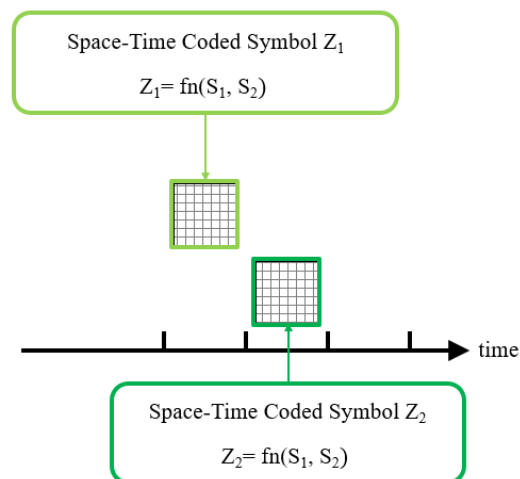
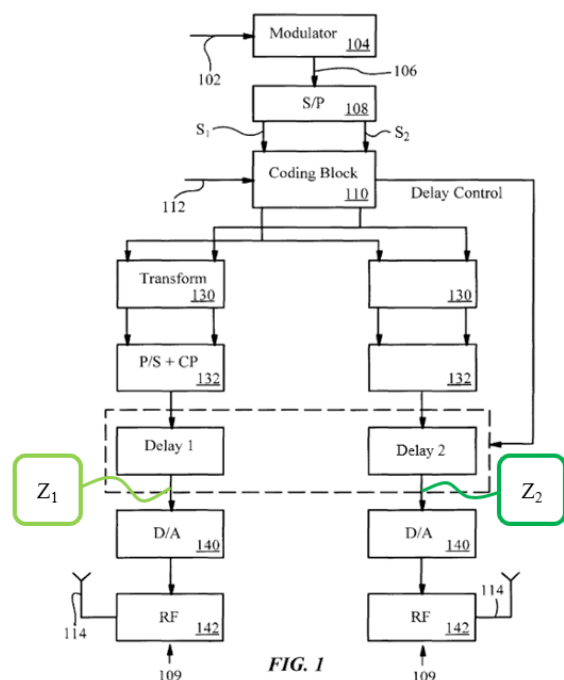
(Paulraj '632, 4:65-5:5.) And that the amount of delay can be controlled by coding block 110 based on the feedback regarding the channel length if available:

The resulting $M+L-1$ complex valued symbols of each diversity branch go through individual delays. The amount of delay can be controlled by coding block 110 based on the feedback regarding the channel length if available.

(Paulraj '632, 7:57-61.)

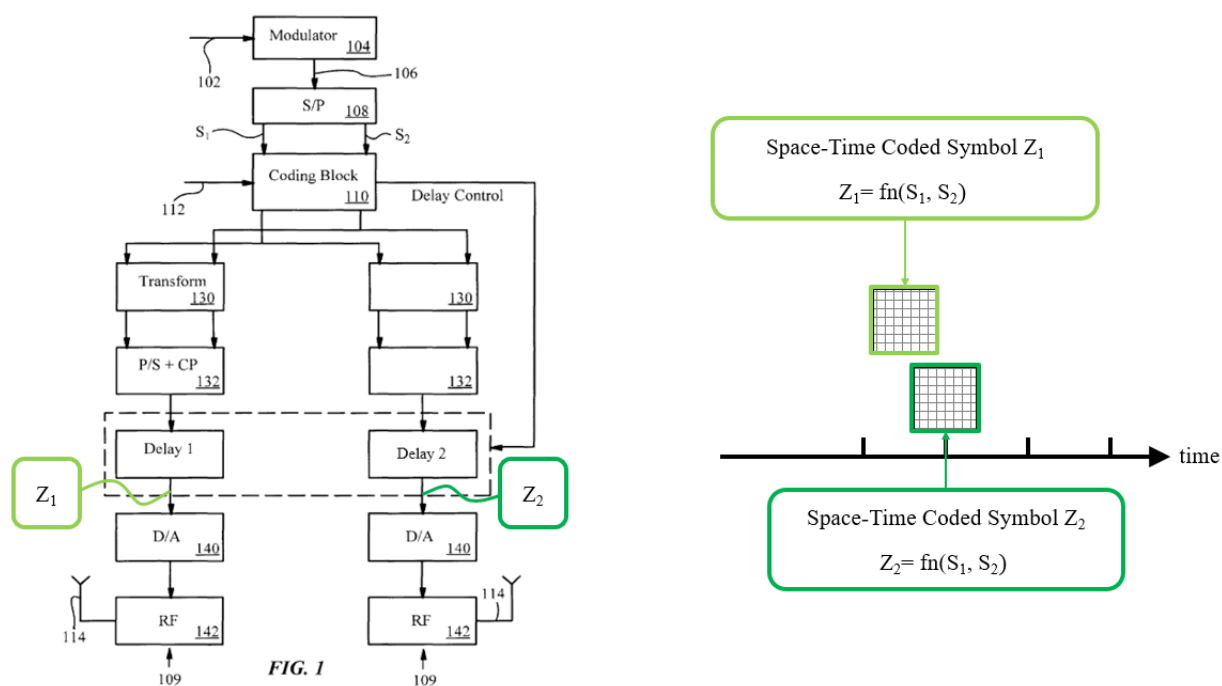
115. In accordance with Paulraj '632's disclosure that “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted,” a person of skill in the art would understand that the delays would cause the symbols in each diversity path to be transmitted at different times. For example, using the embodiment discussed above where there are two diversity paths ($N=P=2$), for input symbols S_1 and S_2 at a given time period T , a person of skill in the art would understand that the “unique amount of delay” taught by Paulraj '632 would result in

the space-time coded symbol transmitted from the first antenna (Z_1) to be transmitted at a different time than the space-time coded symbol transmitted from the second antenna (Z_2). As shown in the exemplary drawing below, this results in each symbol of the $N=2$ symbol substreams (each symbol in substreams S_1 and S_2) having a time of representation in the $N=2$ space time coded streams that is different. Space-time coded symbol Z_1 is output from Delay 1 prior to space-time coded symbol Z_2 being output from Delay 2:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-time coded symbols).) Note that, in the above example, Delay 2 causes space-time coded symbol Z_2 to be delayed by a full symbol period as compared to space-time

coded symbol Z_1 (output from Delay 1). As taught by Paulraj '632, however, a person of skill in the art would understand that the amount of delay may vary. (Paulraj '632, 4:65-5:5.) Accordingly, a person of skill in the art would understand that in some circumstances Z_2 may only be delayed by a partial symbol as compared to Z_1 (or vice versa) as shown below:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-time coded symbols).) Either of these examples satisfies the claims because substream symbols (S_1 and S_2) are represented in each of the space-time coded symbols Z_1 and Z_2 , and space-time coded symbols Z_1 and Z_2 are transmitted at different times. Therefore, the time of representation of the substream symbols (S_1 and S_2) is different in each of the space-time coded streams.

116. Paulraj '632 thus discloses that the transmitter comprises a delay arrangement (collectively, Delays 1 and 2) arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams (the amount delay in each diversity branch changes the time of representation of the N substream symbols ($S_1, \dots, S_N$) in the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132).

(g) “each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams;” (claim 1[d])

117. Paulraj '632 discloses “each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams.”

118. As discussed above, in Paulraj '632 the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 corresponds to the claimed space-time coded symbol. Paulraj '632 teaches that the “M” complex valued symbols are created by coding and transforming the input frame of symbols $\{S_1, \dots, S_N\}$. (Paulraj '632, 5:22-7:2 (coding) and 7:16-47 (transformation).) As shown in FIG. 1, Paulraj '632 teaches that the coding block takes an input frame of N symbols and outputs a multi-datastream output of N complex values that is input into each transform block 130. (See, e.g., Paulraj '632, 7:16-21 (“The multi-

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datastream output of coding block 110 is fed to transform blocks 130 (see FIG. 1), where each data frame is multiplied by a transform matrix. This transformation maps an input frame of N complex values”) Paulraj '632 further teaches that each transformation block 130 maps each input frame of N complex values into M values, where “[w]hen the transform is IFFT, then $M=N$.” (Paulraj '632, 7:19-39.) A person of skill in the art would understand from this disclosure that each symbol from the input frame of symbols $\{S_1, \dots, S_N\}$ is represented in the M complex symbols output from the P/S+CP blocks 132.

119. Paulraj '632 thus teaches that each space-time coded symbol (the *collective “ $M+L-1$ complex valued symbols” output* from each P/S+CP block 132) comprises a representation of a symbol of each of the M symbol substreams (each symbol from the input frame of symbols $\{S_1, \dots, S_N\}$).

(h) “a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams,” (claim 1[e])

120. Paulraj '632 discloses “a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams.”

121. As shown in FIG. 1, Paulraj '632 teaches that the “resulting $M+L-1$ complex valued symbols of each diversity branch” undergo a delay, digital-to-analog conversion (and any necessary amplification), and then “are fed to the

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respective antennas for transmission.” (Paulraj ’632, FIG. 1, 7:57-61, 8:28-33.)

Paulraj ’632 further teaches that “[e]ach diversity branch 109 has an antenna 114 for transmitting a signal.” (Paulraj ’632, FIG. 1, 4:65-66.)

122. Paulraj ’632 thus teaches a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams.

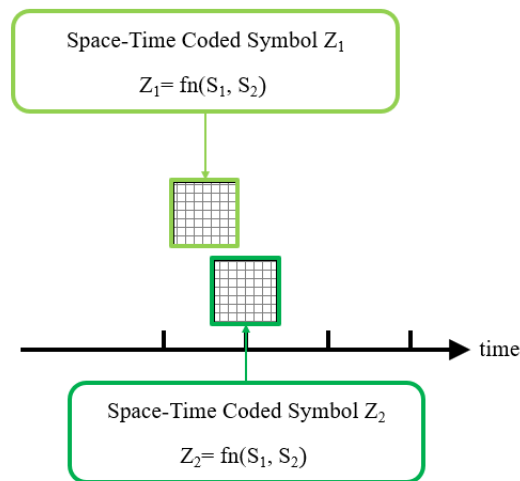
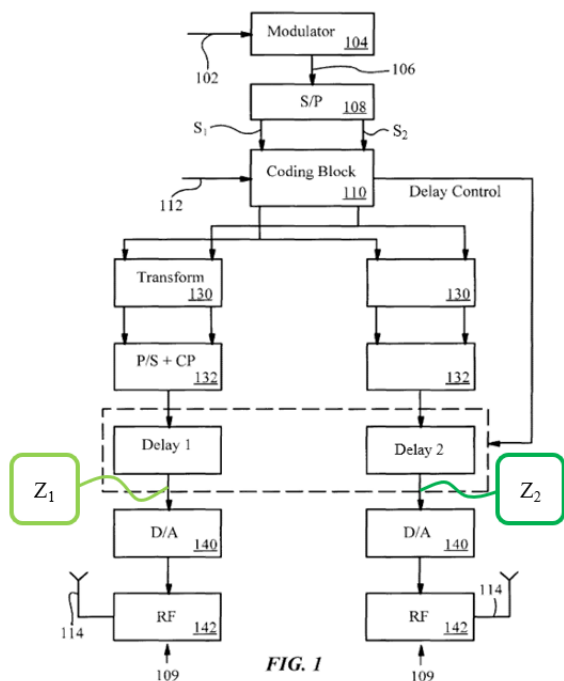
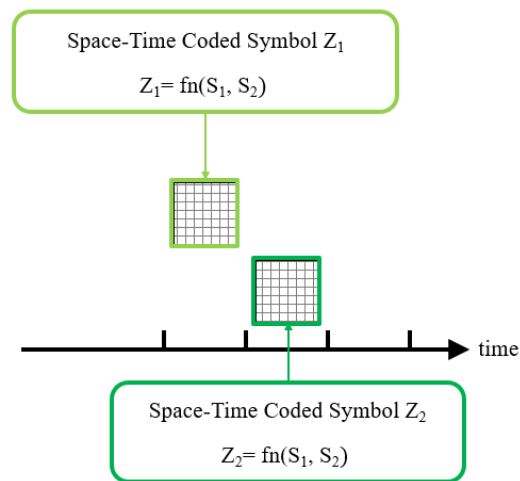
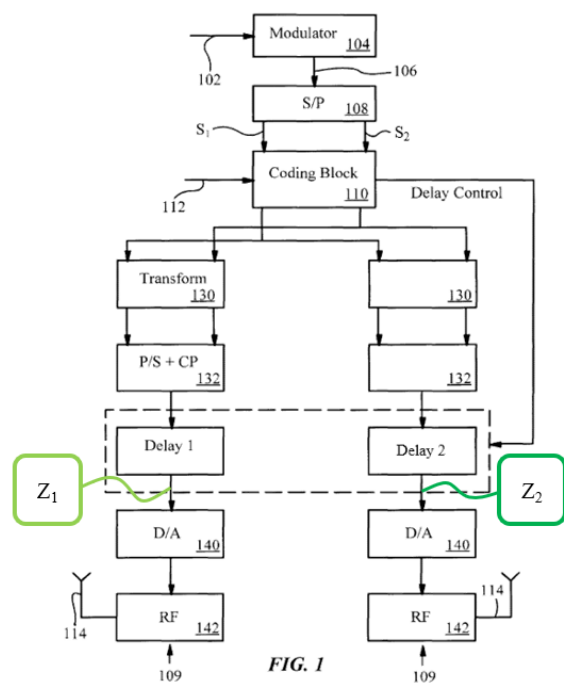
- (i) **“such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.” (claim 1[f])**

123. Paulraj ’632 teaches and renders obvious “such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.”

124. As set forth above, the *collective “ $M+L-1$ complex valued symbols” output* in each diversity branch corresponds to the claimed “space-time coded symbols.” Paulraj ’632 further teaches that “[e]ach diversity branch 109 also has a unique delay (shown as delays 1- P),” and that “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted.” (Paulraj ’632, FIG. 1, 4:65-5:5.) As a result of these unique delays, the *collective “ $M+L-1$ complex valued symbols” output* from each diversity branch is transmitted at a different time.

125. The exemplary figures discussed above for $N=P=2$ show how Delays 1 and Delay 2 cause the space-time coded symbols to be transmitted at different times:

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(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-

time coded symbols).)

126. Paulraj '632 thus teaches and renders obvious such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.

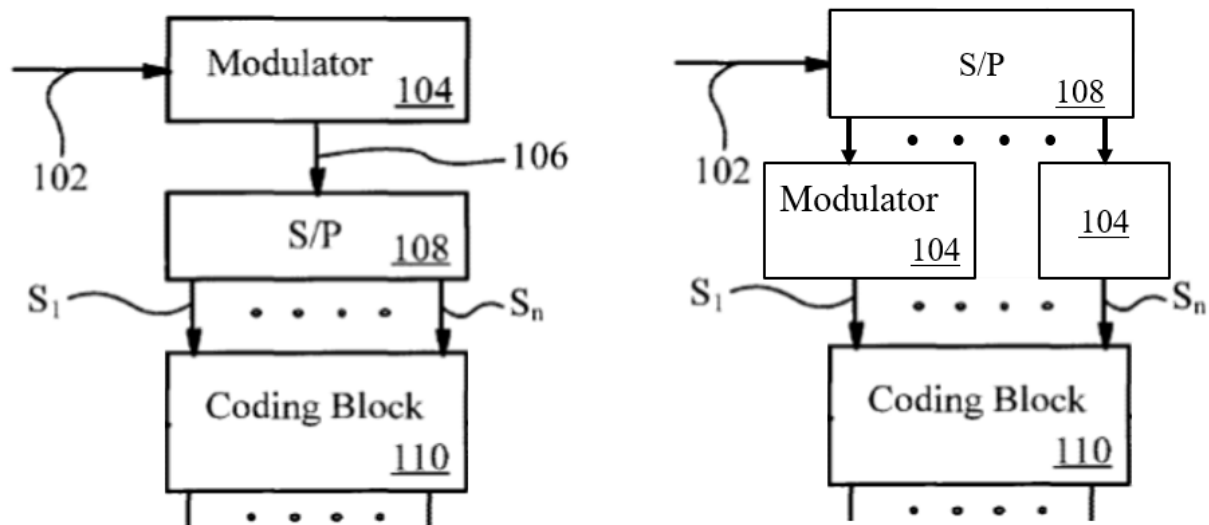
2. **Claim 2: “A transmitter according to claim 1 further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”**

(a) Ground 1 – Paulraj '632 Alone

127. Paulraj '632 alone renders obvious the transmitter of claim 1, “further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

128. Paulraj '632 teaches the same operations recited in claim 2, simply in a different order. In particular, for FIG. 1, Paulraj '632 discloses “a bitstream 102 of information is fed to a modulation block 104, which generates an output symbol stream 106” which “is then fed to a serial to parallel converter 108[.]” (Paulraj '632, 4:55-60.) A person of skill in the art would have considered it obvious to perform

the same steps, to achieve the same result, but simply modifying the order of the steps as recited in the claims, as shown in the figure below:



(Paulraj '632, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised).) A person of skill in the art would have understood that the order of operations of these steps was an obvious modification. Indeed, prior art at the time recognized the interchangeability and obviousness of switching between (i) modulating/encoding and then demultiplexing, and (ii) demultiplexing and then modulating/encoding. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15 ("In FIG. 1, the data are first forward-error-correction (FEC) encoded by FEC encoder 21 and interleaved by interleaver 22, and then demultiplexed by demultiplexer 32 into four data streams.... Alternatively, as shown in FIG. 2, the data could first be demultiplexed by demultiplexer 32 and then each data stream could be FEC encoded by a plurality of

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FEC encoders”), 12:30-57 (confirming another embodiment where demultiplexing is performed prior to encoding).)

129. Accordingly, Paulraj ’632 alone renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj ’632’s serial-to-parallel converter arranged prior to (rather than after) modulation), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (a modulator as taught in Paulraj ’632 connected to each output of the serial-to-parallel).

(b) Ground 2 – Paulraj ’632 in view of Jalali ’454

130. In addition, a person of skill in the art would have considered it obvious to modify Paulraj ’632 in view of Jalali ’454 to “further compris[e] a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

131. Jalali ’454 is analogous art to Paulraj ’632 in that it discloses transmitter and receiver designs for wireless communications, including OFDM based data communication, using multiple antennas. Jalali ’454 teaches a demultiplexer that

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demultiplexes an input data stream and produces $M=k$ outputs, and $M=k$ encoder/modulators 312a-312k to produce the symbol $(x_1, \dots, x_k)$ substreams, where each encoder/modulator is connected to receive a respective one of the demultiplexer outputs:

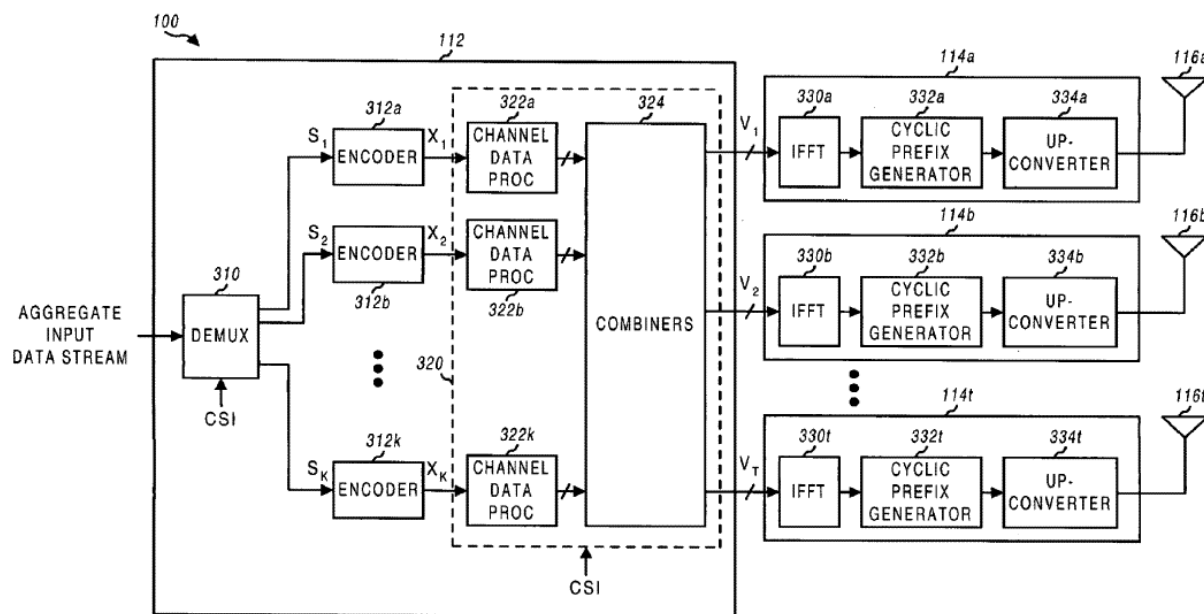
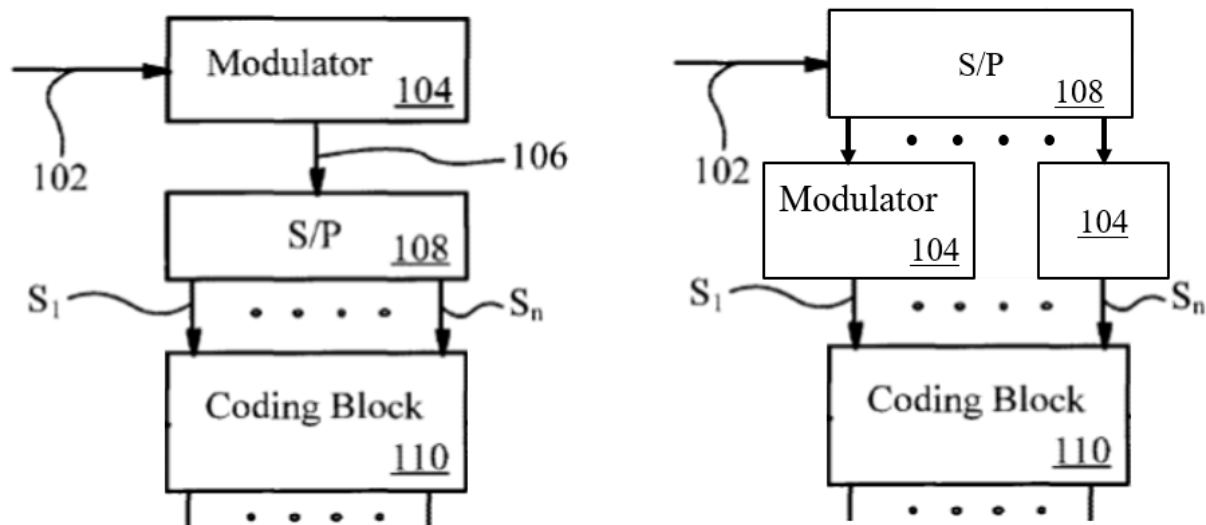


FIG. 3

(EX1027 (Jalali '454), FIG. 3, 16:23-58.) A person of skill in the art would understand that substituting the modulator and S/P converter in Paulraj '632 with a demultiplexer and then encoders as taught in Jalali '454 merely involves the simple substitution of one known element for another to obtain predictable results. Following Jalali '454's teaching that it is an acceptable alternative to demultiplex and then encode, a person of skill in the art would have considered it obvious to

modify Paulraj '632 such that modulation occurs after the serial to parallel conversion:



(Paulraj '632, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised based on Jalali '454).) A person of skill in the art would understand there is no material difference between (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, and would have every expectation of success in making this modification. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15.)

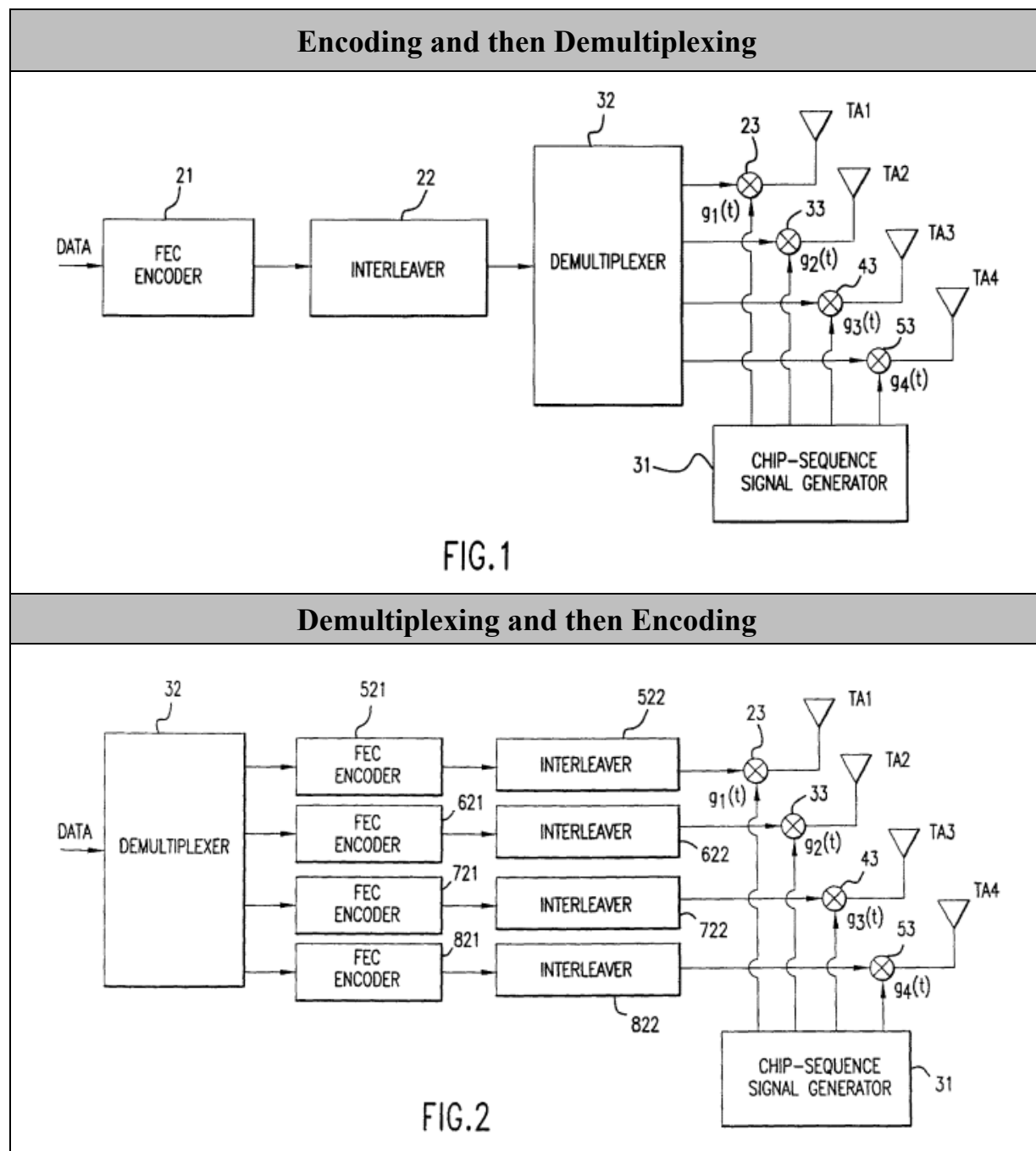
132. Accordingly, Paulraj '632 in view of Jalali '454 renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj '632's serial-to-parallel converter arranged prior to (rather than after) modulation, as shown by Jalali '454's demultiplexer), and M encoder/modulators each producing a respective one of the M symbol substreams,

with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (a modulator as taught in Paulraj '632 connected to each output of the serial-to-parallel converter, as taught by Jalali '454's encoders which are each connected to an output of the demultiplexer).

(c) Ground 3 – Paulraj '632 in view of Schilling '330

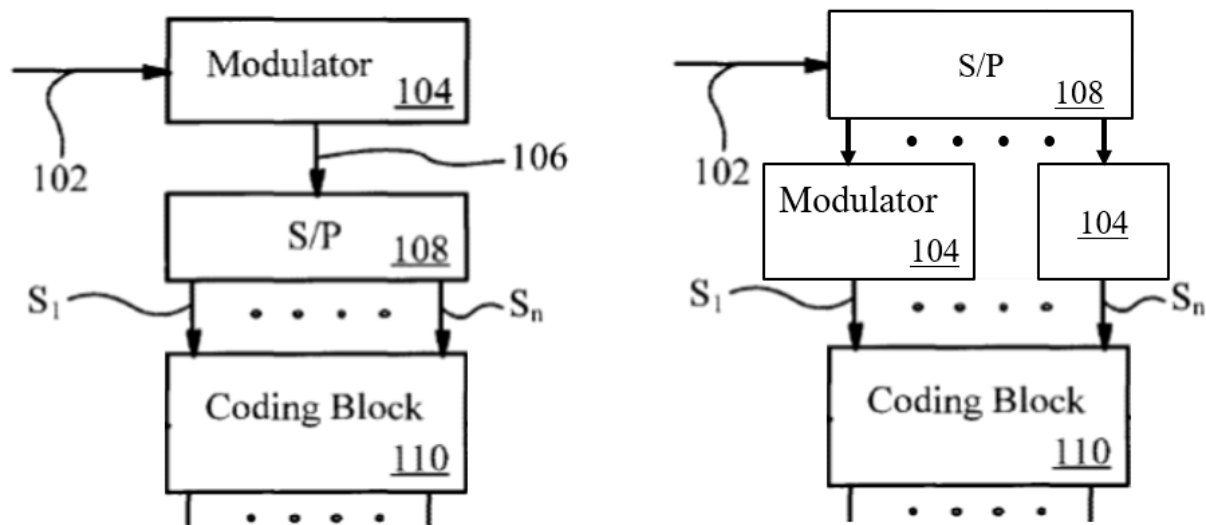
133. In addition, a person of skill in the art would have considered it obvious to modify Paulraj '632 in view of Schilling '330 to “further compris[e] a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

134. Schilling '330 is analogous art to Paulraj '632 in that it discloses transmitter and receiver designs for wireless communications using multiple antennas. Schilling '330 teaches that (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, are alternatives. For example, for FIG 1 Schilling '330 teaches encoding and then demultiplexing, and for FIG. 2 Schilling '330 teaches that “alternatively” the same result can be accomplished by demultiplexing and then encoding:



(EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15 (confirming FIGs. 1 and 2 are alternatives); *see also id.* at 12:30-57 (confirming another embodiment where demultiplexing is performed prior to encoding).) Following Schilling '330's

teaching that it is an acceptable alternative to demultiplex and then encode, a person of skill in the art would have considered it obvious to modify Paulraj '632 such that modulation occurs after the serial to parallel conversion:



(Paulraj '632, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised based on Schilling '330).) A person of skill in the art would have had an expectation of success in making this modification because it merely involves a different order of operations, and the prior art (including, but not limited to, Schilling '330) showed it was an acceptable design option to demultiplex prior to encoding. (*See also* EX1027 (Jalali '454), FIG. 3, 16:23-58.)

135. Accordingly, Paulraj '632 in view Schilling '330 renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj '632's serial-to-parallel converter arranged

prior to (rather than after) modulation, as Schilling '330 teaches is an alternative), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (a modulator as taught in Paulraj '632 connected to each output of the serial-to-parallel converter, each configured to produce a respective one of the substream symbols ($S_1, \dots, S_N$)).

3. Claim 3: “A transmitter according to claim 2 wherein the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.”

136. Paulraj '632 alone (Ground 1), Paulraj '632 in view of Jalali '454 (Ground 2), and/or Paulraj '632 in view of Schilling '330 (Ground 3), renders obvious the transmitter of claim 2, “wherein the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.”

137. **Ground 1:** As discussed for claim 2, it was well-known in the art that when parallel streams are desired (such as in Paulraj '632) it would be obvious to either (i) encode/modulate and then demultiplex (as in Paulraj '632), or (ii) demultiplex and then encode/modulate. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15 (“In FIG. 1, the data are first forward-error-correction (FEC) encoded by FEC encoder 21 and interleaved by interleaver 22, and then demultiplexed by demultiplexer 32 into four data streams.... Alternatively, as shown in FIG. 2, the

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data could first be demultiplexed by demultiplexer 32 and then each data stream could be FEC encoded by a plurality of FEC encoders"); EX1027 (Jalali '454), FIG. 3, 16:23-58.) Regardless of the operation of these steps, Paulraj '632 teaches that the parallel M symbol substreams are produced from "bitstream 102 of information." (Paulraj '632, 4:55-60.)

138. **Ground 2**: If a person of skill in the art modified Paulraj '632 in view of Jalali '454 (as discussed for claim 2, Ground 2), this combination would result in a "demultiplexing and encoding block [that] is adapted to produce the M symbol substreams from an input stream" since both Paulraj '632 and Jalali '454 teach starting with a single input stream. As shown below, Jalali '454 teaches that the input is an aggregate input data stream:

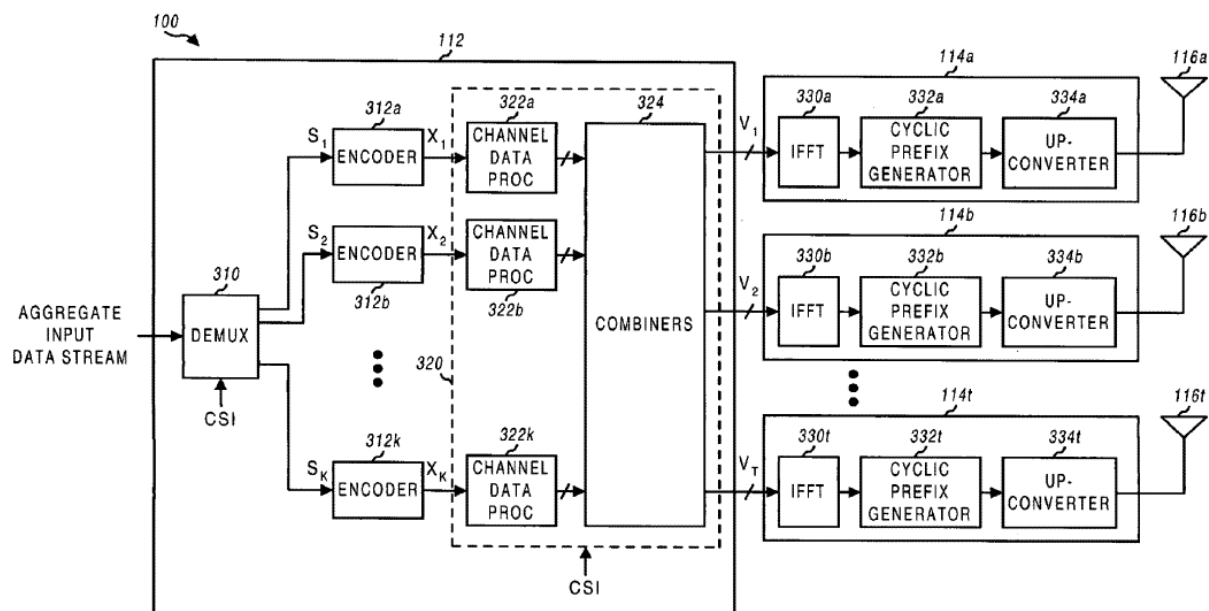


FIG. 3

(EX1027 (Jalali '454), FIG. 3, 16:23-58.)

139. **Ground 3:** If a person of skill in the art modified Paulraj '632 in view of Schilling '330 (as discussed for claim 2, Ground 3), this combination would result in a “demultiplexing and encoding block [that] is adapted to produce the M symbol substreams from an input stream” since both Paulraj '632 and Schilling '330 teach starting with a single input stream. As shown below, Schilling '330 teaches that the input is a single data stream:

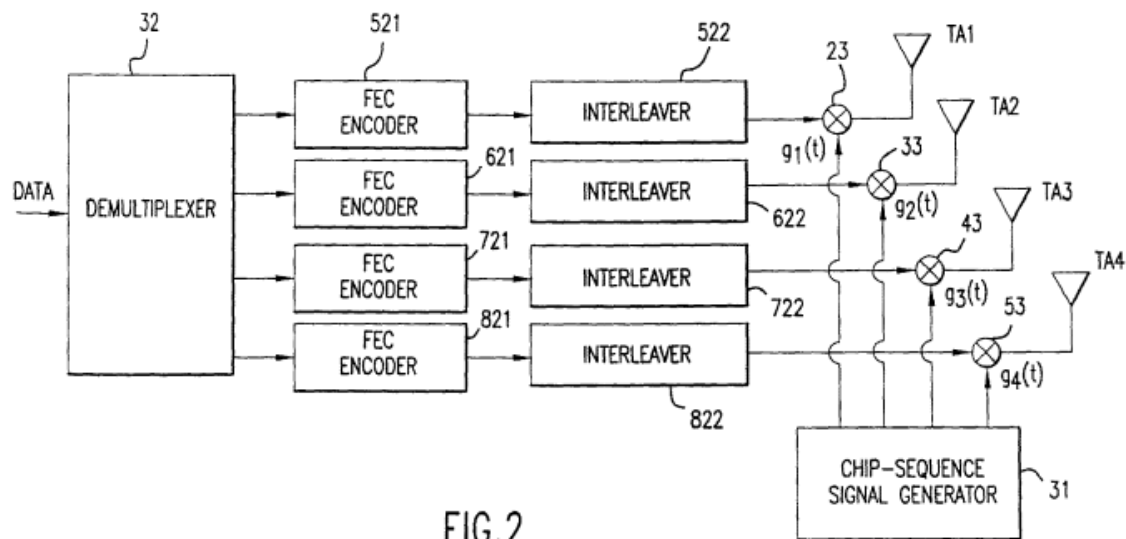


FIG.2

(EX1026 (Schilling '330), FIG. 2.)

140. Accordingly, Paulraj '632 alone (Ground 1) and/or Paulraj '632 in view of Jalali '454 (Ground 2), and/or Paulraj '632 in view of Schilling '330 (Ground 3) renders obvious the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.

4. Claim 6: (Depending on Claim 1)

141. As is explained below, Paulraj '632 alone anticipates and renders obvious claim 6 (Ground 1), and Paulraj '632 in view of Schilling '330 renders obvious claim 6 (Ground 3). For reference, claim 6 recites (with bracketed notations to delineate its limitations):

6[a] A transmitter according to claim 1 wherein the delay arrangement comprises: delay elements adapted to insert a delay

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in at least one of the M substreams; and

- 6[b]** the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.

(’305 patent, 6:35-43 (Claim 6; bracketed notations (e.g., [a]) added).)

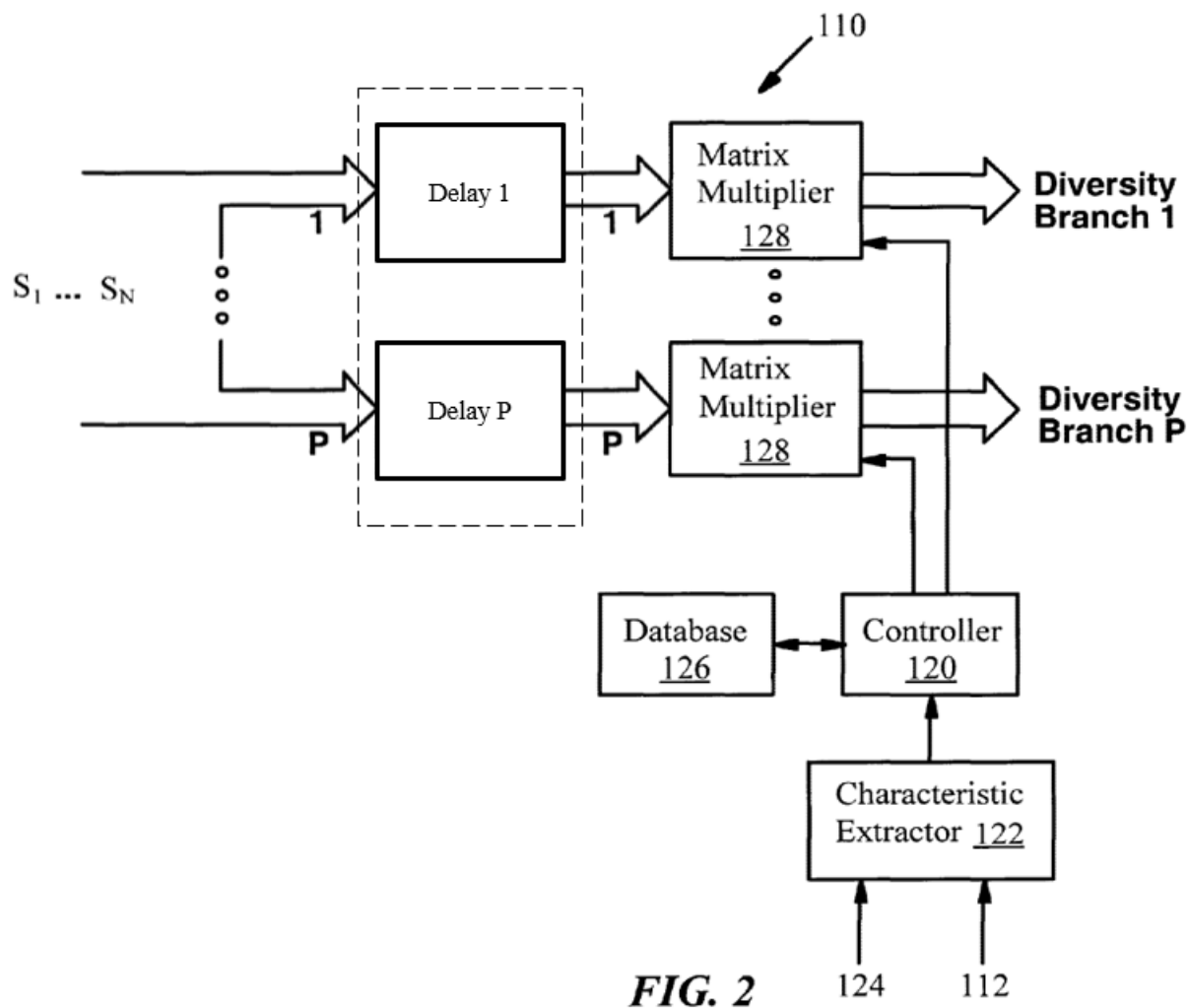
- (a) “A transmitter according to claim 1 wherein the delay arrangement comprises: delay elements adapted to insert a delay in at least one of the M substreams; and” (claim 6[a])**

142. Paulraj ’632 discloses or renders obvious “wherein the delay arrangement comprises: delay elements adapted to insert a delay in at least one of the M substreams.”

143. I understand that Petitioner and Patent Owner agree that “the M substreams” refers to “the M symbol substreams.”

144. I understand that Petitioner has argued that, consistent with the specification, this limitation should be limited to “delay elements adapted to insert a time delay in at least one of the M symbol substreams.” (EX1014.) I further understand that Patent Owner has argued this limitation is broader and includes additional forms of delays such as phase delays. (EX1043, ¶44.) Paulraj ’632 discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies Patent Owner’s broader construction.

145. As discussed for claim 1, Paulraj '632 discloses a time delay in each diversity branch in order to "improve the effect of diversity as well as reduce the overhead resulting in a higher throughput." (Paulraj '632, 7:62-67.) In Paulraj '632, the delays are shown after the P/S + CP blocks. However, a person of skill in the art would consider it obvious (and mathematically equivalent) to add the delays prior to the matrix multipliers 128 in coding block 110 as shown below:



(Paulraj '632, FIG. 2 (modified to include Delays 1-P).) As shown in the prior art figure below, it was known in the prior art to use a configuration where the delay (104) is prior to space-time diversity encoding:

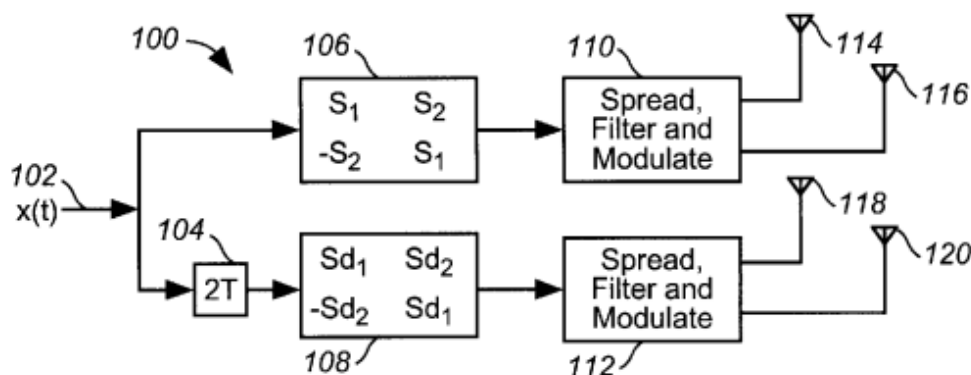


FIG. 1

(EX1032 (U.S. Patent No. 6,542,556), FIG.1, 4:3-5 (“Offset block 104 causes a 2 symbol period delay.”).) In addition, the prior art confirms that a person of skill in the art would understand adding delays prior to the matrix multipliers is mathematically equivalent to adding the delays after the P/S + CP block. For example, as shown in the figures below, the prior art recognized that an embodiment with the delay before encoding/interleaving (FIG. 5) is a known “alternative” for achieving delay diversity that is equivalent to the delay coming after encoding/interleaving (FIG. 4):

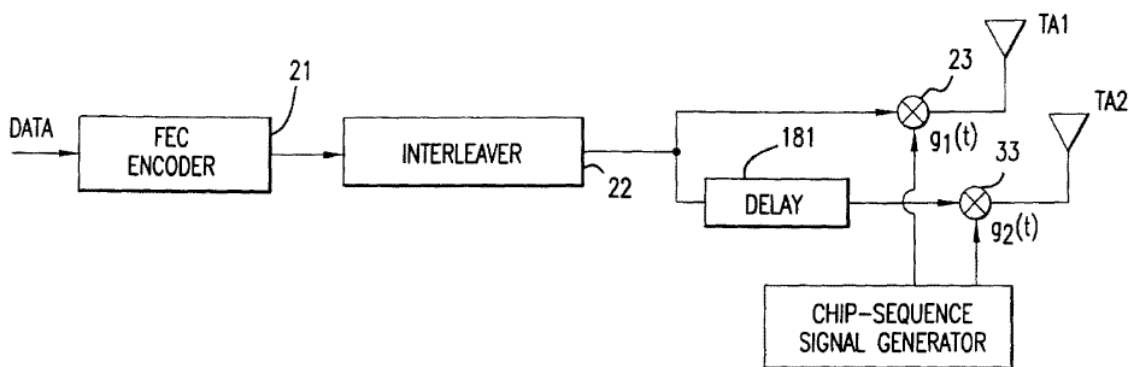


FIG.4

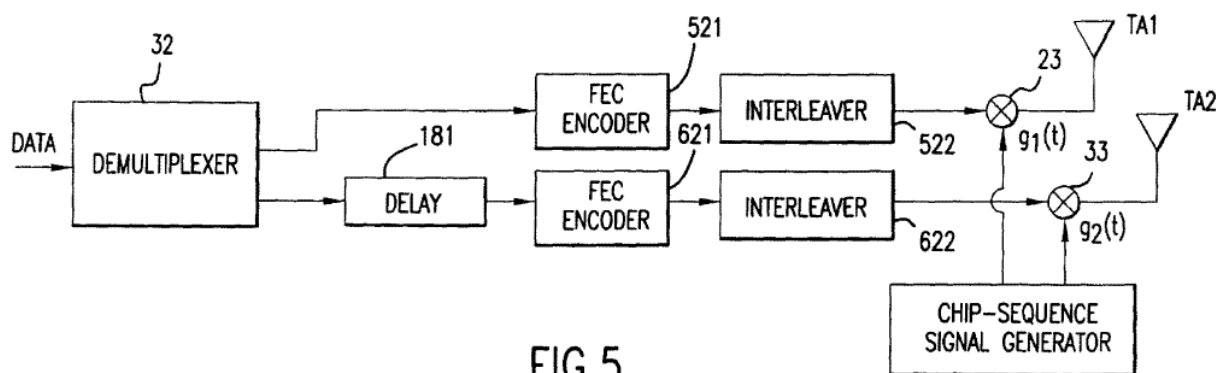


FIG.5

(Schilling '330, FIG. 4 v. FIG. 5, 12:30-57 (*Compare* "FIG. 4, the invention includes FEC encoder 21, coupled to the interleaver 22. From the interleaver 22, the system includes at least one delay device 181 The system may include a plurality of delay devices, with each delay device having a delay different from other delay devices in the plurality of delay devices. The delay device 181 delays the interleaved data going to the second spread-spectrum device 33." *with* "An alternative to FIG. 4 is shown in FIG. 5. Data are first demultiplexed by demultiplexer 32 into a first stream of data and a second stream of data. The second stream of data is delayed

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by delay device 181 with respect to the first stream of data. The first stream of data is FEC encoded by first FEC encoder 521 and interleaved by first interleaver 622. The delayed second stream of data is FEC encoded by second FEC encoder 621 and interleaved by second interleaver 622.”.)

146. **Ground 3:** To the extent necessary, it would have been obvious to combine Paulraj ’632 with Schilling ’330 for this limitation. As discussed above, Schilling ’330 teaches that it was a known alternative to place the delay before encoding/interleaving (FIG. 5). Following Schilling ’330’s teaching, modifying Paulraj ’632 to include the delay prior to encoding would merely be a simple substitution of one known approach (obtaining delay diversity by inserting a delay after encoding) for another (obtaining delay diversity by inserting a delay before encoding) to obtain predictable results.

147. Paulraj ’632 alone (Ground 1) and Paulraj ’632 in view of Schilling ’330 (Ground 3) therefore renders obvious wherein the delay arrangement (for example, Delay 1 and Delay 2 when added prior to the matrix multiplier 128) comprises: delay elements adapted to insert a delay in at least one of the M symbol substreams (when added before the matrix multiplier 128, Delay 1 inserts a time delay (or no time delay) in the substreams going to Diversity Branch 1 and Delay 2 inserts a different amount of time delay in the substreams going to Diversity Branch

2).

(b) “the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.” (claim 6[b])

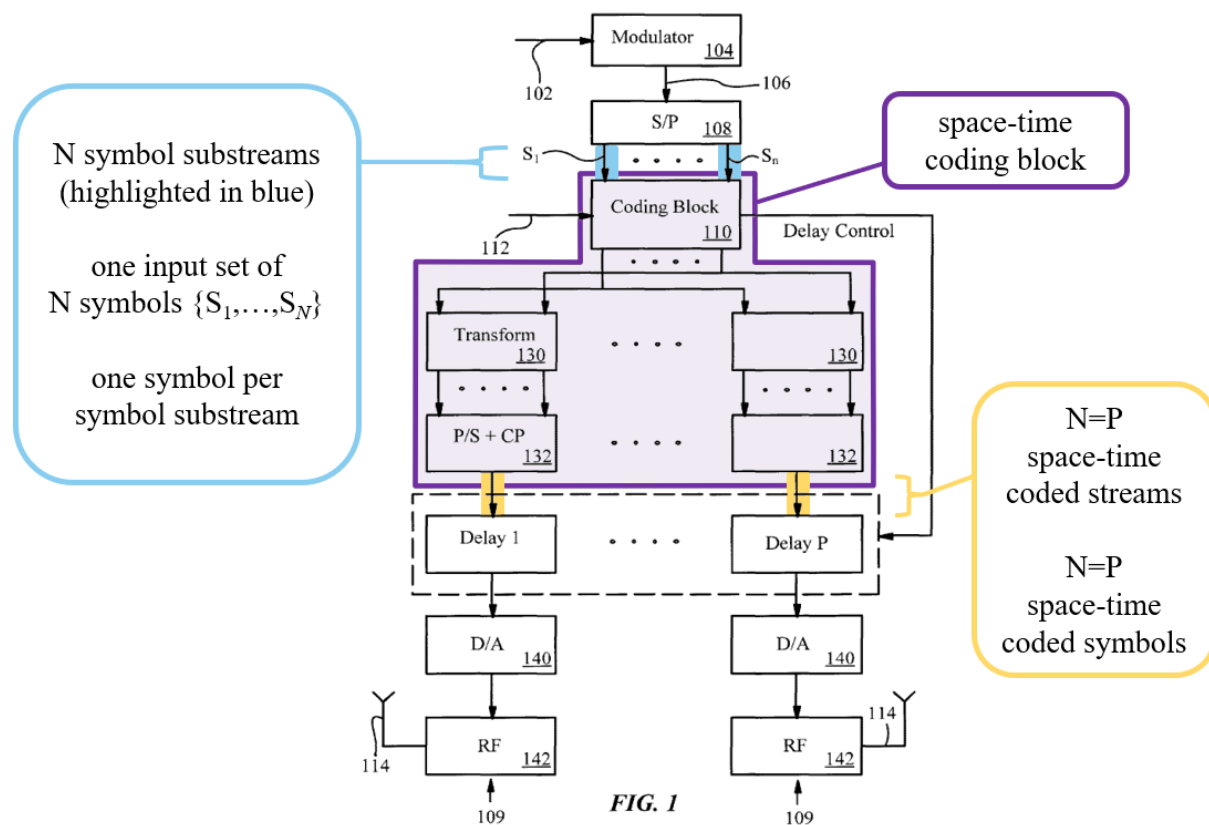
148. Paulraj '632 discloses and renders obvious “the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.”

149. I understand that Petitioner and Patent Owner agree that “the space-time coding function” refers to “the space-time coding block.”

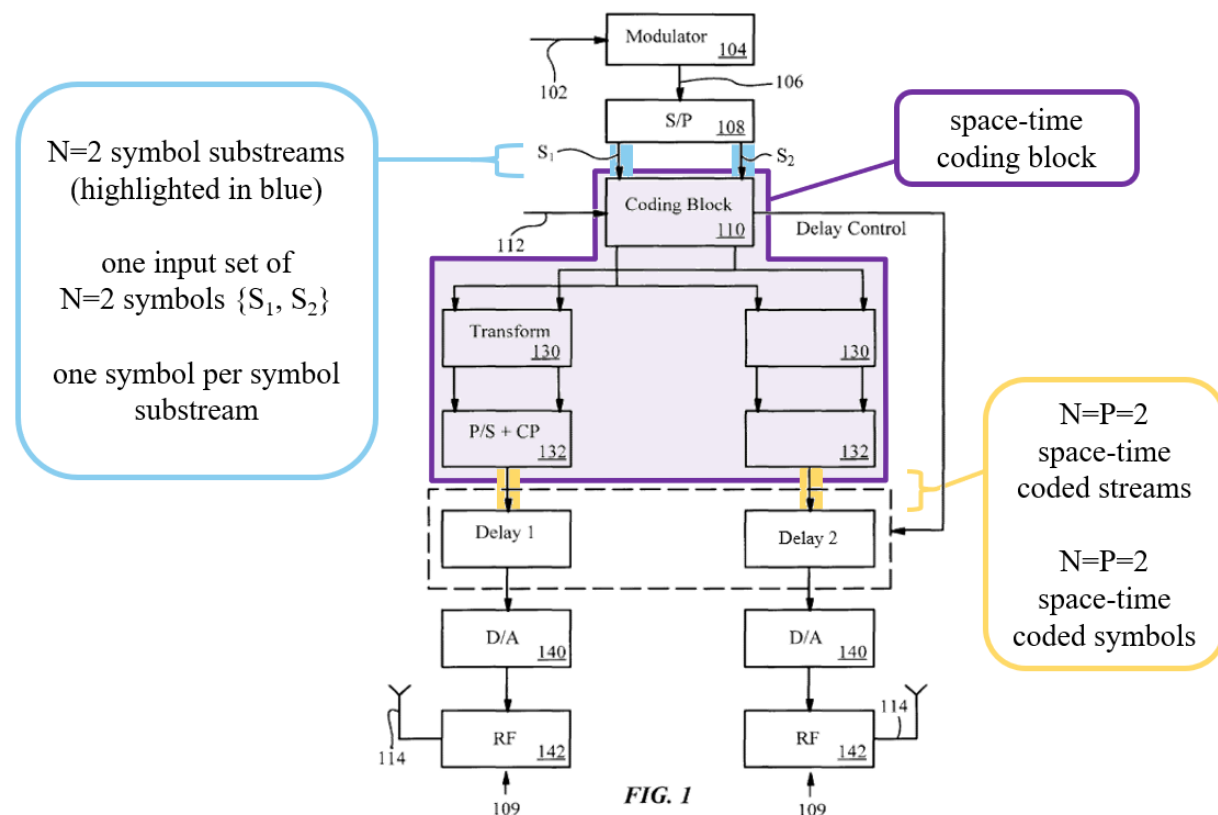
150. I understand that Patent Owner argues that this limitation should be construed such that it is satisfied as long as the limitation is met for any single value of m , where $1 \leq m \leq M$. (EX1042, p.003.) I understand that Petitioner has taken the position this limitation should be construed to require that the claim be satisfied for every value of m , where $1 \leq m \leq M$. As set forth below, Paulraj '632 discloses and renders obvious this limitation under either construction.

151. As discussed above, the space-time coding function/block in Paulraj '632 includes coding block 110, transform block 130, and parallel-to-serial converter (P/S+CP) block 132:

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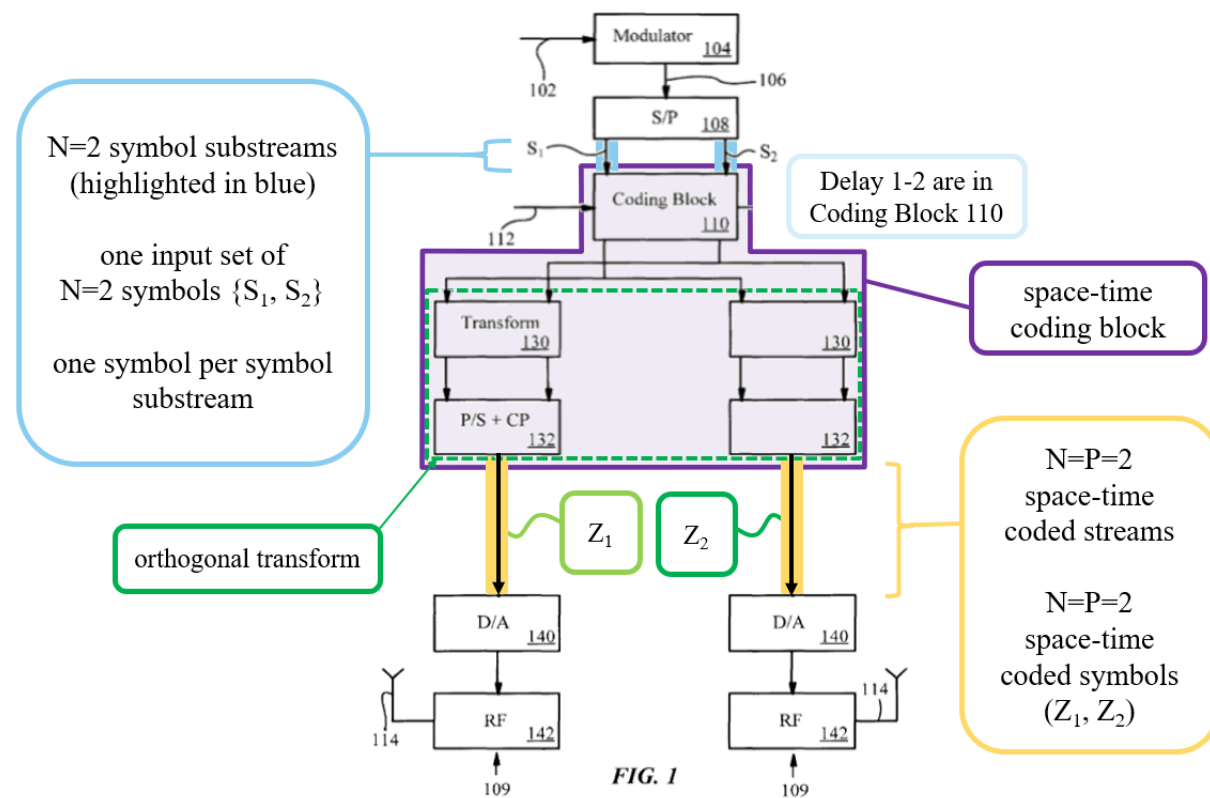


(Paulraj '632, FIG. 1 (annotated).) An annotated version of this figure is also provided for $N=P=2$:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, and annotated).) In addition, because for claim 6 the delays are moved within the coding block, I have provided annotated figures for $N=P=2$ with the delays included in coding block 110 (as shown in the modified version of FIG. 2). As shown below, when the delays are moved into coding block 110, the orthogonal transform (boxed in green) produces two outputs Z_1 and Z_2 which are each space-time coded symbols that are transmitted on their respective space-time coded streams (highlighted in yellow):

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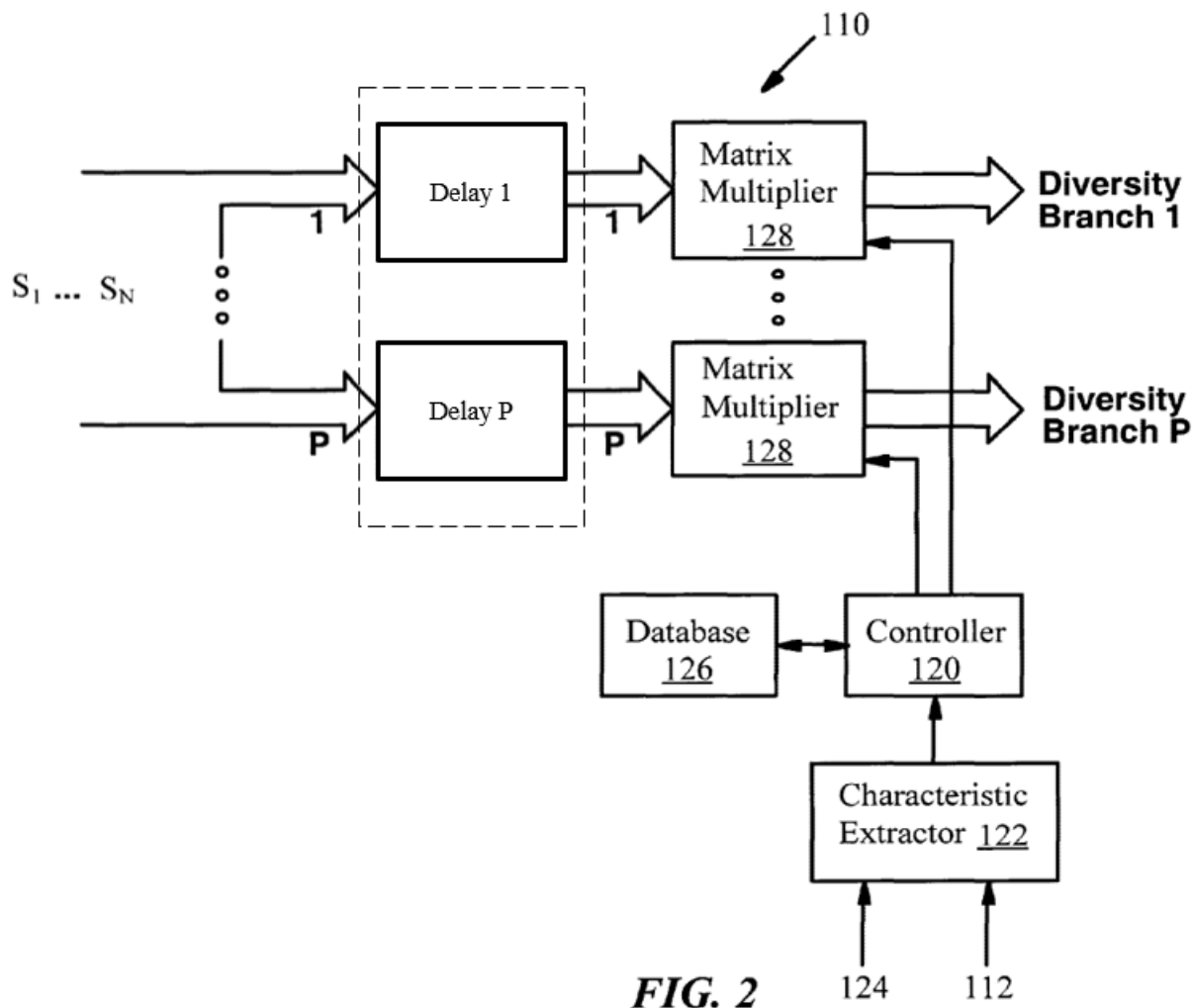


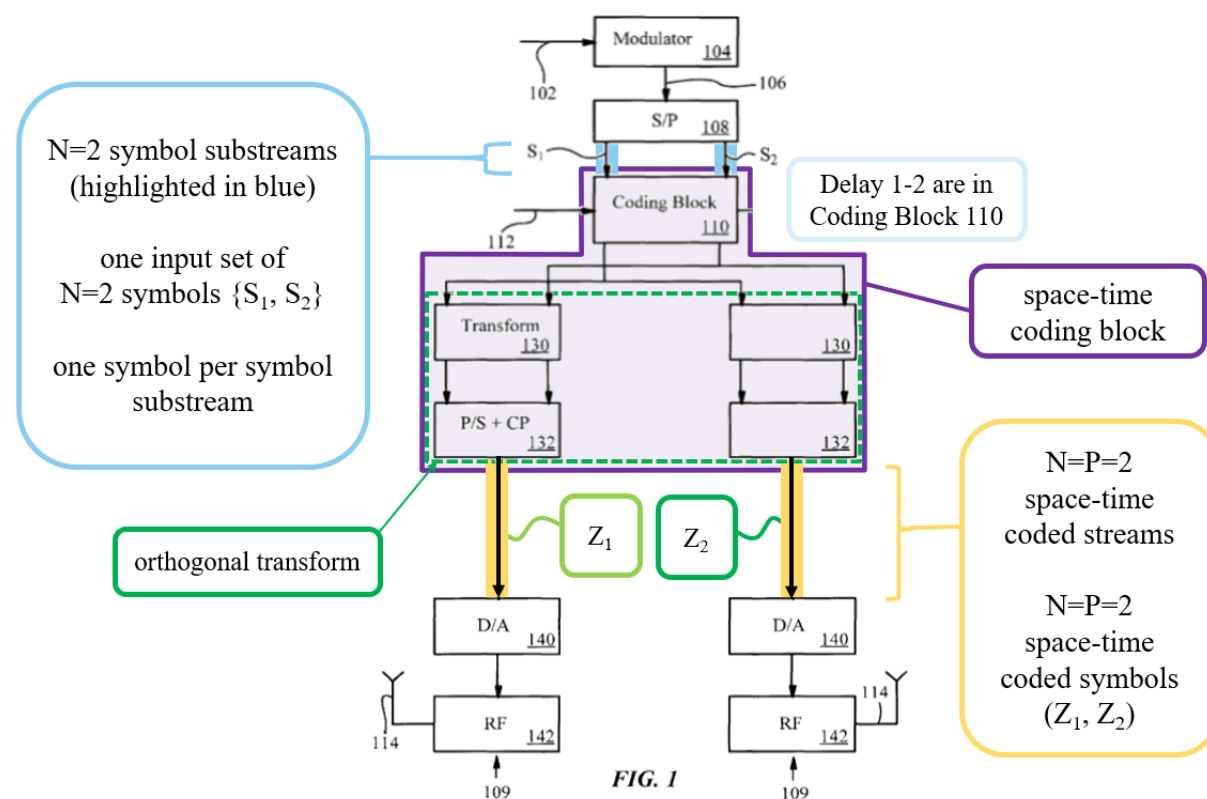
FIG. 2

(Paulraj '632, FIG. 1 (modified for $N=P=2$, modified to move Delay 1 and Delay 2 to within the coding block, and annotated); Paulraj '632, FIG. 2 (modified to include Delays 1-P).)

152. Paulraj '632 discloses that transform block 130 “maps an input frame of N complex values into M values” where “[t]he transform matrix can be an IFFT (Inverse Fast Fourier Transform) at the transmit station.” (Paulraj '632, 7:15-22.)

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A person of skill in the art would recognize that each IFFT is an orthogonal transform. For purpose of claim 6, a person of skill in the art would further understand that collectively, the IFFT blocks and the P/S+CP blocks form an orthogonal transform adapted to produce M orthogonal outputs. For the case of $N=P=2$, this is annotated below:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, modified to move Delay 1 and Delay 2 to within the coding block, and annotated).) In the '305 patent, the term “orthogonal output” is used to refer to any output of an orthogonal function, regardless of whether the outputs are orthogonal to each other. Based on this understanding of the term

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“orthogonal output,” the outputs of each IFFT (and P/S+CP block) in Paulraj ’632 would be considered an “orthogonal output” because each output is the output of an orthogonal function. Similarly, a 2-dimensional Walsh Hadamard code used in a two-chip per bit CDMA system would have the same structure as the $N=P=2$ IFFT output.

153. Under Patent Owner’s construction, this claim is satisfied because a person of skill in the art would understand that when Delay 1 is added before the matrix multiplier 128, Delay 1 would not insert any delay. This is because the purpose of Delay 1 and Delay 2 are to create a difference in time delay between the two diversity branches. The easiest way to accomplish the desired relative difference in delay between the two diversity branches is to apply no delay to one diversity branch and the desired amount of delay to the other diversity branch. In this circumstance, at least the first ($m=1$) orthogonal output (Z_1) is a function of the M substreams delayed in said delay elements by 0 ($(m=1)-1$) symbol periods.

154. Under Petitioner’s construction, a person of skill in the art would understand that when Delays 1 and 2 are added before the matrix multiplier 128 (as discussed above), it would be obvious for Delay 1 to not insert any delay and Delay 2 to insert a delay of 1 symbol period. Using a delay of 1 symbol period has several advantages. For example, a delay of 1 symbol period would (i) be simple, (ii) allow

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diversity with relative ease of decoding, and (iii) be within keeping of typical delay spreads. Indeed, space-time coding prior art at that time encouraged the use of “delays of the order of symbol period.” (EX1035 (Sampath 1999), p.003.)

155. In addition, Paulraj '632 discloses that the invention applies to “any kind of access techniques such as TDMA, FDMA, CDMA, OFDMA.” (Paulraj '632, 9:46-49.) And Paulraj '632 teaches that the “value of differential time delay between the diversity branches is preferably at least equal to the channel length (delay spread of the channel).” (Paulraj '632, 5:3-5.) Following Paulraj '632's teaching of a time delay “at least equal” to the delay spread, this would necessarily result in a delay of 1 symbol period when the delay spread is approximately equal to the symbol period—which is a practical occurrence. For example, at the time proposed data rates for Fixed Wireless Access ranged from 1-20 Mbps depending on the channel conditions. (EX1036 (Varshney 2000), p.004.) For a low-rate Rayleigh channel (e.g., 1 Mbps, which is approximately equal to 1 bits/ μ s⁵) where

⁵ This approximation assumes 1 bit per symbol period and does not account for overhead such as error control coding. However, as this analysis is conservatively based on the lowest data rate (1 Mbps), even accounting for overhead and higher bits

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diversity could be used to improve the performance, a person of skill in the art would understand the symbol period to be approximately 1 μ s. Channel length for Fixed Wireless Access ranged from at least 0 to 1 μ s depending on different factors such as the antenna directionality, distance from the transmitter to receiver, etc. (EX1037 (Erceg 1999), pp.003-10.)⁶ Accordingly, since the low-rate data rate symbol period (1 μ s) is within measured delay spread, a delay from the second diversity branch of one symbol (which is equivalent to or greater than the delay spread as taught by Paulraj '632, 5:3-5) would increase the delay diversity of the channel. As the symbol periods become smaller (for higher data rates), this is also encompassed by known

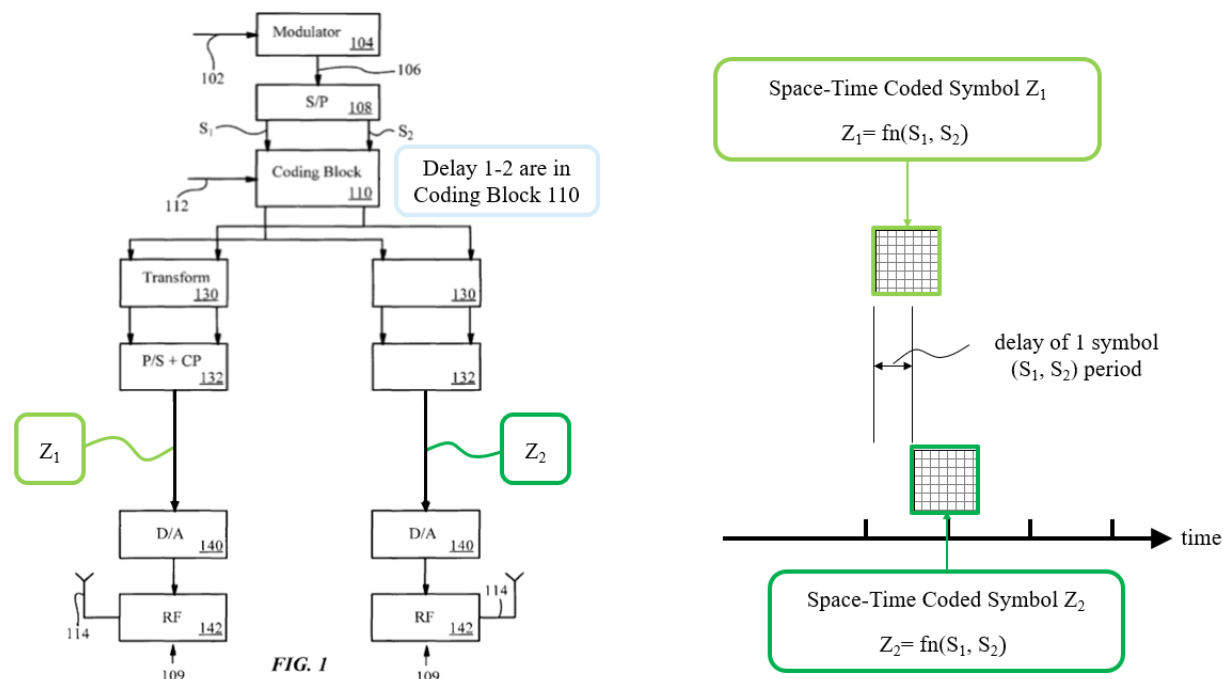
per symbol would not impact the conclusion that it is practical for the delay spread to be approximately equal to the symbol period.

⁶ EX1037 reports a root-mean-square (average) delay spreads ranging from 0-0.5 μ s, and indicates delay spreads of at least up to 1 μ s. (EX1037 (Erceg 1999), pp.003-10.) Paulraj '632 discusses delay spread in terms of channel length. (Paulraj '632, 5:3-5.) A person of skill in the art would understand that an rms delay spread is approximately half of the channel length. Accordingly, to convert (i) rms delay spread to (ii) delay spread in terms of channel length, the rms delay spread is approximately doubled.

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delay spreads. For example, EX1037 (Erceg 1999) discloses rms delay spreads of less than $0.1 \mu\text{s}$ (which corresponds to a channel length of $0.2 \mu\text{s}$) 70% of the time. (EX1037, p.006.) This suggests it was practical for a system with a symbol period of $0.2 \mu\text{s}$ or less (approximately 5 Mbs or greater) to experience a channel with a delay equal to the symbol period. Adding a delay of $0.2 \mu\text{s}$ (a symbol period), would improve the diversity of the channel consistent with the teachings of Paulraj '632, 5:3-5.

156. In this circumstance, the first ($m=1$) orthogonal output (Z_1) is a function of the M substreams delayed in said delay elements by 0 ($(m=1)-1$) symbol periods and the second ($m=2$) orthogonal output (Z_2) is a function of the M substreams delayed in said delay elements by 1 ($(m=2)-1$) symbol period. An exemplary figure is provided below:



(Paulraj '632, FIG. 1 (modified for $N=P=2$, modified to move Delay 1 and Delay 2 to within the coding block, and annotated).)

157. Paulraj '632 alone (Ground 1) and/or Paulraj '632 in view of Schilling '330 (Ground 3) thus discloses and renders obvious the space-time coding function/block (coding block 110, transform block 130, and parallel-to-serial converter (P/S+CP) block 132) further comprises an orthogonal transform (the transforms 130 and parallel-to-serial converter (P/S+CP) blocks 132) adapted to produce M orthogonal outputs, with the m th orthogonal output being a function of the M symbol substreams delayed in said delay elements by $m-1$ symbol periods.

C. Grounds 4-6: Claims 1-3, 6 Are Obvious Over Rowitch '702 in View of Paulraj '632 (Ground 4); and/or Claims 2-3 are Obvious Over Rowitch '702 in view of Paulraj '632 and Jalali '454 (Ground 5); and/or Claims 2-3 are Obvious Over Rowitch '702 in view of Paulraj '632 and Schilling '330 (Ground 6)

158. As explained in greater detail below, claims 1-3, 6 of the '305 patent are rendered obvious by Rowitch '702 in view of Paulraj '632 (Ground 4). To the extent certain limitations in claims 2-3 are not disclosed and/or rendered obvious by Rowitch '702 in view of Paulraj '632, claims 2-3 are obvious over Rowitch '702 in view of Paulraj '632 and Jalali '454 (Ground 5). Likewise, to the extent certain limitations in claims 2-3, and 6 are not disclosed and/or rendered obvious by Rowitch '702 in view of Paulraj '632, claims 2-3 and 6 are obvious over Rowitch '702 in view of Paulraj '632 and Schilling '330 (Ground 6).

1. Claim 1 (Independent)

159. As is explained below, claim 1 is obvious over the prior art. For reference, claim 1 recites (with bracketed notations to delineate its limitations):

- 1[p]** A transmitter adapted to process a plurality M of symbol substreams, the transmitter comprising:
- 1[a.i]** a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols,
- 1[a.ii]** each input set of M symbols comprising one symbol per symbol substream,
- 1[a.iii]** each of the M space-time coded symbols being included in a

- respective one of M space-time coded streams,
- 1[b]** wherein each symbol of the M symbol substreams is represented in all M space-time coded streams,
- 1[c]** wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams,
- 1[d]** each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams;
- 1[e]** a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams,
- 1[f]** such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.

(’305 patent, 5:60-6:14 (Claim 1; bracketed notations (e.g., [a.i]) added).)

- (a) “A transmitter adapted to process a plurality M of symbol substreams, the transmitter comprising:”
(claim 1, preamble)**

160. To the extent the preamble is treated as limiting, Rowitch ’702 discloses “[a] transmitter adapted to process a plurality M of symbol substreams.”

161. Rowitch ’702 discloses a transmitter unit 110 that includes modulator

116. (Rowitch ’702, 4:32-43.) As shown in FIG. 2, in the modulator 116 data

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symbols Y are demultiplexed into two complex symbol streams, Y_{EVEN} and Y_{ODD} .⁷

I have highlighted Y_{EVEN} and Y_{ODD} in blue in the figure below:

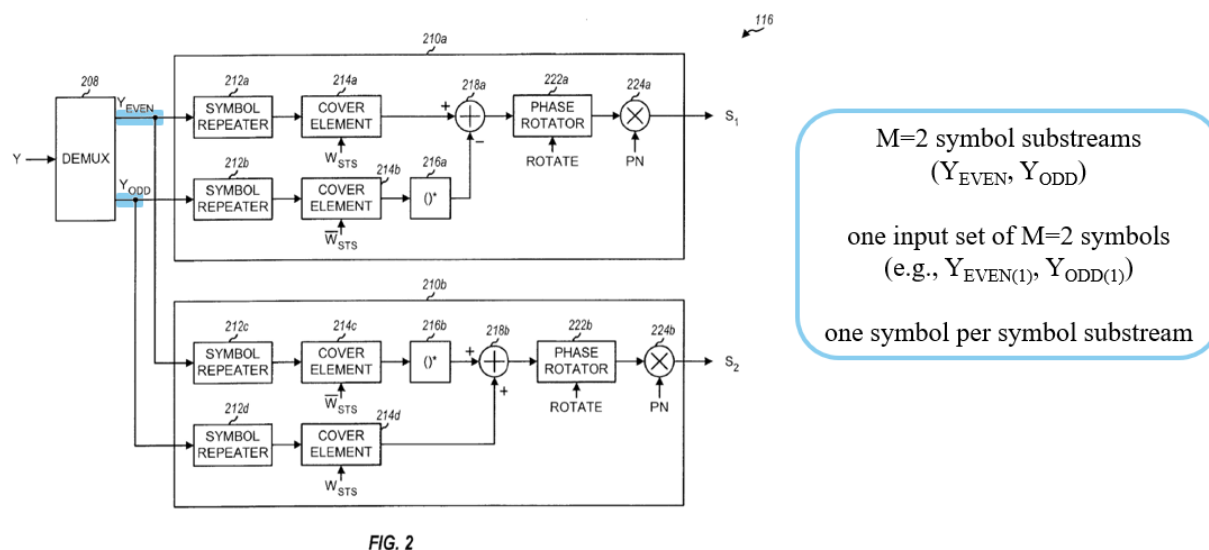


FIG. 2

(Rowitch '702, FIG. 2 (annotated), 5:46-51.)

162. Rowitch '702 thus teaches a transmitter adapted to process a plurality M of symbol substreams ($M=2$ complex symbol streams, Y_{EVEN} and Y_{ODD}).

⁷ Rowitch '702 uses both all-caps (Y_{EVEN} and Y_{ODD}) (see, e.g., FIG. 2) and lower-case (Y_{even} and Y_{odd}) (see, e.g., 5:47-57, 7:11-57) when referring to the complex symbol streams produced by the demultiplexer 208. A person of skill in the art would understand there is no difference. Because FIG. 2 uses Y_{EVEN} and Y_{ODD} , and that figure is the primary figure used for my annotations, I will use Y_{EVEN} and Y_{ODD} for simplicity.

(b) “a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols,” (claim 1[a.i])

163. Rowitch '702 discloses “a space-time coding block adapted to produce M space-time coded symbols per input set of M symbols.”

164. Rowitch '702 teaches that modulator 116 “process[es] a downlink data transmission in a Space-Time Spreading transmit diversity mode[.]” (Rowitch '702, 5:43-47.) As shown in FIG. 2 and described in Rowitch '702, a person of skill in the art would understand that for a given time period $T=(1)$ there will be a complex symbol $Y_{\text{EVEN}(1)}$ in substream Y_{EVEN} and a complex symbol $Y_{\text{ODD}(1)}$ in symbol substream Y_{ODD} . For each set of $M=2$ symbols (e.g., $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$) the transmitter produces $M=2$ space-time coded symbols ($S_{1(1)}$ and $S_{2(1)}$). I have annotated FIG. 2 below to show the substreams (highlighted in blue) and the space-time coded streams (highlighted in yellow):

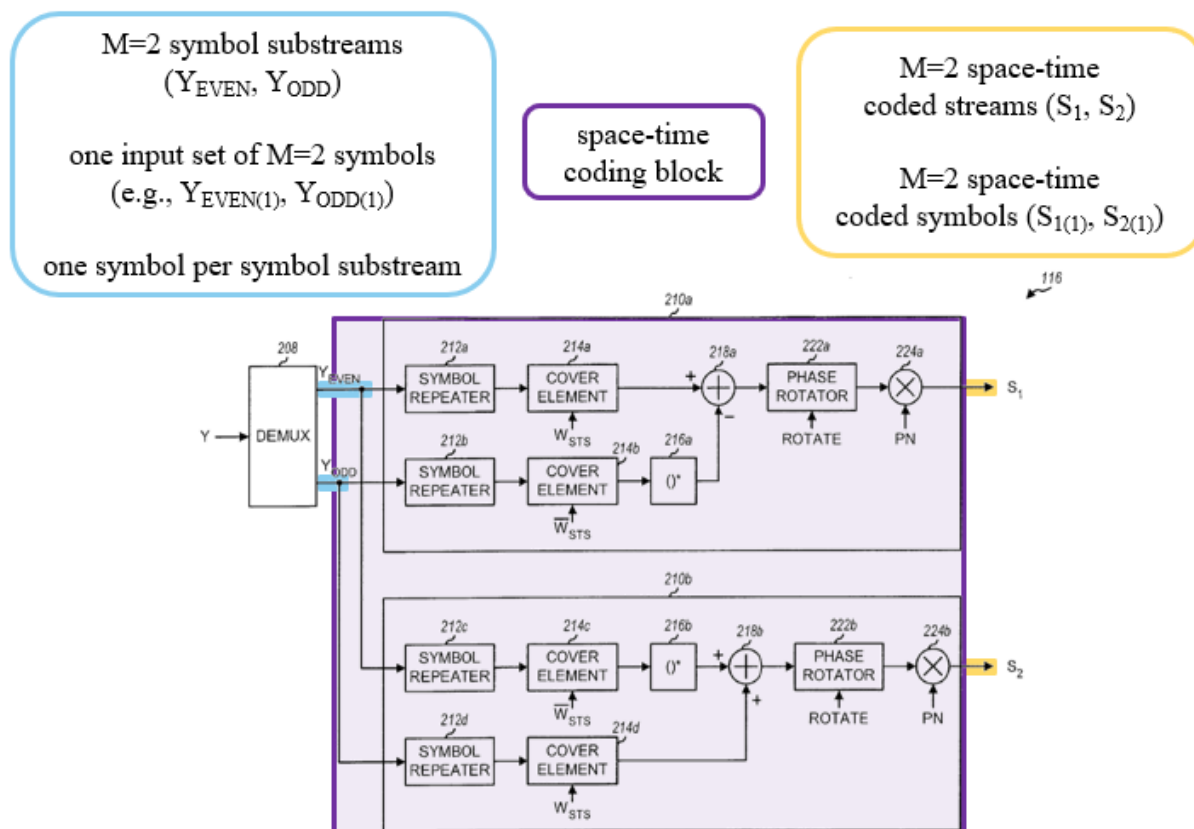
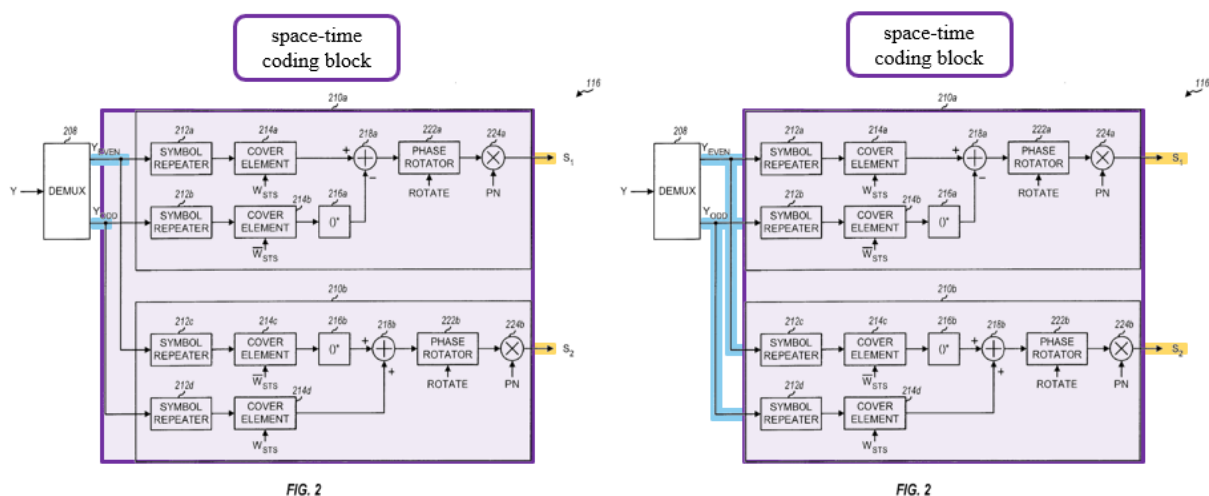


FIG. 2

(Rowitch '702, FIG. 2 (annotated).)

165. At a high-level, as to Rowitch '702, claim 1 requires the space-time coding block to input a set of $M=2$ symbols and produce as its output $M=2$ space-time coded streams that are transmitted over $M=2$ antenna. A person of ordinary skill in the art would understand that there are multiple ways to draw a box around the various transmitter components described and shown in Rowitch '702 that would satisfy the claim requirements for the space-time coding block. For example, two alternatives are shown below:

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166. For purposes of simplicity of explanation, for the present analysis I will refer to the space-time coding block in Rowitch '702 to be comprised of modulators 210a/b. However, a person of ordinary skill in the art would understand that whether the input paths to the modulators 210a/b are drawn in or outside the space-time coding block is not substantively different. Using this example, the output of the space-time coding block in Rowitch '702 is symbol streams S_1 and S_2 , which for the given time period $T=(1)$ corresponds to symbols $S_{1(1)}$ and $S_{2(1)}$.

167. A person of ordinary skill in the art would understand that symbols $S_{1(1)}$ and $S_{2(1)}$ are each a space-time coded symbol. For example, Rowitch '702 teaches that modulator 116 "process[es] a downlink data transmission in a Space-Time Spreading transmit diversity mode[.]" (Rowitch '702, 5:43-47.) And within modulators 210a/b, Rowitch '702 teaches that cover elements 214a/c and 214b/d

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cover the data symbols using a Walsh space-time spreading symbol (W_{STS} or $\bar{W}_{STS}$). (Rowitch '702, 5:44-6:21.) Those skilled in the art recognized that Space-Time Spreading (STS) is a form of space-time coding. (See, e.g., EX1012 (Mitra 1999), p.006 (describing STS as disclosed in EX1011 as an example of applying “space-time coding to DS-CDMA systems”).)

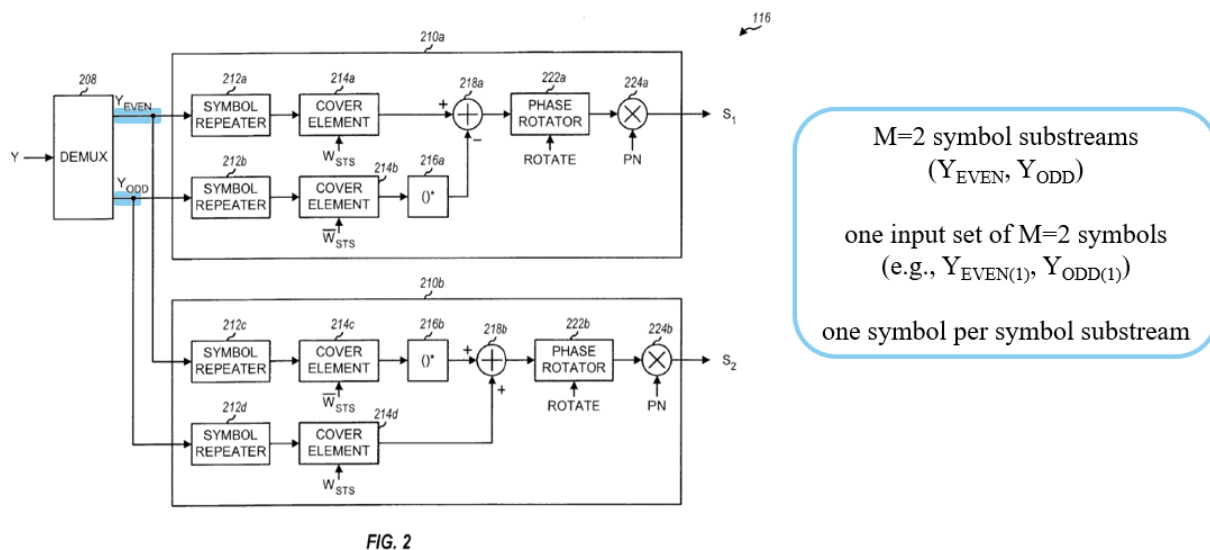
168. Rowitch '702 thus discloses a space-time coding block (modulators 210a/b) adapted to produce M space-time coded symbols (M=2 symbols $S_{1(1)}$ and $S_{2(1)}$) per input set of M symbols (per input set of M=2 symbols $Y_{EVEN(1)}$ and $Y_{ODD(1)}$)).

(c) “each input set of M symbols comprising one symbol per symbol substream,” (claim 1[a.ii])

169. Rowitch '702 discloses “each input set of M symbols comprising one symbol per symbol substream.”

170. As discussed for the prior limitations, a person of ordinary skill in the art would recognize that for each input set of M=2 symbols, $Y_{EVEN(1)}$ and $Y_{ODD(1)}$, one symbol is sent on each symbol substream:

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(Rowitch '702, FIG. 2 (annotated), 5:46-51 (data symbols Y are “demultiplexed into two complex symbol streams, Y_{even} and Y_{odd}”).)

171. Rowitch '702 thus discloses that each input set of M symbols (M=2 symbols Y_{EVEN(1)} and Y_{ODD(1)}) comprises one symbol per symbol substream (Y_{EVEN(1)} on substream Y_{EVEN} and Y_{ODD(1)} on substream Y_{ODD(1)}).

(d) “each of the M space-time coded symbols being included in a respective one of M space-time coded streams,” (claim 1[a.iii])

172. Rowitch '702 discloses “each of the M space-time coded symbols being included in a respective one of M space-time coded streams.”

173. As shown in FIGS. 1-2, Rowitch '702 discloses that “complex output symbol streams, S₁ and S₂, are subsequently provided to two respective processing paths in transmitter 118.” (Rowitch '702, 7:40-55 (further noting that S₁ goes to

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antenna 1 and S_2 goes to antenna 2).) And that “[i]n the STS mode, two complex data symbols are transmitted in parallel over two antennas[.]” (Rowitch ’702, 5:65-66.)

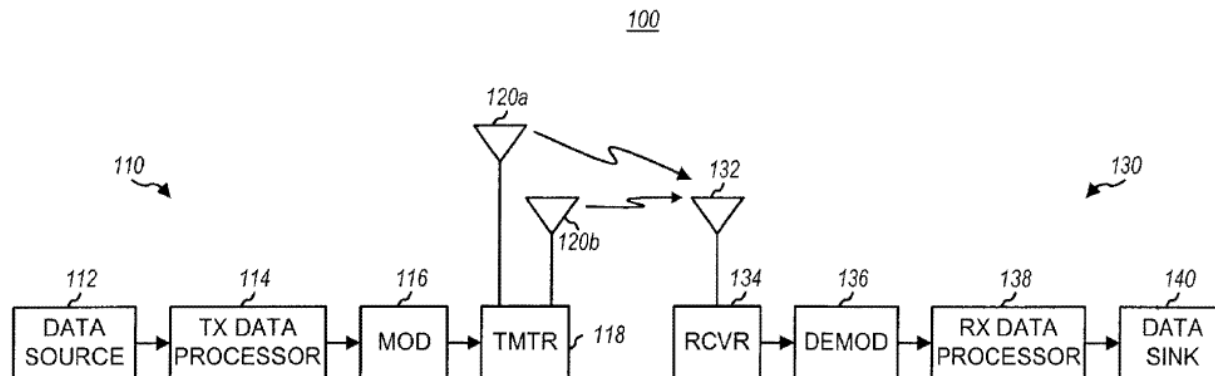


FIG. 1

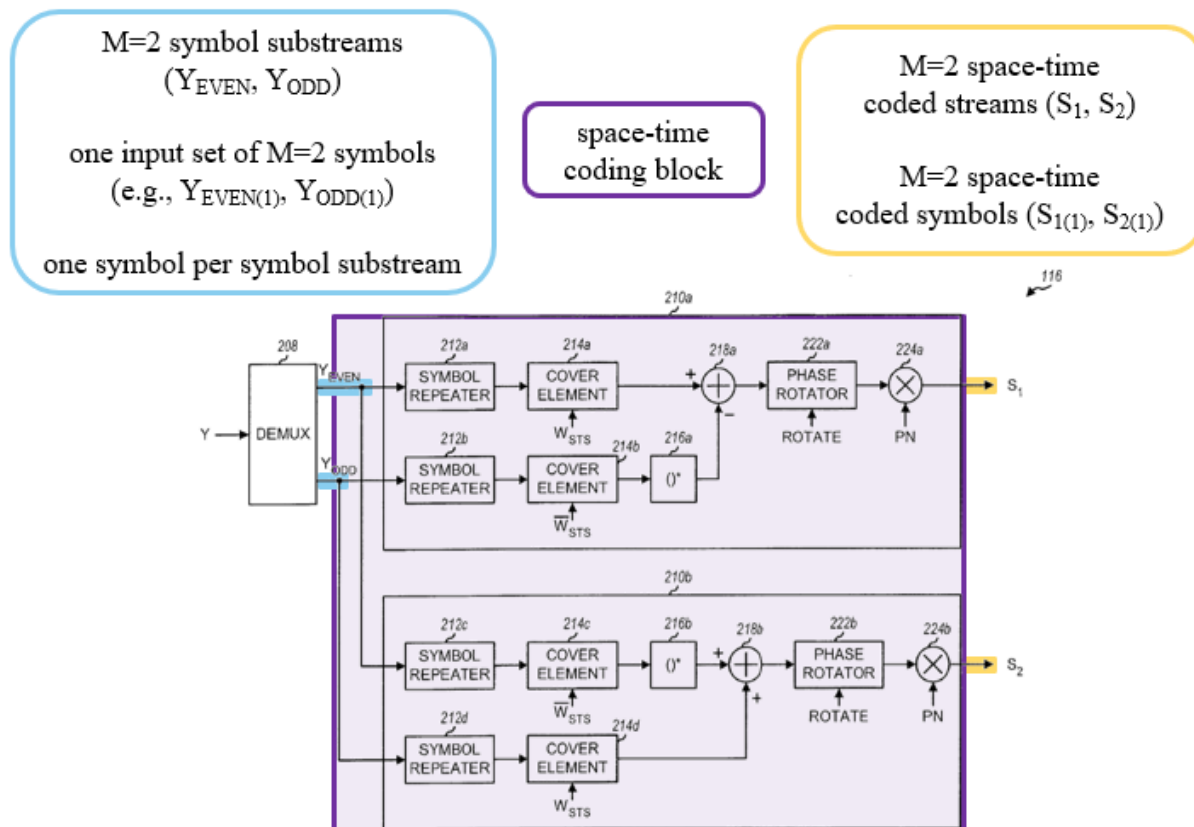


FIG. 2

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(Rowitch '702, FIG.1 and FIG. 2 (annotated).)

174. Rowitch '702 thus teaches that each of the M space-time coded symbols (M=2 symbols $S_{1(1)}$ and $S_{2(1)}$) is included in a respective one of M space-time coded streams (symbol $S_{1(1)}$ in stream S_1 and symbol $S_{2(1)}$ in stream S_2).

(e) “wherein each symbol of the M symbol substreams is represented in all M space-time coded streams,” (claim 1[b])

175. Rowitch '702 discloses “each symbol of the M symbol substreams is represented in all M space-time coded streams.”

176. Equations (4) and (5) of Rowitch '702 describe the complex output symbol stream S_1 (for antenna 1) and S_2 (for antenna 2). As shown in Eq(4) and Eq(5), symbols from each substream Y_{EVEN} and Y_{ODD} are each included in each of the space-time coded streams S_1 and S_2 :

If only the data symbols and the covering are considered (i.e., ignoring the PN spreading, phase rotation, transmit gain, pulse shaping, and other signal processing), the complex output symbol stream for antenna 1 can be expressed as:

$$S_1 = Y_{even} WW - Y_{odd} * W\bar{W}, \quad \text{Eq(4)} \quad 45$$

where the asterisk (*) denotes a complex conjugate operation. Similarly, the complex output symbol stream for antenna 2 can be expressed as:

$$S_2 = Y_{even} * W\bar{W} + Y_{odd} WW. \quad \text{Eq(5)} \quad 50$$

(Rowitch '702, 7:40-52.)

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177. Using the example above, for the given time period $T=(1)$ each symbol $S_{1(1)}$ and $S_{2(1)}$ includes each corresponding substream symbol $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$:

$$S_{1(1)} = Y_{\text{EVEN}(1)}WW - Y_{\text{ODD}(1)}*W\bar{W} \quad \text{Eq(4) for } T=(1)$$

$$S_{2(1)} = Y_{\text{EVEN}(1)}*W\bar{W} + Y_{\text{ODD}(1)}WW \quad \text{Eq(5) for } T=(1)$$

178. Rowitch '702 thus discloses that each symbol of the M symbol substreams (Y_{EVEN} and Y_{ODD}) is represented in all M space-time coded streams (S_1 and S_2).

(f) “wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams,” (claim 1[c])

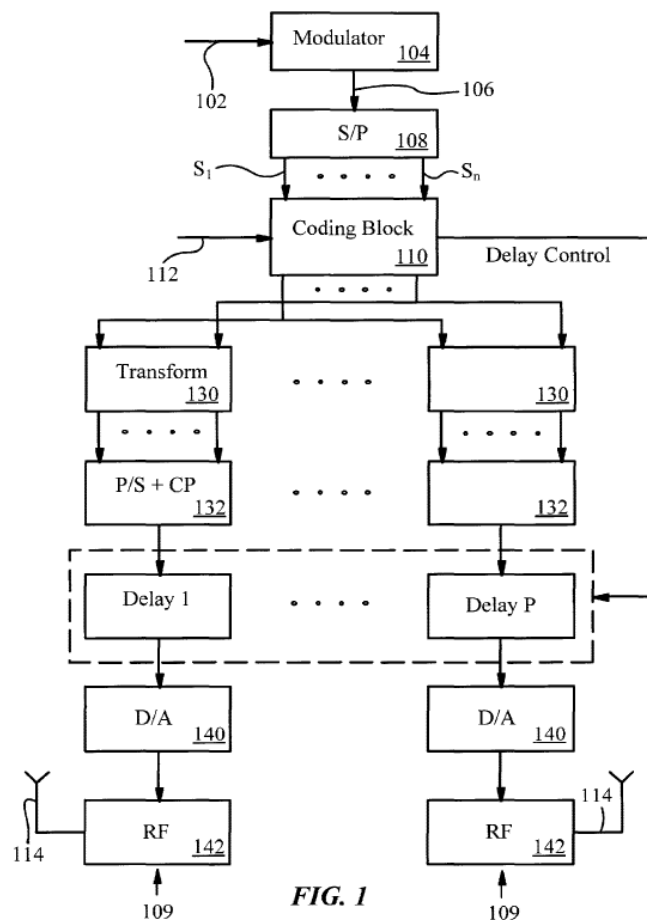
179. Rowitch '702 in view of Paulraj '632 renders obvious “wherein the transmitter comprises a delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams.”

180. I understand that Petitioner has argued that this limitation should be limited to “a time delay arrangement, arranged such that for each symbol of the M symbol substreams a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams.” (EX1014.) I further understand that Patent Owner has argued this limitation is broader and

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includes additional forms of delays such as phase delays. (EX1043, ¶39.) Rowitch '702 in view of Paulraj '632 discloses this limitation under Petitioner's narrower construction, and therefore also satisfies Patent Owner's broader construction.

181. Rowitch '702 discloses space-time diversity but does not disclose delay diversity. Paulraj '632, however, teaches including a time delay in each diversity branch in order to "improve the effect of diversity as well as reduce the overhead resulting in a higher throughput." (Paulraj '632, 7:62-67.) Paulraj '632 further teaches that it is beneficial to include delay diversity "when there is considerable fading (low K-factor) and delay spread in the channel." (Paulraj '632, 2:29-31.) As shown in FIG. 1, Paulraj '632 teaches adding a delay that delays the groupings of symbols prior to digital-to-analog conversion and then transmission:



(Paulraj '632, FIG. 1.)

182. Paulraj '632 teaches that “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted”:

Each diversity branch 109 has an antenna 114 for transmitting a signal. Each diversity branch 109 also has a unique delay (shown as delays 1–P) that is controlled by the coding block 110. Each of the P delays imposes a particular, unique amount of delay on the symbols being transmitted. The value of differential time delay between the diversity branches is preferably at least equal to the channel length (delay spread

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of the channel).

(Paulraj '632, 4:65-5:5.) And that the amount of delay can be controlled by coding block 110 based on the feedback regarding the channel length if available:

The resulting $M+L-1$ complex valued symbols of each diversity branch go through individual delays. The amount of delay can be controlled by coding block 110 based on the feedback regarding the channel length if available.

(Paulraj '632, 7:57-61.)

183. Just like Paulraj '632, Rowitch '702 teaches that the modulator 116 “generate[s] symbols that are then converted to analog signals” for transmission. (Rowitch '702, 4:41-43.) Following Paulraj '632's teaching of including a time delay prior to D/A conversion in each diversity branch in order to “improve the effect of diversity” (Paulraj '632, 7:62-67) particularly when the channel exhibits Rayleigh fading (Paulraj '632, 2:25-31), a person of skill in the art would understand that the delays could be added to Rowitch '702 as follows:

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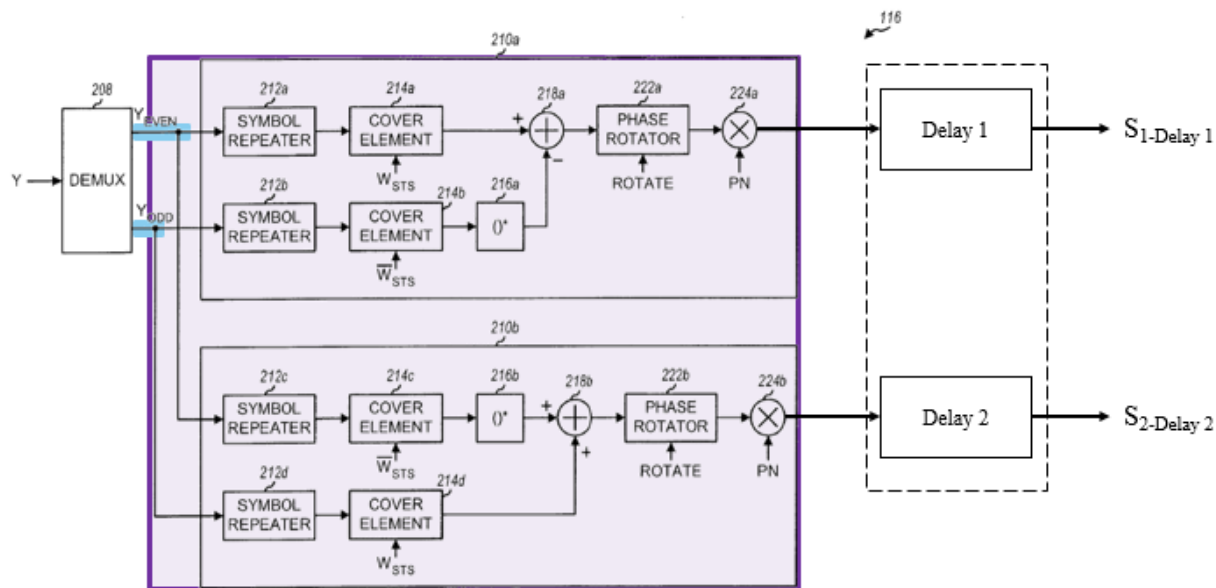


FIG. 2

(Rowitch '702, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj '632, FIG. 1 (Delay 1...Delay P)).) In the figure above, a delay is shown for each diversity path. A person of skill in the art, however, would understand that only a relative delay between symbol streams S_1 and S_2 is required and that this could be accomplished using a singular delay as shown below.

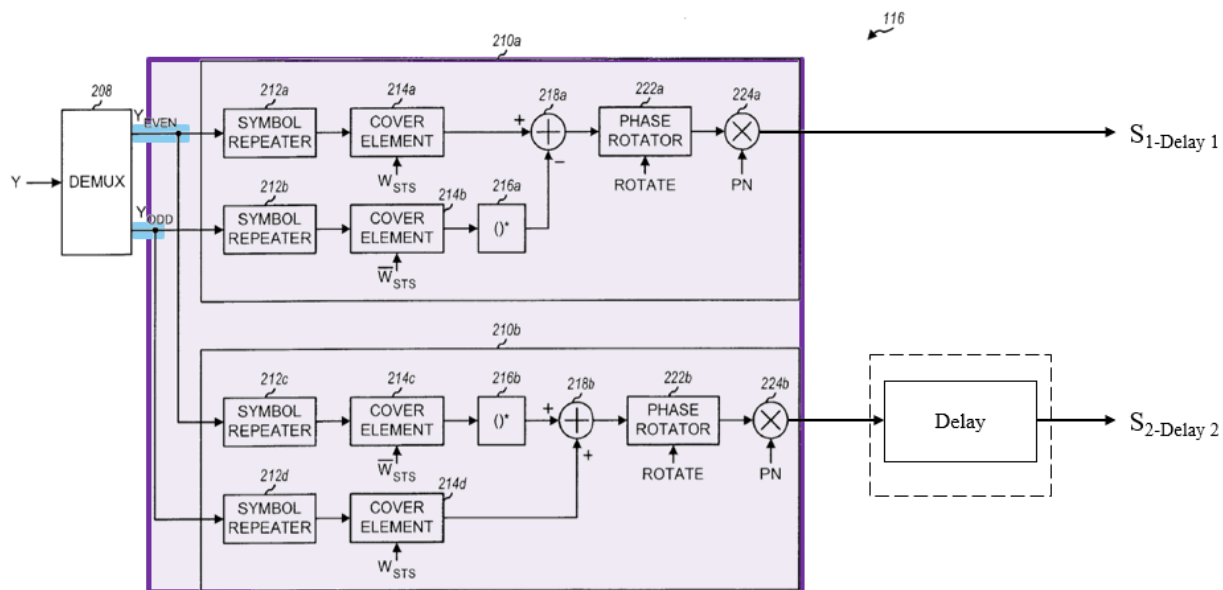
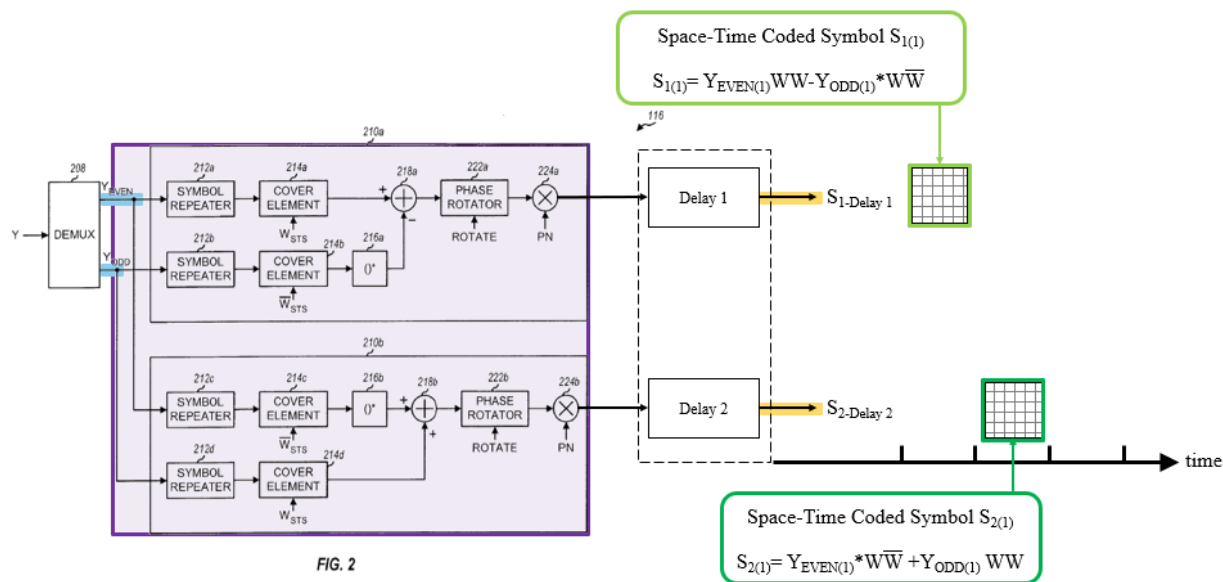


FIG. 2

(Rowitch '702, FIG. 2 (annotated to add a delay as taught by Paulraj '632, FIG. 1).)

184. In accordance with Paulraj '632's disclosure that "[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted," (Paulraj '632, 5:1-2), a person of skill in the art would understand that Delay 1 and Delay 2 would cause the symbols in stream S₂ to be delayed as compared to the symbols in stream S₁ (or vice versa). Using the example above for the given time period T=(1), a person of skill in the art would understand that the "unique amount of delay" taught by Paulraj '632 would results in symbols S₁₍₁₎ and S₂₍₁₎ being transmitted at different times. As shown in the exemplary drawing below, this results in each symbol of the M=2 symbol substreams (each symbol in streams Y_{EVEN} and Y_{ODD}) having a time of representation in the M=2 space time coded streams (S₁

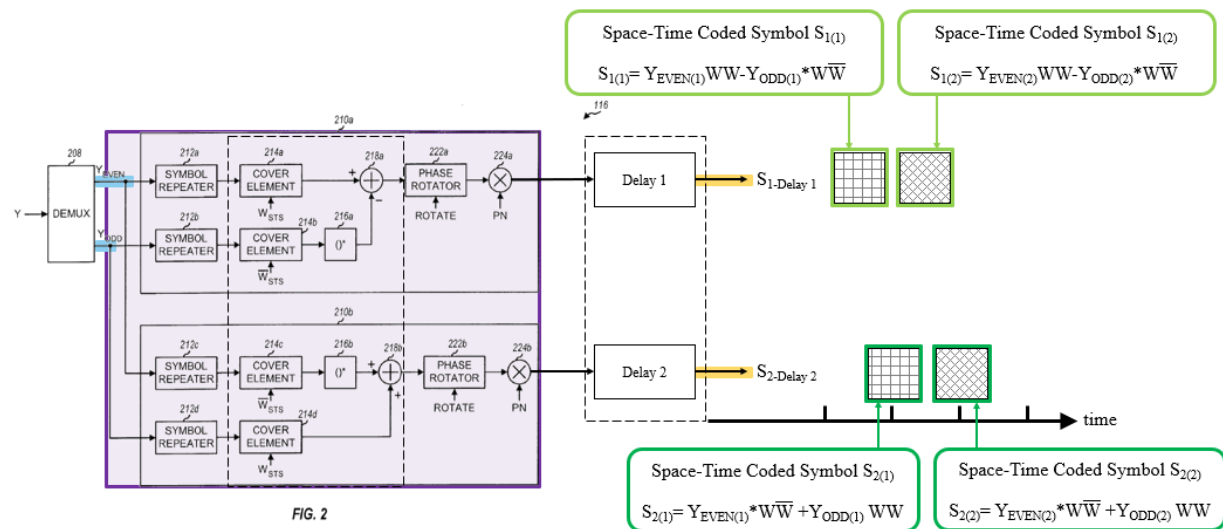
and S_2) that is different. For example, due to the different delays imposed by Delay 1 and Delay 2, the symbol $S_{1(1)}$ for symbol stream S_1 (annotated as $S_{1\text{-Delay}1}$) is transmitted before the symbol $S_{2(1)}$ for symbol stream S_2 (annotated as $S_{2\text{-Delay}2}$):



(Rowitch '702, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj '632, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols).)

185. Note that, in the above example, Delay 2 causes a full space-time coded symbol delay as compared to Delay 1. As taught by Paulraj '632, however, a person of skill in the art would understand that the amount of delay may vary. (Paulraj '632, 4:66-5:5.) Accordingly, a person of skill in the art would understand that in some circumstances $S_{2(1)}$ may only be delayed by a partial symbol as compared to $S_{1(1)}$ (or

vice versa) as shown below:



(Rowitch '702, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj '632, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols).) Either of these examples satisfies the claims because the symbols $S_{1(1)}$ and $S_{2(1)}$ (and subsequent symbols $S_{1(2)}$ and $S_{2(2)}$, etc.) are transmitted at different times.

186. Accordingly, Rowitch '702 in view of Paulraj '632 renders obvious that the transmitter comprises a delay arrangement (Delay 1 and Delay 2 are obvious to add based on Paulraj '632), arranged such that for each symbol of the M symbol substreams (each symbol of the two substreams Y_{EVEN} and Y_{ODD} , such as $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$) a time of representation of the symbol in the M space-time coded streams is different for each of the M space-time coded streams (Delay 1 and Delay 2

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cause $S_{1(1)}$ and $S_{2(1)}$, which each contain $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$, to be transmitted at different times from each antenna and therefore $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$ are transmitted at different times from each antenna).

(1) Manner and rationales for combining the teachings of Rowitch '702 and Paulraj '632

187. Rowitch '702 and Paulraj '632 teach similar methods and devices such that a person of skill in the art would have considered it obvious to, and would have been motivated to, combine the teachings of these references in order to lead to improved transmit-receive methods and devices.

188. Both Rowitch '702 and Paulraj '632 teach diversity transmit-receive methods and devices. (Rowitch '702, 1:8-11 (“The present invention relates to data communications. More particularly, the present invention relates to method and apparatus for efficiently demodulating signals that have been processed and transmitted in a diversity mode.”) and Paulraj '632, Abstract (“A method and apparatus for wireless transmission of a digital bit stream. The present method employs diversity techniques to minimize multipath fading.”).)

189. In both Rowitch '702 and Paulraj '632, signals are space-time coded and then converted from digital to analog prior to transmission. (Rowitch '702, 4:41-43 (modulator 116 “generate[s] symbols that are then converted to analog signals” for transmission) and 5:43-47 (modulator 116 transmits in “a Space-Time

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Spreading transmit diversity mode”); and Paulraj ’632, Title (“Wireless Communication System and Method Using Stochastic Space-Time/Frequency Division Multiplexing”) and 8:28-33 (“after the above diversity operations the symbols are then converted to analog values in D/A converter blocks 140 and then are modulated onto the carrier frequency at modulation blocks 142. Then the signals go through required RF amplification and are fed to the respective antennas 114 for transmission.”).)

190. Paulraj ’632 adds to the methods and devices in Rowitch ’702 by further teaching that it may be beneficial to add a time delay to each diversity branch:

Each diversity branch 109 also has a unique delay (shown as delays 1–P) that is controlled by the coding block 110. Each of the P delays imposes a particular, unique amount of delay on the symbols being transmitted. The value of differential time delay between the diversity branches is preferably at least equal to the channel length (delay spread of the channel).

(Paulraj ’632, 4:66-5:5.)

191. Paulraj ’632 further teaches that controlling the time delay using information about the channel characteristics can improve the effect of diversity:

The control of diversity parameters for example in the present embodiment time delay, in a judicious way based on the information about the channel characteristics (delay spread values in this case) can

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improve the effect of diversity as well as reduce the overhead resulting
in a higher throughput.

(Paulraj '632, 7:63-67.) For example, Paulraj '632 teaches that delay diversity is particularly suitable when there is considerable fading and delay spread in the channel. (Paulraj '632, 2:25-31.)

192. Those skilled in the art encouraged the combination of space-time diversity (as in Rowitch '702) and delay diversity (provided by Delays 1-P in Paulraj '632) to improve the performance of wireless communication systems. (*See, e.g.*, EX1032 (U.S. Patent No. 6,542,556), Abstract, 2:74-57 (“A method and apparatus for space-time coding signals for transmission on multiple antennas. A received input symbol stream is transformed using a predefined transform and transmitted on a first set of N antennas. The same input symbol stream is then offset by M symbol periods to generate an offset input symbol stream.”); EX1003 (Tarokh 1998), pp.001-02 (“When possible, cellular systems should be designed to encompass all forms of diversity to ensure adequate performance[.]”); EX1033 (U.S. Patent No. 6,351,499), 7:20-40 (teaching symbol delay can be used with space-time coding); EX1030 (Damen 2000), p.002 (teaching combination of delay and spatial diversity); EX1026 (Schilling '330), FIG. 5, 4:27-34, 12:10-57.) Indeed, using delay diversity with a CDMA system (such as Rowitch '702) had been well-known since at least the early 1990s. (EX1028 (Salmasi 1991), p.006.) And multiple antenna CDMA

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systems (such as Rowitch '702) were known to employ delay diversity for the downlink transmitter. (EX1025 (Yong 2000), FIG. 1, pp.001-02.) Accordingly, the prior art encouraged the proposed combination.

193. Moreover, Paulraj '632 teaches using time delays with space-time coded symbols in order to improve diversity for Rayleigh fading channels. (Paulraj '632, 2:25-31.) And the 3G systems used as examples in Rowitch (CDMA 2000 and WCDMA) were designed to operate in Rayleigh fading channels with multipath fading. (EX1024 (Dabak 2000), p.005 (using Rayleigh fading conditions when testing WCDMA designs).) Accordingly, introducing more diversity into the channel using a time delay was a known way to increase reliability in the presence of a fading channel that is encouraged by Paulraj '632 and applies to Rowitch '702.

194. Based on the teachings in Paulraj '632, a person of skill in the art would have had every expectation of success in adding the time delays to Rowitch '702. Rowitch '702 teaches modulator 116 transmits in "a Space-Time Spreading transmit diversity mode in accordance with the CDMA-2000 standard" (Rowitch '702, 5:43-47) and Paulraj '632 teaches that its techniques apply to CDMA based systems. (Paulraj '632, 9:45-49 ("The embodiments of the invention can be used in conjunction with any kind of access techniques such as TDMA, FDMA, CDMA, OFDMA or any combination of such techniques.").)

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195. Moreover, Rowitch '702 includes discussion of multiple design options in the receiver to account for different time delays on each path. (*See, e.g.*, Rowitch '702, 8:13-46 (teaching that demodulator 400 aligns pilots to account for path delay); Rowitch '702, 14:13-21 (noting that demodulator 500 is designed to address path delay without requiring pilot alignment); *see also* Rowitch '702, FIGS. 6-7 and discussion (disclosing demodulators 600 and 700, which also address path delay without requiring path alignment).) This provides evidence to a person of skill in the art that you would be able to successfully add time delays to the transmitter in Rowitch '702 because the receiver is already designed to account for delay.

196. In addition, Rowitch '702 explicitly teaches that the correlators in FIGS. 5, 6, and 7 “can be operated to track the timing corresponding to the signal instances being processed.” (Rowitch '702, 17:10-14.) A person of skill in the art would understand that this combines well with Paulraj '632's disclosure that it is beneficial to control Delays 1-P based on channel conditions such as delay spread. (Paulraj '632, 4:65-5:5.) In effect, Rowitch '702 provides a receiver that can provide the type of channel information that Paulraj '632 discloses is useful for controlling the transmitter.

197. Accordingly, a person of ordinary skill in the art would have found it obvious to combine, and would have been motivated to combine, the teachings of

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Rowitch '702 and Paulraj '632 because it merely involves using the known technique from Paulraj '632 (of adding delays to each diversity branch) to improve the known device in Rowitch '702 (a diversity transmitter) in the same way (improving the effect of diversity, including for Rayleigh conditions).

198. Likewise, a person of ordinary skill in the art would have found it obvious to combine, and would have been motivated to combine, the teachings of Rowitch '702 and Paulraj '632 because it merely involves applying the known technique from Paulraj '632 (of adding delays to each diversity branch) to the known device in Rowitch '702 (a diversity transmitter) to predictably result in improving the transmit-receive diversity methods and devices in Rowitch '702 (improving (W)CDMA based diversity methods and systems).

(g) “each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams;” (claim 1[d])

199. Rowitch '702 discloses “each space-time coded symbol comprising a representation of a symbol of each of the M symbol substreams.”

200. Rowitch '702 teaches that each symbol (e.g., $S_{1(1)}$ and $S_{2(1)}$) in symbol streams S_1 and S_2 includes a representation of each symbol (e.g., $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$) from streams Y_{EVEN} and Y_{ODD} .

201. Using the example above, for the given time period $T=(1)$ each symbol

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$S_{1(1)}$ and $S_{2(1)}$ includes each corresponding substream symbol $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$:

$$S_{1(1)} = Y_{\text{EVEN}(1)}WW - Y_{\text{ODD}(1)}W\bar{W} \quad \text{Eq(4) for } T=(1)$$

$$S_{2(1)} = Y_{\text{EVEN}(1)}W\bar{W} + Y_{\text{ODD}(1)}WW \quad \text{Eq(5) for } T=(1)$$

(Rowitch '702, Eq(4) and Eq(5) (modified for $T=(1)$).)

202. Rowitch '702 thus discloses each space-time coded symbol ($S_{1(1)}$ and $S_{2(1)}$) comprising a representation of a symbol of each of the M symbol substreams ($Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$).

(h) “a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams,” (claim 1[e])

203. Rowitch '702 discloses “a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams.”

204. Rowitch '702 teaches that each of the $M=2$ space time coded streams S_1 and S_2 are transmitted over a respective antenna. (See, e.g., Rowitch '702, 5:58-61 (“Each modulator 210...provides a complex output symbol stream S for a respective antenna.”), 5:65-66 (“In the STS mode, two complex data symbols are transmitted in parallel over two antennas”), 7:40-52 (identifying S_1 as “the complex output symbol stream for antenna 1” and S_2 as “the complex output symbol stream for antenna 2”).) For example, antenna 102a and 120b are shown in FIG. 1 below:

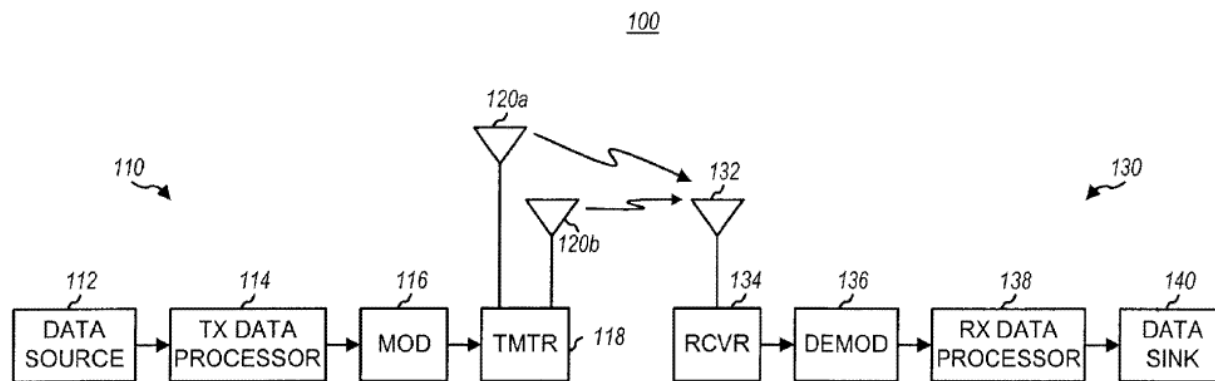


FIG. 1

(Rowitch '702, FIG. 1.)

205. Rowitch '702 thus discloses a plurality M of transmit antennas ($M=2$ antennas: antenna 1 and antenna 2) each adapted to transmit a respective one of the M space-time coded streams (S_1 (on antenna 1) and S_2 (on antenna 2)).

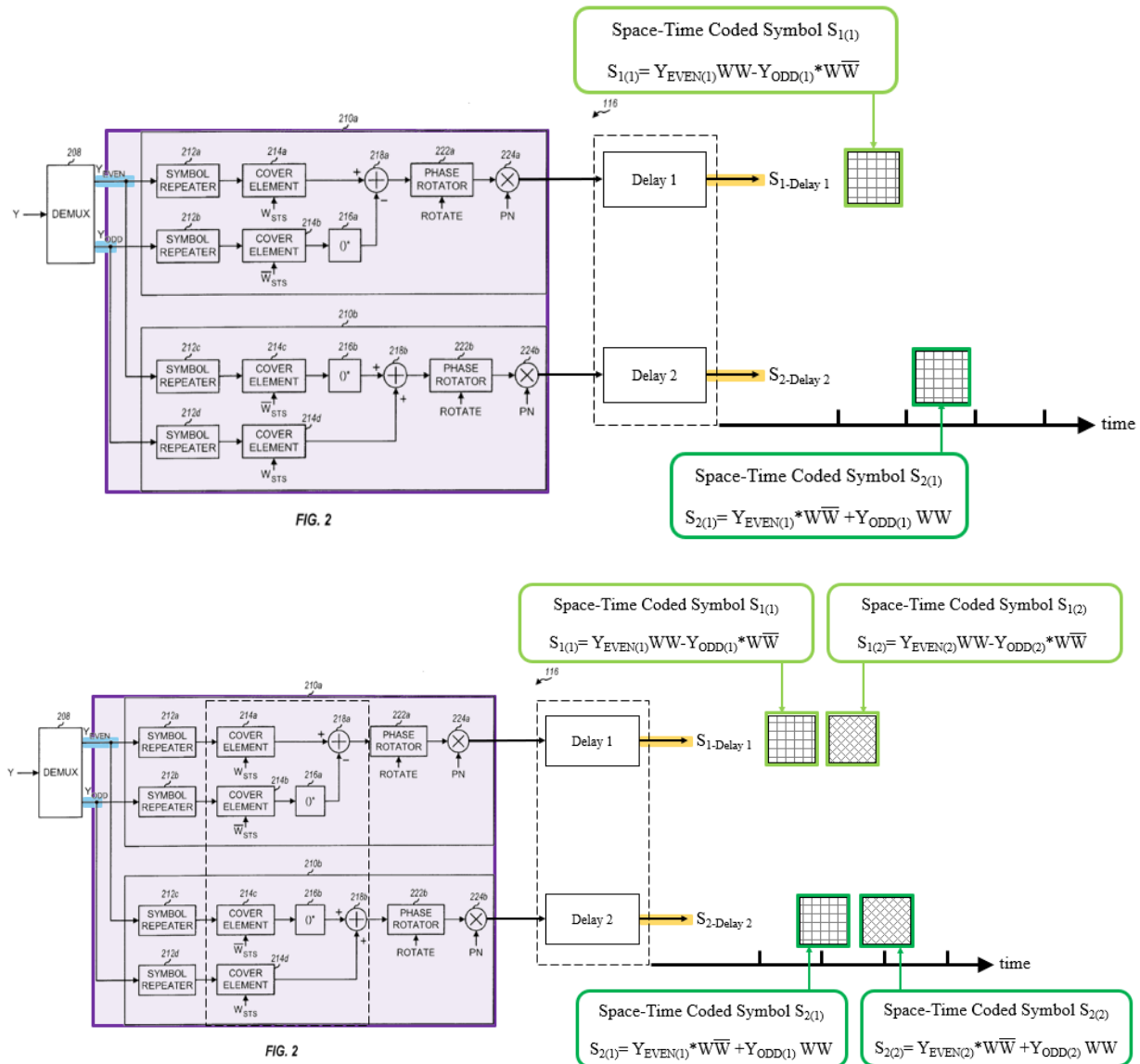
- (i) “such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.” (claim 1[f])

206. Rowitch '702 in view of Paulraj '632 renders obvious “such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.”

207. As set forth above, a person of skill in the art would have considered it obvious to add delays to each diversity branch in Rowitch '702 in order to “improve the effect of diversity” (Paulraj '632, 7:62-67), resulting in the space-time coded symbols ($S_{1(1)}$ and $S_{2(1)}$ for $T(1)$, $S_{1(2)}$ and $S_{2(2)}$ for $T(2)$, etc.) being transmitted at

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different times:



(Rowitch '702, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj '632, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols).)

208. Accordingly, Rowitch '702 in view of Paulraj '632 renders obvious that for each symbol of each input set of M symbols (each input set of M=2 symbols in streams Y_{EVEN} and Y_{ODD} , such as $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$), the M space-time coded symbols that contain a representation of the symbol (each corresponding symbol in streams S_1 and S_2 , such as $S_{1(1)}$ and $S_{2(1)}$) are transmitted at different times (Delay 1 and Delay 2 are unique delays that cause $S_{1(1)}$ and $S_{2(1)}$ to be transmitted at different times from each antenna).

2. **Claim 2: “A transmitter according to claim 1 further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”**

(a) Ground 4 – Rowitch '702 in view of Paulraj '632

209. Rowitch '702 in view of Paulraj '632 renders obvious the transmitter “further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

210. Rowitch '702 teaches that traffic data is sent to “transmit (TX) data processor 114 that formats, encodes, and processes the data” prior to modulator 116.

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(Rowitch '702, 4:34-43.) Rowitch '702 teaches that the output of the TX data processor 116, which is comprised of data symbols Y, is then provided to modulator 116 which then “demultiplexe[s] [the data symbols Y] into two complex symbol streams, Y_{even} and Y_{odd} .” (Rowitch '702, 5:46-51.)

211. A person of skill in the art, however, would have considered it obvious to demultiplex the traffic data prior to encoding/modulating by the TX data processors, encoding/modulating using parallel TX data processors, and then inputting the parallel streams of symbols (Y_{EVEN} and Y_{ODD}) to the space-time coding. Indeed, it was well-known in the art that when parallel streams are desired (such as in Rowitch '702) it would be obvious to either (i) encoded/modulate and then demultiplex (as in Rowitch '702), or (ii) demultiplex and then encode/modulate. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15 (“In FIG. 1, the data are first forward-error-correction (FEC) encoded by FEC encoder 21 and interleaved by interleaver 22, and then demultiplexed by demultiplexer 32 into four data streams.... Alternatively, as shown in FIG. 2, the data could first be demultiplexed by demultiplexer 32 and then each data stream could be FEC encoded by a plurality of FEC encoders[.]”), 12:30-57 (confirming another embodiment where a stream of data is demultiplexed and then encoded).)

212. Accordingly, Rowitch '702 in view of Paulraj '632 renders obvious the

transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (a demultiplexer having M=2 outputs), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (M=2 TX data processors).

(b) Ground 5 – Rowitch '702 in view of Paulraj '632 in further view of Jalali '454

213. In addition, a person of skill in the art would have considered it obvious to modify Rowitch '702 in view of Paulraj '632 in further view of Jalali '454 to “further compris[e] a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

214. Jalali '454 teaches a demultiplexer that demultiplexes an input data stream and produced M=k outputs, and M=k encoder/modulators 312a-312k to produce the symbol substreams (where each encoder/modulator is connected to receive a respective one of the demultiplexer outputs):

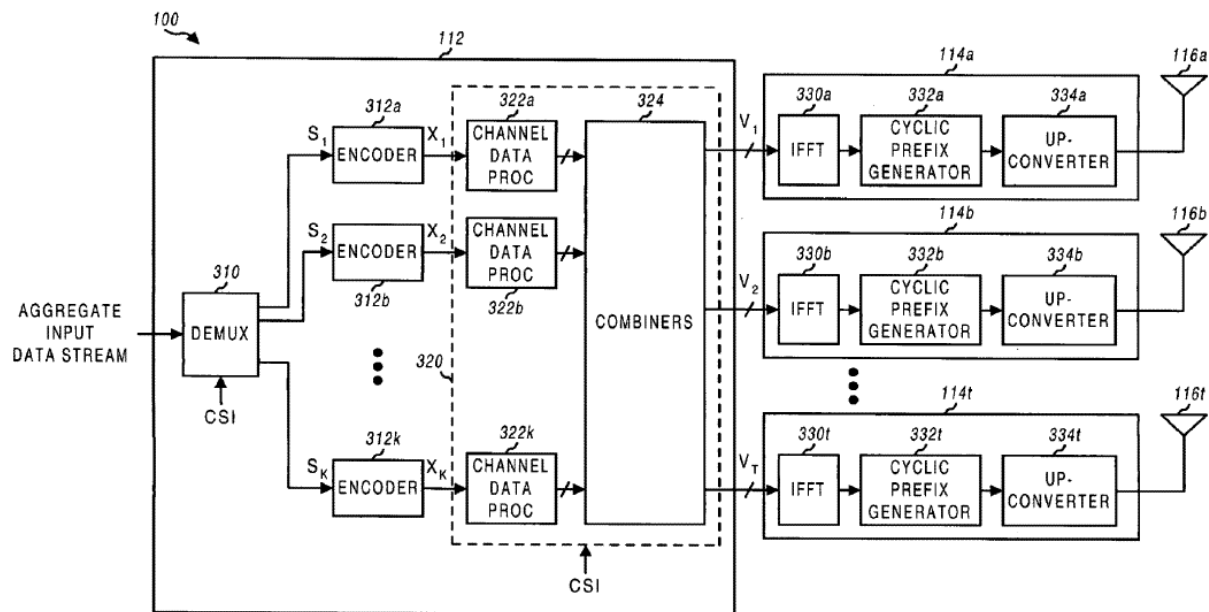


FIG. 3

(EX1027 (Jalali '454), FIG. 3, 16:23-58.) A person of skill in the art would have understood that substituting (i) the encoding and then demultiplexing design in Rowitch '702 with (ii) a demultiplexer and then encoding design as taught in Jalali '454, merely involves the simple substitution of one known element for another to obtain predictable results. Indeed, a person of skill in the art would understand there is no material difference between (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, and would have every expectation of success in making this modification. Indeed, the prior art recognizes the interchangeability of these approaches and shows that changing the order of operations is an obvious design alternative. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15.)

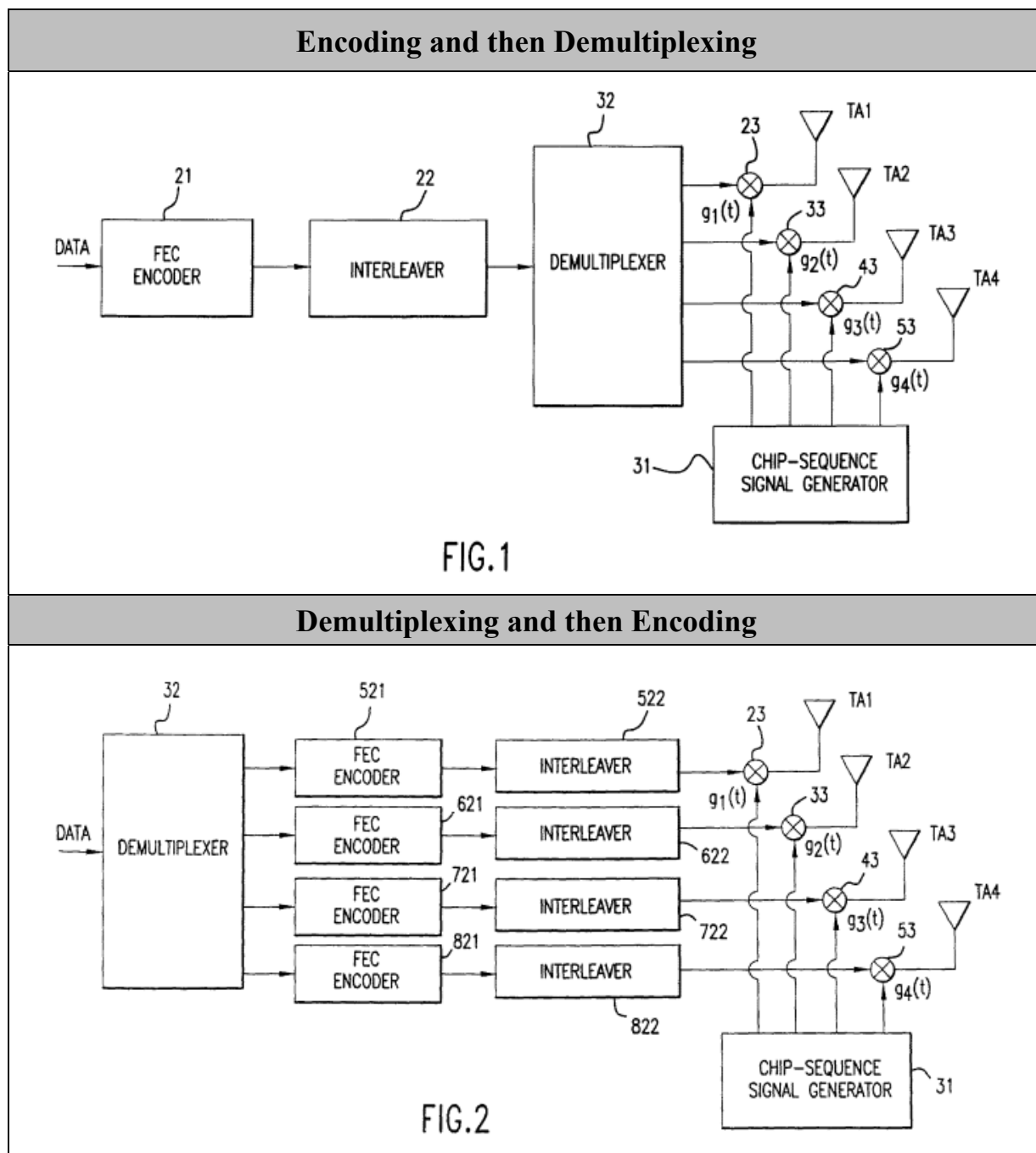
215. Accordingly, Rowitch '702 in view of Paulraj '632 in further view of

Jalali '454 renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (a demultiplexer having M=2 outputs), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (M=2 TX data processors, consistent with the encoders 312a-312k in FIG. 3 of Jalali '454).

(c) Ground 6 – Rowitch '702 in view of Paulraj '632 in further view of Schilling '330

216. In addition, a person of skill in the art would have considered it obvious to modify Rowitch '702 in view of Paulraj '632 in further view of Schilling '330 to “further compris[e] a demultiplexing and encoding block comprising a demultiplexer having M outputs, and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs.”

217. Schilling '330 teaches that (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, are alternatives. For example, for FIG 1 Schilling '330 teaches encoding and then demultiplexing, and for FIG. 2 Schilling '330 teaches that “alternatively” the same result can be accomplished by demultiplexing and then encoding:



(EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15; *see also id.* at 12:30-57 (confirming another embodiment where demultiplexing is performed prior to encoding).)

Following Schilling '330's teaching that it is an acceptable alternative to demultiplex

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and then encode, a person of skill in the art would have considered it obvious to substitute the encoding and then demultiplexing design in Rowitch '702 with a demultiplexer and then encoding design as taught in Schilling '330 because it merely involves the simple substitution of one known element (encoding and then demultiplexing) for another (demultiplexing and then encoding) to obtain predictable results. A person of skill in the art would have had an expectation of success in making this modification because it merely involves a different order of operations, and the prior art (including, but not limited to, Schilling '330) showed it was an acceptable design option to demultiplex prior to encoding. (*See also* EX1027 (Jalali '454), FIG. 3, 16:23-58.)

218. Accordingly, Rowitch '702 in view of Paulraj '632 in further view of Schilling '330 renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (a demultiplexer having M=2 outputs), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (M=2 TX data processors, consistent with the demultiplexer and then encoders in Schilling '330).

3. Claim 3: “A transmitter according to claim 2 wherein the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.”

219. Rowitch '702 in view of Paulraj '632 (Ground 4), Rowitch '702 in view of Paulraj '632 in further view of Jalali '454 (Ground 5), and/or Rowitch '702 in view of Paulraj '632 in further view of Schilling (Ground 6) renders obvious the transmitter according to claim 2, “wherein the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.”

220. **Ground 4:** As discussed for Claim 2, it was well-known in the art that when parallel streams are desired (such as in Rowitch '702) it would be obvious to either (i) encoded/modulate and then demultiplex (as in Rowitch '702), or (ii) demultiplex and then encode/modulate. (EX1026 (Schilling '330), FIG. 1 v. 2, 6:1-15 (“In FIG. 1, the data are first forward-error-correction (FEC) encoded by FEC encoder 21 and interleaved by interleaver 22, and then demultiplexed by demultiplexer 32 into four data streams.... Alternatively, as shown in FIG. 2, the data could first be demultiplexed by demultiplexer 32 and then each data stream could be FEC encoded by a plurality of FEC encoders[.]”), 12:30-57.) Moreover, it was well-known to a person of skill in the art that the demultiplexing/encoding would be adapted to produce the M symbol substreams from an input stream. (See, e.g., EX1027 (Jalali '454), FIGS. 3, 4A, 5A; EX1026 (Schilling '330), FIG. 1 v. 2.)

221. **Ground 5:** In addition, if a person modified Rowitch '702 in view of Paulraj '632 in further view of Jalali '454 (as discussed for claim 2, Ground 5), this combination results in a “demultiplexing and encoding block [that] is adapted to produce the M symbol substreams from an input stream.” Indeed, Jalali '454 teaches that the input is an aggregate input data stream:

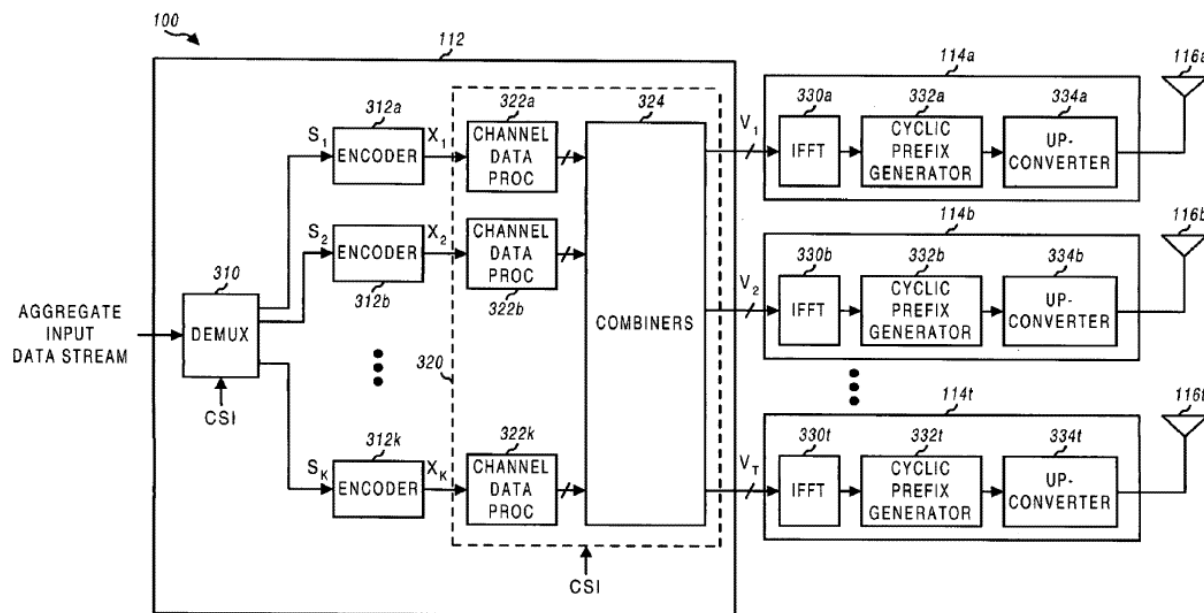


FIG. 3

(EX1027 (Jalali '454), FIG. 3, 16:23-58.) And Rowitch '702 teaches generating the two complex streams (Y_{EVEN} and Y_{ODD}) by demultiplexing one data stream. (Rowitch '702, FIG. 1 and FIG. 2.)

222. **Ground 6:** In addition, if a person of skill in the art modified Rowitch '702 in view of Paulraj '632 in further view of Schilling '330 (as discussed for claim 2, Ground 6), this combination would result in a “demultiplexing and encoding block

[that] is adapted to produce the M symbol substreams from an input stream” since both Rowitch ’702 and Schilling ’330 teach starting with a single input stream. As shown below, Schilling ’330 teaches that the input is a single data stream:

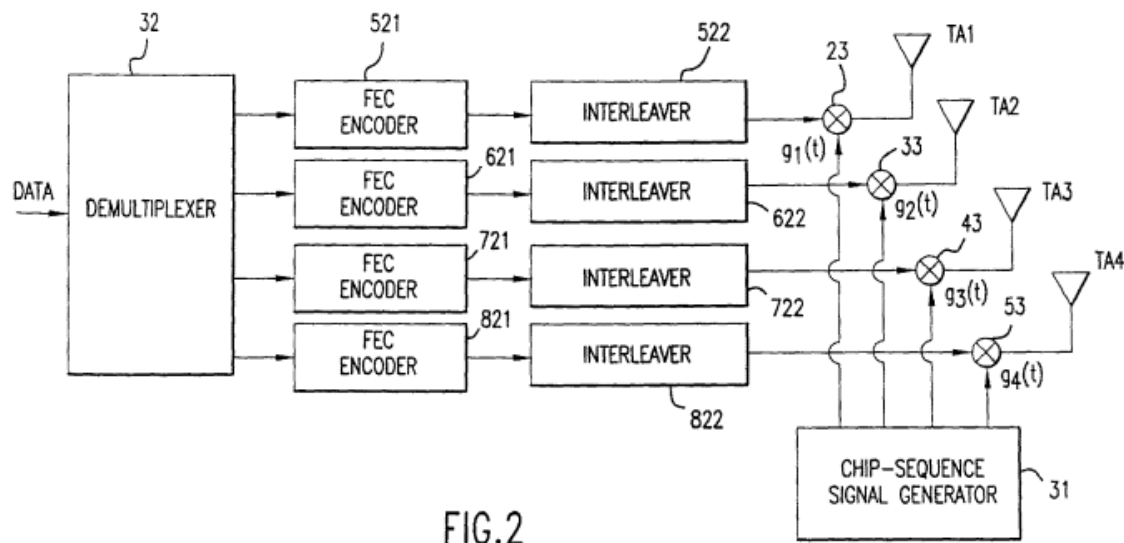


FIG.2

(EX1026 (Schilling ’330), FIG. 2.)

223. Accordingly, Rowitch ’702 in view of Paulraj ’632 (Ground 4), Rowitch ’702 in view of Paulraj ’632 in further view of Jalali ’454 (Ground 5), and/or Rowitch ’702 in view of Paulraj ’632 in further view of Schilling (Ground 6) renders obvious the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream.

4. Claim 6: (Depending on Claim 1)

224. As is explained below, claim 6 is disclosed and rendered obvious by Rowitch ’702 in combination with Paulraj ’632 (Ground 4), and/or Rowitch ’702 in

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combination with Paulraj '632 in further view of Schilling '330 (Ground 6). For reference, claim 6 recites (with bracketed notations to delineate its limitations):

- 6[a]** A transmitter according to claim 1 wherein the delay arrangement comprises: delay elements adapted to insert a delay in at least one of the M substreams; and
- 6[b]** the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.

('305 patent, 6:35-43 (Claim 6; bracketed notations (e.g., [a]) added).)

- (a) “A transmitter according to claim 1 wherein the delay arrangement comprises: delay elements adapted to insert a delay in at least one of the M substreams; and” (claim 6[a])**

225. Rowitch '702 in view of Paulraj '632 renders obvious “wherein the delay arrangement comprises: delay elements adapted to insert a delay in at least one of the M substreams.”

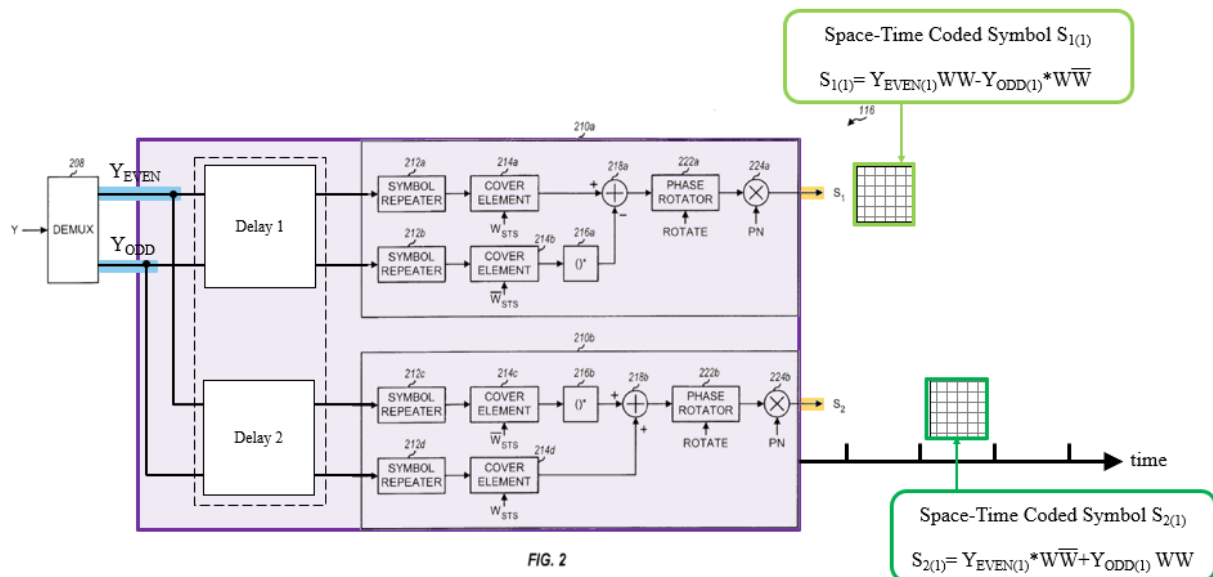
226. I understand that Petitioner and Patent Owner agree that “the M substreams” refers to “the M symbol substreams.”

227. I understand that Petitioner has argued that this limitation should be limited to “delay elements adapted to insert a time delay in at least one of the M symbol substreams.” (EX1014.) I further understand that Patent Owner has argued

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this limitation is broader and includes additional forms of delays such as phase delays. (EX1043, ¶44.) Rowitch '702 in view of Paulraj '632 discloses this limitation under Petitioner's narrower construction, and therefore also satisfies Patent Owner's broader construction.

228. As discussed for Claim 1, a person of skill in the art would have considered it obvious to add delays to each diversity branch in Rowitch '702 in order to "improve the effect of diversity[.]" (Paulraj '632, 7:62-67.) For purposes of claim 1, the delay elements were added after modulators 210a/b. However, a person of skill in the art would consider it obvious (and mathematically equivalent) to add the delay elements at the input of modulators 210a/b as shown below:



(Rowitch '702, FIG. 2 (annotated based on teachings of Paulraj '632).) As shown

in FIG. 1 below, it was known in the prior art to use a configuration where the delay (104) is prior to space-time diversity encoding:

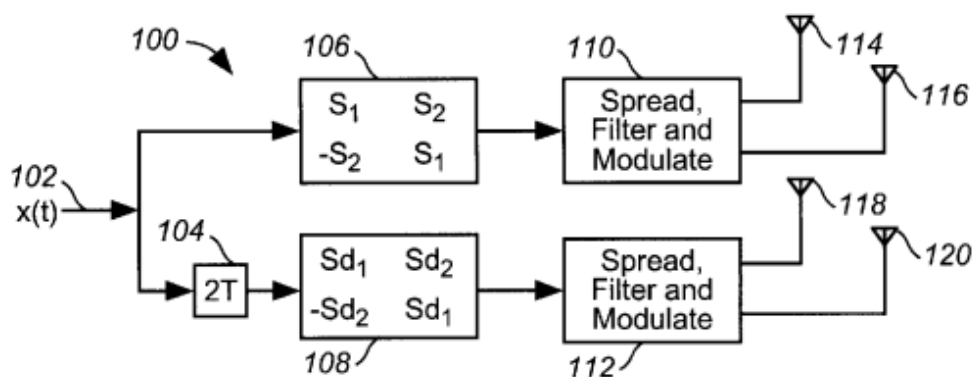


FIG. 1

(EX1032 (U.S. Patent 6,542,556), FIG.1, 4:3-5 (“Offset block 104 causes a 2 symbol period delay[.]”).) In addition, a person of skill in the art would understand adding delays prior to modulators 210a/b is mathematically equivalent to adding the delays after modulators 210a/b. For example, as shown in the figures below, the prior art recognized that an embodiment with the delay before encoding/interleaving (FIG. 5) is a known “alternative” for achieving delay diversity that is equivalent to the delay coming after encoding/interleaving (FIG. 4):

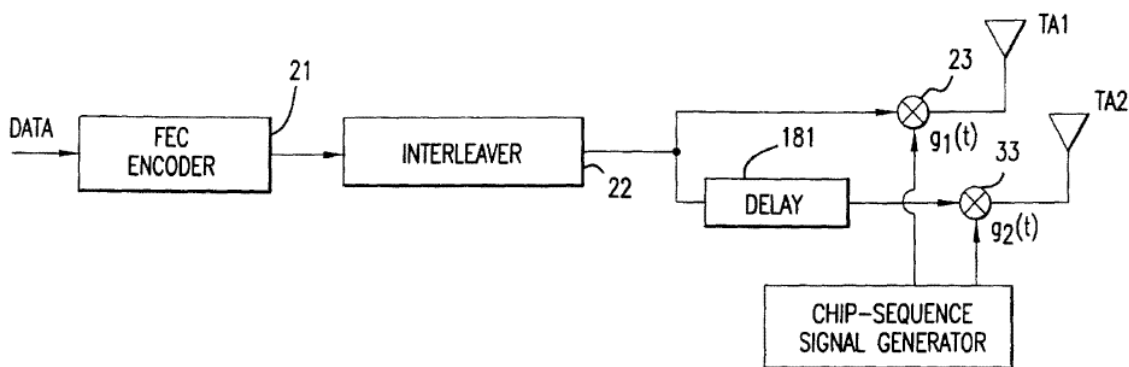


FIG.4

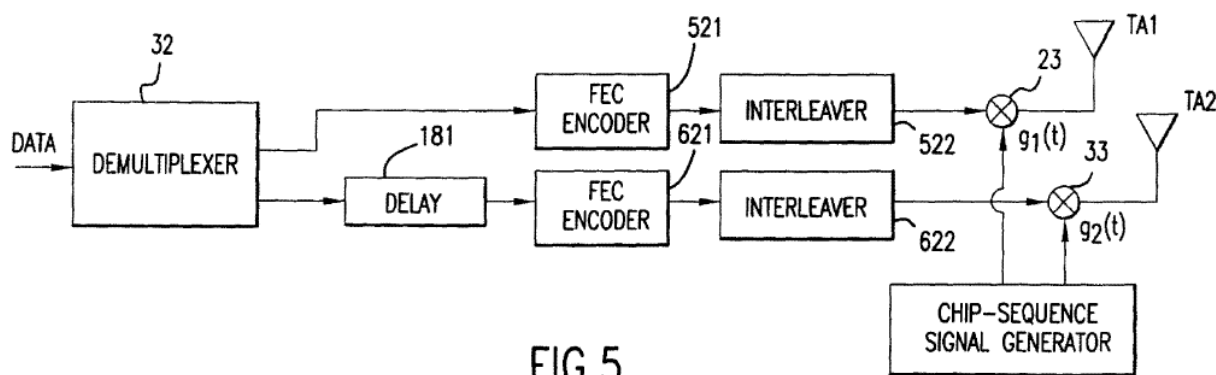


FIG.5

(EX1026 (Schilling '330), FIG. 4 v. FIG. 5, 12:30-57 (*Compare* “FIG. 4, the invention includes FEC encoder 21, coupled to the interleaver 22. From the interleaver 22, the system includes at least one delay device 181.... The system may include a plurality of delay devices, with each delay device having a delay different from other delay devices in the plurality of delay devices. The delay device 181 delays the interleaved data going to the second spread-spectrum device 33.” *with* “An alternative to FIG. 4 is shown in FIG. 5. Data are first demultiplexed by demultiplexer 32 into a first stream of data and a second stream of data. The

second stream of data is delayed by delay device 181 with respect to the first stream of data. The first stream of data is FEC encoded by first FEC encoder 521 and interleaved by first interleaver 622. The delayed second stream of data is FEC encoded by second FEC encoder 621 and interleaved by second interleaver 622.”.)

229. **Ground 6:** To the extent necessary, it would have been obvious to combine Rowitch ’702 and Paulraj ’632 with Schilling ’330 for this limitation. As discussed above, Schilling ’330 teaches that it was a known alternative to place the delay before encoding/interleaving (FIG. 5). Following Schilling ’330’s teaching, modifying Rowitch ’702 and Paulraj ’632 to include the delay prior to encoding would merely be a simple substitution of one known approach (obtaining delay diversity by inserting a delay after encoding) for another (obtaining delay diversity by inserting a delay before encoding) to obtain predictable results.

230. Rowitch ’702 in view of Paulraj ’632 (Ground 4) and Rowitch ’702 in view of Paulraj ’632 in further view of Schilling ’330 (Ground 6) therefore renders obvious wherein the delay arrangement (Delay 1 and Delay 2 are obvious to add based on Paulraj ’632) comprises: delay elements adapted to insert a delay in at least one of the M symbol substreams (when added before the modulators 210a/b the delays insert a delay in the M =2 substreams Y_{EVEN} and Y_{ODD}).

- (b) “the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.” (claim 6[b])

231. Rowitch '702 in view of Paulraj '632 (Ground 4) and/or Rowitch '702 in view of Paulraj '632 in further view of Schilling '330 (Ground 6) renders obvious “the space-time coding function further comprises an orthogonal transform adapted to produce M orthogonal outputs, with the mth orthogonal output being a function of the M substreams delayed in said delay elements by $m-1$ symbol periods.”

232. I understand that Petitioner and Patent Owner agree that “the space-time coding function” refers to “the space-time coding block.”

233. I understand that Patent Owner argues that this limitation should be construed such that it is satisfied as long as the limitation is met for any single value of m, where $1 \leq m \leq M$. (EX1042, p.003.) I understand that Petitioner has taken the position this limitation should be construed to require that the claim be satisfied for every value of m, where $1 \leq m \leq M$. As set forth below, Rowitch '702 in view of Paulraj '632 renders this limitation obvious under either construction.

234. Rowitch '702 discloses modulators 210 which perform an orthogonal transformation function to produce M orthogonal outputs (S_1 and S_2 are orthogonal outputs). The vectors $S_1 = Y_{\text{EVEN}}WW - Y_{\text{ODD}}*W\bar{W}$ and $S_2 = Y_{\text{EVEN}}*W\bar{W} + Y_{\text{ODD}}WW$

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can be shown to be orthogonal (their inner product is zero) by construction. The Walsh sequence W is equal to negative $\bar{W}$. If one takes the inner product of S_1 and S_2 there are four terms. The multiplication terms with Y_{EVEN} only and Y_{ODD} only are zero as $(\dot{W}, \bar{W})(W, W)^H = 0$. And the two cross terms cancel out.

235. Under Patent Owner's construction, a person of skill in the art would understand that when Delays 1 and 2 are added to Rowitch '702 (as discussed above), it would be obvious for Delay 1 to not insert any delay. This is because the purpose of Delay 1 and Delay 2 is to create a difference in time delay between the two diversity branches. The easiest way to accomplish the desired relative difference in delay between the two diversity branches is to apply no delay to one diversity branch and the desired amount of delay to the other diversity branch. In this circumstance, at least the first ($m=1$) orthogonal output (S_1) is a function of the M substreams delayed in said delay elements by 0 ($((m=1)-1)$ symbol periods.

236. Under Petitioner's construction, a person of skill in the art would understand that when Delays 1 and 2 are added to Rowitch '702 (as discussed above), it would be obvious for Delay 1 to not insert any delay and Delay 2 to insert a delay of 1 symbol period. Using a delay of 1 symbol has several advantages. For example, a delay of 1 symbol period would (i) be simple, (ii) allow diversity with relative ease of decoding, and (iii) be within keeping of typical delay spreads.

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Indeed, space-time coding prior art at that time encouraged the use of “delays of the order of symbol period.” (EX1035 (Sampath 1999), p.003.) If the delay were longer that would give a longer delay period requiring more complexity with a RAKE detector, MLSE, or any other type of detector. Paulraj ’632 teaches that the “value of differential time delay between the diversity branches is preferably at least equal to the channel length (delay spread of the channel).” (Paulraj ’632, 5:3-5.)

237. Following Paulraj ’632’s teaching of a time delay “at least equal” to the delay spread would result in a delay of 1 symbol period when the delay spread is equal to the symbol period—which is a practical occurrence. For 3G technologies (such as CDMA-2000 and WCDMA discussed in Rowitch ’702), data rates could vary between 4 chips per bit to 256 chips per bit. (*See, e.g.*, EX1044, pp.005-06; EX1045, p.010; etc.) For a chip rate of 3.84 Mchips/s, (EX1044, p.005 (noting “harmonized standard for the DS mode will be based on the W-CDMA proposal with a chip rate of 3.84 Mchips/s”); EX1045, p.010) the symbol period (corresponding to symbols on substreams Y_{EVEN} and Y_{ODD}) would vary from approximately 4 to 64 μs . This range (4-64 μs) overlaps substantially with measured delay spreads. For example, EX1034 reported root-mean-square (rms) delay spreads of 1.3-25 μs for urban environments, which equates to approximately a 2.6-50 μs channel length delay spread. (EX1034 (Rappaport), p.002 (reporting urban delay

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spread from NYC of 1300 ns avg., and urban delay spread for San Francisco of 25 μ s; citing EX1038-1041).⁸ Accordingly, since the potential symbol periods (4-64 μ s) overlaps substantially with the practical delay spread (2.6-50 μ s), Paulraj '632's teaching of a time delay "at least equal" to the delay spread would practically result in a delay of 1 symbol period when the delay spread is equal to the symbol period. Indeed, when the delay spread is near the symbol period length, a person of skill in the art would be motivated to select a delay of one symbol period for implementation simplicity. In this circumstance, the first ($m=1$) orthogonal output (S_1) is a function of the M substreams delayed in said delay elements by 0 ($(m=1)-1$) symbol periods and the second ($m=2$) orthogonal output (S_2) is a function of the M substreams delayed in said delay elements by 1 ($(m=2)-1$) symbol period.

⁸ Paulraj '632 discusses delay spread in terms of channel length. (Paulraj '632, 5:3-5.) A person of skill in the art would understand that an rms delay spread, however, is approximately half of the channel length. Accordingly, to convert (i) rms delay spread to (ii) delay spread in terms of channel length, the rms delay spread is approximately doubled. Note, however, that even if rms delay spread is used, there is still substantial overlap between the potential symbol periods (4-64 μ s) and the rms delay spread (1.2-25 μ s).

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VIII. NO SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

238. I understand from counsel that Patent Owner in the underlying district court litigation has not yet identified any evidence with respect to secondary considerations of non-obviousness. To the extent Patent Owner subsequently identifies any such evidence, I reserve the right to consider and revise any of my opinions should it be necessary to do so.

IX. CONCLUSION

239. I hereby declare that all statements made herein of my own knowledge are true and that all statements are 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 18 U.S.C. § 1001.

Dated: October 3, 2025

Respectfully submitted,



Sarah Kate Wilson, Ph.D.