

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

IPR2026-00003

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

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 7,529,305 B1**

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List of Exhibits

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)
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)

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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
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)

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Exhibit No.	Description of Exhibit
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)
1029	<i>Reserved</i>
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, H., 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”

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Exhibit No.	Description of Exhibit
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)
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)
1047-1049	<i>Reserved</i>
1050	Declaration of Sarah Kate Wilson, Ph.D.
1051	<i>Malikie, et al. v. Nintendo, et al.</i> , No. 2:24-cv-01490-JLR, D.I. 15, Stipulated Motion for Extending Time for Defendants to Respond to Complaint (W.D. Wash.) (Filed Oct. 21, 2024)
1052	Listing of challenged claims with bracketed notations (e.g., [a.i]) for individual limitations

Petition for *Inter Partes* Review of
U.S. Patent No. 7,529,305 B1

I. MANDATORY NOTICES UNDER § 42.8(A)(1)

A. Real Parties-In-Interest under § 42.8.(b)(1)

Nintendo Co., Ltd. and Nintendo of America Inc. (“Petitioner”) are the real parties-in-interest to this petition.

B. Related Matters under § 42.8(b)(2)

U.S. Patent No. 7,529,305 (“’305 patent”) (EX1001) is asserted in pending litigation involving Petitioner: *Malikie Innovations Ltd. v. Nintendo Co.*, No. 2:24-cv-01490-JLR (W.D. Wash.). The complaint was served on October 21, 2024. (EX1051.) The ’305 patent is also at issue in: *Vantiva USA LLC v. Malikie Innovations Ltd.*, 1:25-cv-03600 (N.D. Ga.) and *Malikie Innovations Ltd. v. Vantiva SA f/k/a Technicolor SA*, 2:25-cv-00163 (E.D. Tex.).

C. Lead and Back-Up Counsel under § 42.8(b)(3)

Petitioner provides the following designation of counsel.

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D. Service Information

This Petition is being served by Priority Mail Express to the attorneys of record for the '305 patent: Dowell & Dowell, P.C., POB 200, 3200 Ridge Pike, Ste 300, Norristown, PA 19403. Petitioner consents to electronic service at the addresses above for lead and back-up counsel.

II. FEE PAYMENT UNDER § 42.103

Petitioner requests review of 4 claims, with a \$51,875.00 payment.

III. REQUIREMENTS UNDER §§ 42.104 AND 42.108

A. Grounds for Standing

Petitioner certifies that the '305 patent is available for IPR and that Petitioner is not barred or otherwise estopped.

B. Identification of Challenge and Statement of Precise Relief Requested

Petitioner requests IPR institution based on:

Ground	Claims	Basis
1	1-3, 6	Paulraj (Anticipation and/or Obviousness)
2	2-3	Paulraj in view of Jalali
3	2-3, 6	Paulraj in view of Schilling
4	1-3, 6	Rowitch in view of Paulraj
5	2-3	Rowitch in view of Paulraj and Jalali
6	2-3, 6	Rowitch in view of Paulraj and Schilling

Submitted with this Petition is the Declaration of Sarah Kate Wilson, Ph.D., (EX1050; “Wilson”), a qualified expert. (Wilson, ¶¶4-12.)

Exhibit 1052 lists the claims, enumerating each element. Bracketed notations (*e.g.*, [a.i]) are used to refer to individual limitations.

C. Considerations Under §§ 314(a) and 325(d)

Discretionary denial is not warranted. This is the first and only IPR petition filed by anyone against the '305 patent, and the validity or patentability of the '305 patent has not been adjudicated previously. None of the references relied on in Grounds 1-6 were identified during prosecution. The pending litigation against Petitioner is in a relatively early stage. Petitioner intends to promptly move to stay the litigation pending IPR. Additionally, in the event an IPR is instituted (and the institution is not subsequently vacated, or a Final Written Decision in the IPR is not subsequently vacated or terminated), Petitioner will not pursue in district court any grounds of invalidity against the challenged claims that were, or reasonably could have been, asserted in IPR under §§ 102 or 103 on the basis of prior art patent or printed publications. Petitioner will further address discretionary denial considerations if Patent Owner seeks discretionary denial of the Petition.

IV. OVERVIEW OF THE '305 PATENT

A. Level of Ordinary Skill

A person of ordinary skill in the art (“POSITA”) as of the alleged priority date would have possessed 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. (Wilson, ¶17.) Additional education could have substituted for professional experience, and significant work experience could have substituted for formal education. (*Id.*)

B. Specification Overview

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.)

The '305 patent Background identifies certain layered 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. ('305 patent, 2:38-44.)

The '305 patent describes two primary sets of embodiments. 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, 5:18-21.) (Wilson, ¶¶45-50.)

For FIG. 4, the specification describes producing encoded substreams $s_1, s_2, \dots, s_M$ and performing an 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.) FIG. 5 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.)

For 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, which map bits to a corresponding output symbol z_m and antenna. (’305 patent, 5:4-17.) FIG. 7 provides a “specific example of the embodiment of FIG. 6[.]” (’305 patent, 5:18-35.)

V. CLAIM CONSTRUCTION

Petitioner does not believe express claim construction is necessary at this time. The proposed grounds satisfy both the narrower and broader constructions proposed by the parties in the related litigation.

VI. CHALLENGED CLAIMS 1-3 AND 6 ARE UNPATENTABLE

A. Paulraj [EX1015]

Paulraj, U.S. Patent No. 6,377,632, is titled “Wireless Communication System and Method Using Stochastic Space-Time/Frequency Division Multiplexing.” (Paulraj.) Paulraj “relates generally to wireless communication systems and adaptive methods of operating such systems in a multipath fading environment.” (Paulraj, 1:8-10.)

Paulraj discloses a transmitter with multiple diversity branches for wireless communication. (Wilson, ¶64.) Paulraj 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, 4:53-66.)

Paulraj FIGS. 2-3 illustrate the operation of embodiments of coding block 110. (Wilson, ¶65.) 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, 5:52-60.)

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, 7:16-38.) Paulraj discloses multiple transforms, including Walsh-Hadamard and IFFTs. (Paulraj, 7:21-34.) Paulraj also teaches that when an IFFT transform matrix is used, then $M=N$. (Paulraj, 7:37-38.) “After the transformation of each datastream, the transformed coefficients are 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 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, 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.”).)

B. Rowitch [EX1016]

Rowitch, U.S. Patent No. 6,628,702, is titled “Method and Apparatus for Demodulating Signals Processed in a Transmit Diversity Mode.” (Rowitch.) Rowitch 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, 1:9-12.)

Rowitch discloses a transmitter 110 and receiver 130 in a communications system 100. (Rowitch, 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, 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, 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 $\bar{W}_{STS}$). (Wilson, ¶69 (citing Rowitch, 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 . (Wilson, ¶69 (citing Rowitch, 6:34-57).)

C. Priority Date and Prior Art Date

The technology and concepts of the challenged claims were long known to those in the field. (*E.g.*, Wilson, ¶¶36-44.)

The '305 patent claims priority to PCT No. PCT/RU00/00426, which was filed October 27, 2000. Petitioner uses this date as the priority date for the challenged claims. PO has not alleged an earlier priority date. (EX1019, p.002-03.)

Paulraj, Rowitch, Jalali, and Schilling are all prior art. Paulraj qualifies as prior art because it was filed January 24, 2000. Rowitch qualifies as prior art because it was filed June 14, 2000. Jalali qualifies as prior art because it was filed July 12,

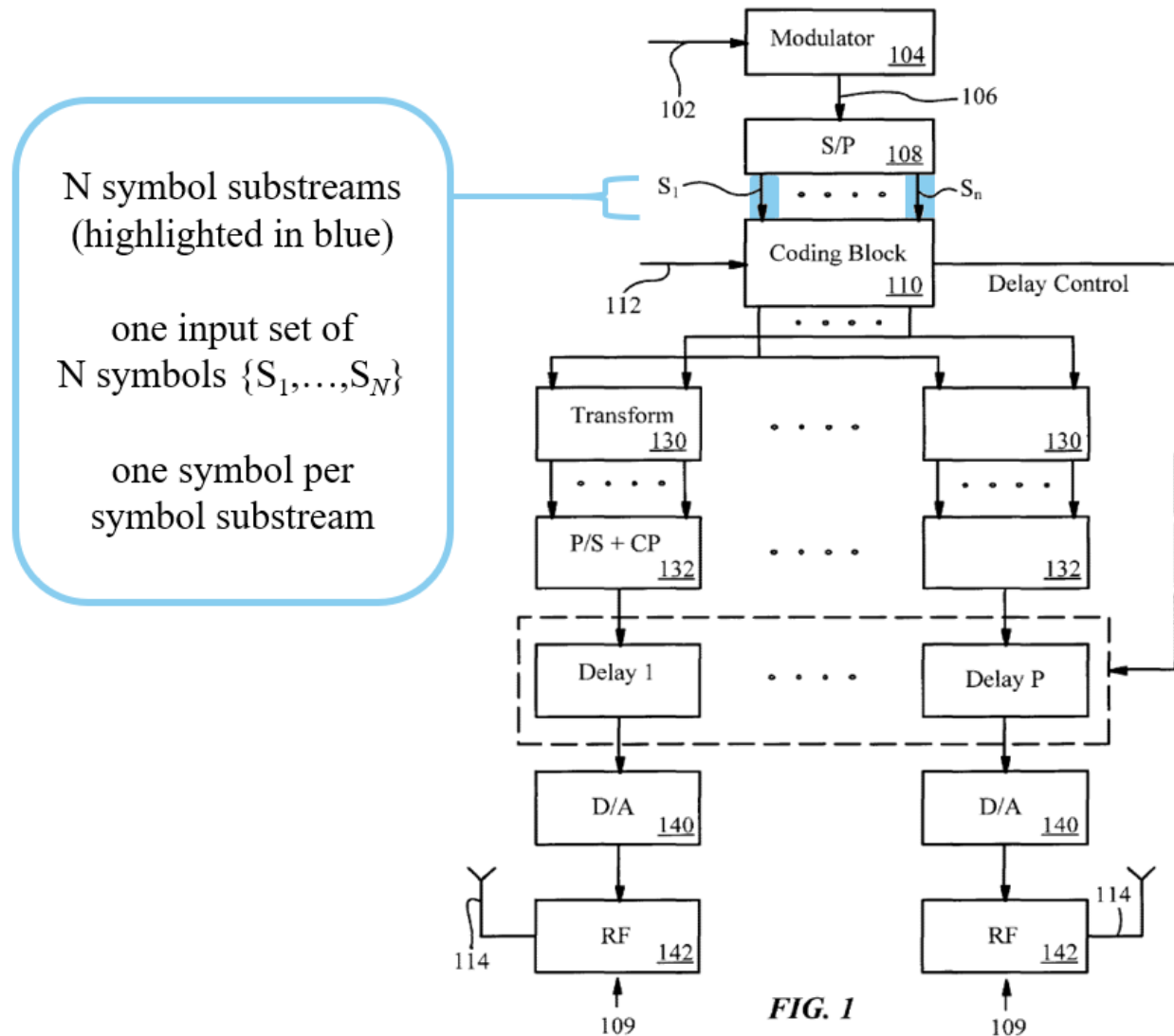
2000. Schilling qualifies as prior art because it was filed November 24, 1998 and published October 3, 2000.

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

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

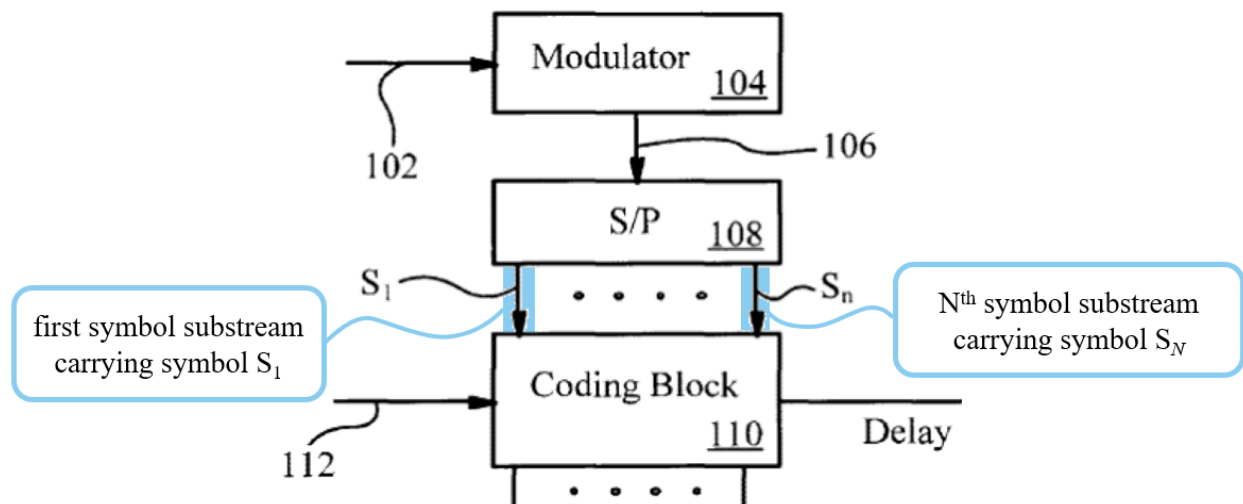
Claim 1 is anticipated and/or obvious over Paulraj. Paulraj teaches and renders obvious a transmitter adapted to process a plurality M of symbol substreams (each stream for symbols $S_1, \dots, S_N$ is a symbol substream, where the “plurality M of symbol substreams” recited in the claim are the same as the N symbol substreams disclosed in Paulraj). (Wilson, ¶¶77-81.)

Paulraj teaches a transmitter that generates N symbol substreams $\{S_1, \dots, S_N\}$:



(Paulraj, FIG. 1 (annotated), 4:53-60; Wilson, ¶78; Paulraj, Abstract (teaching an “apparatus for wireless transmission of a digital bit stream”).)

A POSITA would recognize that the output of the serial-to-parallel converter (S/P) 108 in Paulraj corresponds to a plurality N of symbol substreams. (Wilson, ¶79.) Paulraj illustrates the output of S/P 108 as parallel substreams which each comprise a single symbol:



(Paulraj, FIG. 1 (excerpted and annotated); Wilson, ¶¶79.)

Those skilled in the art recognized that serial-to-parallel conversion takes a single symbol stream and converts it into multiple parallel symbol streams. (Wilson, ¶¶79 (citing EX1017, 4:9-15 (“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, 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”).)

A POSITA would also consider it obvious to implement Paulraj using a plurality N of symbol substreams. (Wilson, ¶¶80.) Paulraj teaches creating a set of N symbols that are fed into coding block 110. As depicted by FIG. 1, one way to

input a set of N symbols into the coding block is by simultaneously transmitting the symbols using parallel symbol substreams. (*Id.*)

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

This element is anticipated and/or obvious over Paulraj. Paulraj teaches and renders obvious a space-time coding block (coding block 110, transform block 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 $\{S_1, \dots, S_N\}$). (Wilson, ¶¶82-100.)

As explained above, Paulraj 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, Title.) A POSITA would understand that in FIG. 1 the output of S/P 108 is input into a series of blocks that convert the N symbol substreams into P space-time coded symbols. (Wilson, ¶83.)

In addition, Paulraj discloses and/or renders obvious embodiments where the number of space-time coded symbols (P) is equal to the number of symbol substreams (N). (Wilson, ¶84.) Paulraj 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, 3:6-15.) Paulraj teaches “at least two diversity branches” (P=2). (Paulraj, 3:9-10, 3:34-35.)¹ A POSITA would understand that one embodiment is to have two diversity branches and two symbol substreams (N=P=2). (Wilson, ¶84.) While Paulraj does not expressly state that N=2, a POSITA would understand that N=2 is encompassed by Paulraj’s disclosure that N can be any plurality (i.e., $N \geq 2$). (*Id.* (citing Paulraj, 3:32-34, 4:59, etc.).)

Moreover, Paulraj teaches an approach intended to work for “a multipath fading environment under varying channel conditions ranging from pure Rayleigh to pure Rician and varying delay spread.” (Paulraj, 2:44-55.) A POSITA would understand that Paulraj is teaching flexibility in the number of diversity branches to

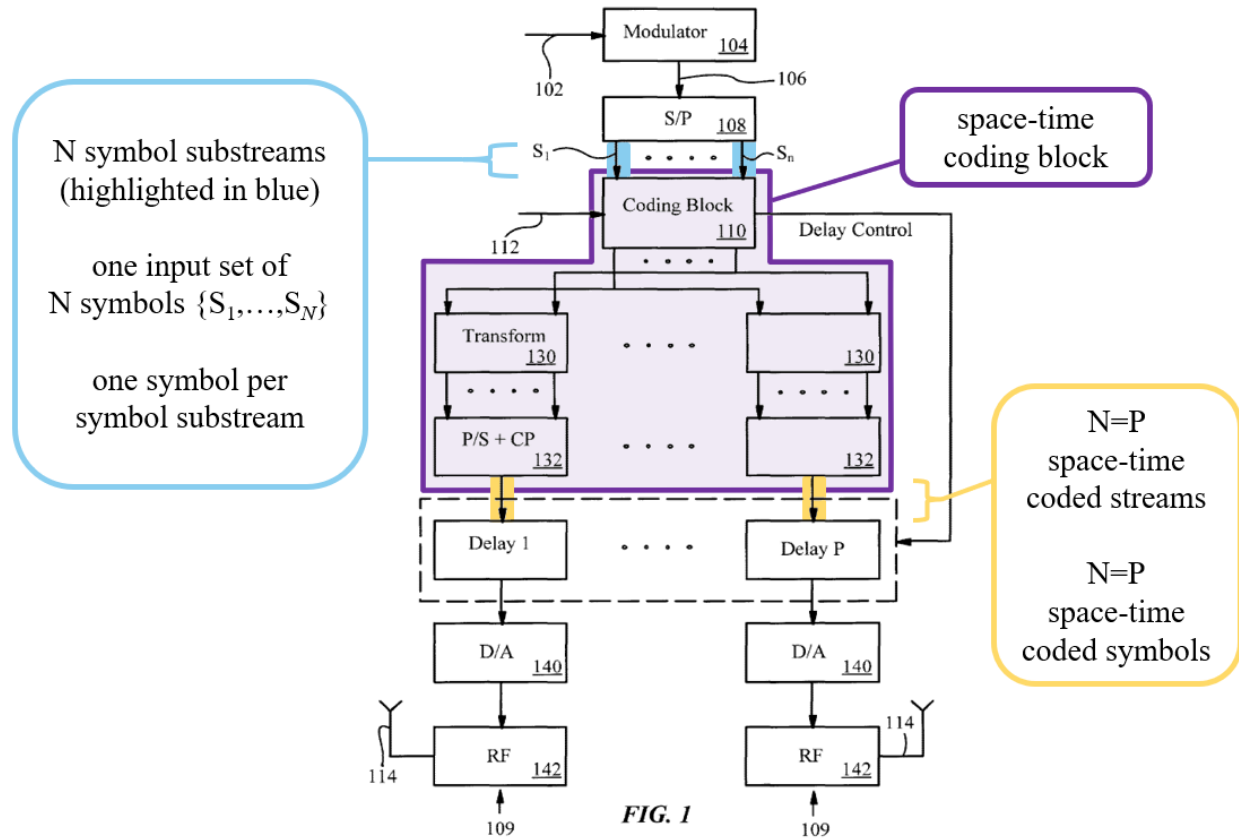
¹ Paulraj discloses that in transform blocks 130 the N symbols are mapped into M values, where $M \geq N$. (Paulraj, 7:19-21, 7:37-38.) The value of M in Paulraj is not relevant, or even if relevant is taught to equal N when the transform is IFFT (or when the selected transform has $N=M$, such as a 2-dimensional Walsh-Hadamard transform for two substreams). (*Id.*; Wilson, n.3.) Accordingly, to avoid confusion between the variable “M” in the claim language and variable “M” as used in Paulraj, this petition does not reference the variable “M” as used in Paulraj in each instance.

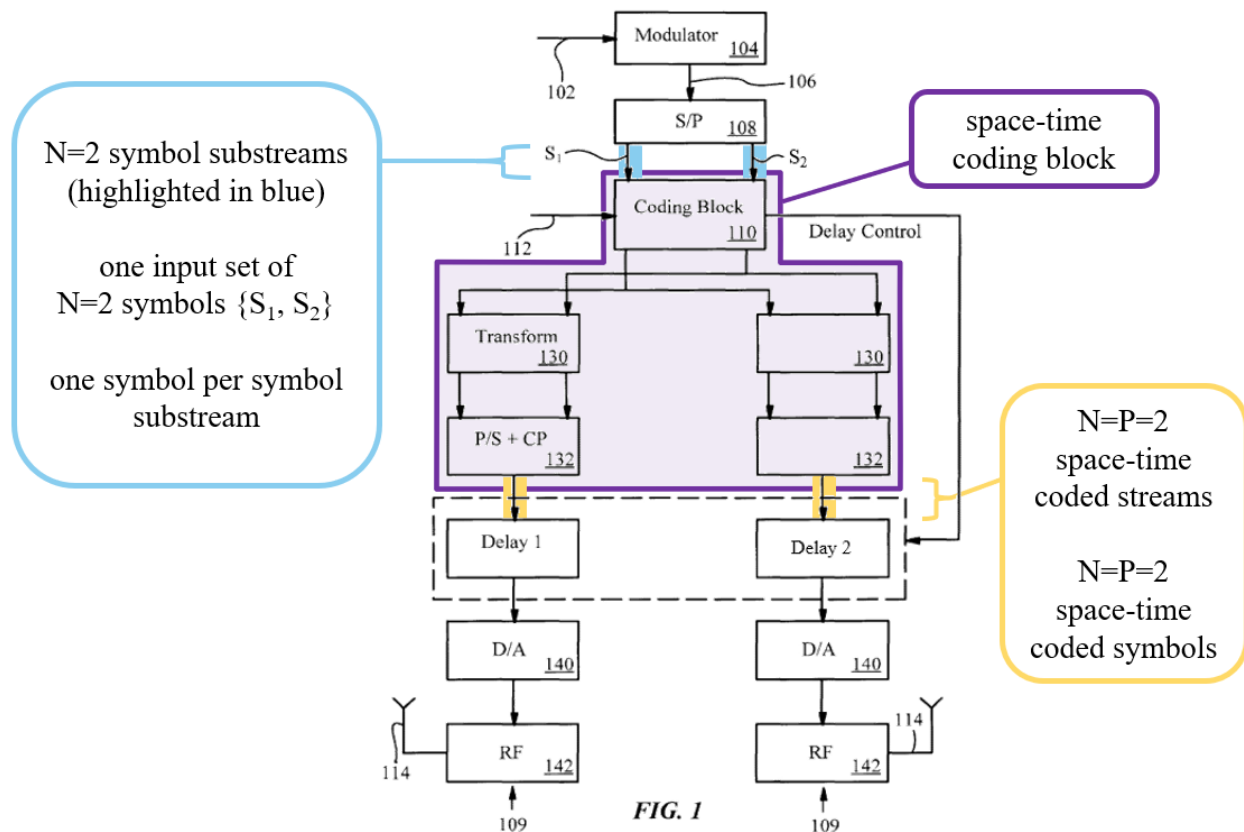
deal with various environments, which would include ranging from a low number of diversity branches (e.g., two) to a larger number of diversity branches. (Wilson, ¶85.)

Moreover, it was a known design choice by those skilled in the art to select an embodiment where $N=P=2$. (Wilson, ¶86.) For example, one of the well-known papers on diversity uses two antenna and two input symbols. (EX1006 (Alamouti), p.002; EX1009, p.003 (“the Alamouti code maps two consecutive symbols to a 2x2 space-time matrix”).) And those skilled in the art taught diversity approaches where the number of substreams matches the number of antenna. (Wilson, ¶86 (citing EX1011, 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 results in a transmitter where the number of diversity branches P would be equal to the number of substreams N . (Wilson, ¶86.) And when $P=2$, this would mean that $N=P=2$. (*Id.*)

Using two symbol substreams and two diversity branches in Paulraj would thus have been considered encompassed by Paulraj’s teachings, an obvious option based on Paulraj’s teachings, and an obvious option based on Paulraj teachings and the knowledge of those skilled in the art. (Wilson, ¶87.)

Below are two annotated versions of Paulraj FIG. 1:





(Paulraj, FIG. 1 (annotated and modified for $N=P=2$); Wilson, ¶88.)² Both examples above show that for each input frame of N symbols ($\{S_1, \dots, S_N\}$) the transmitter produces $N=P$ space-time coded symbols.

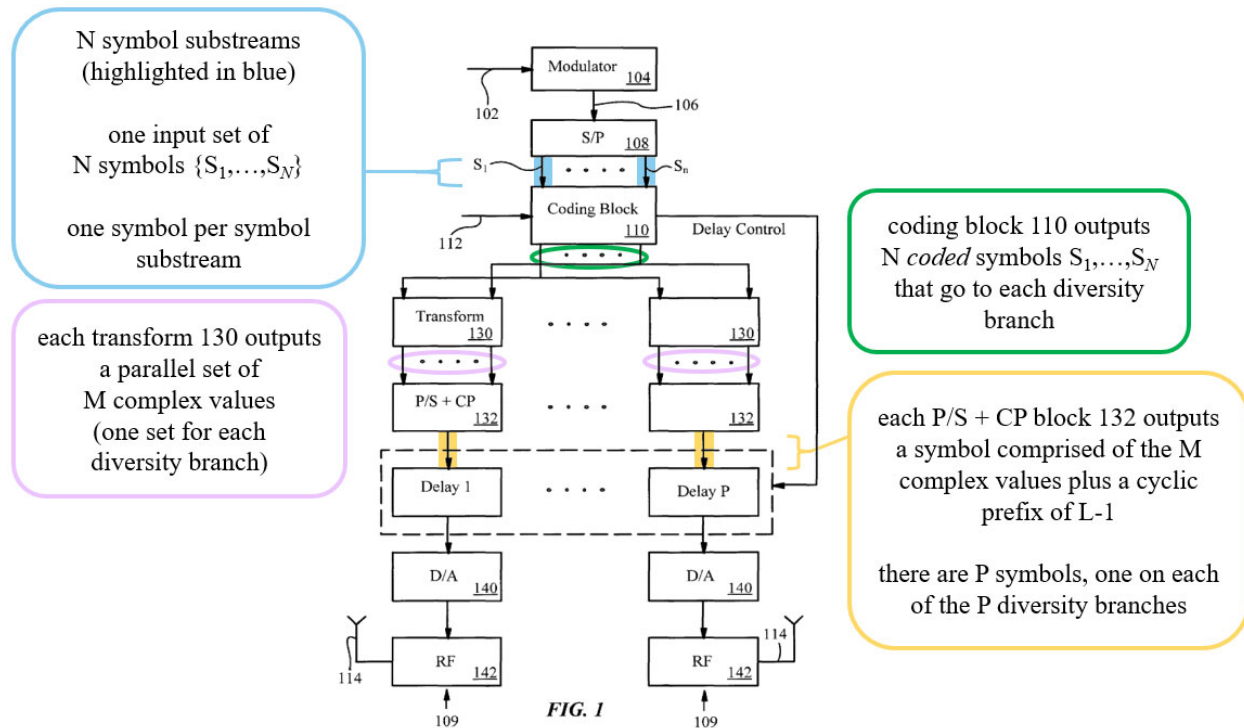
The figures above illustrate an example (in purple) of the space-time coding block as including coding block 110, transform block 130, and parallel-to-serial converter (P/S+CP) block 132. (Wilson, ¶89.) Using this example, the output of the

² There are multiple ways to draw a box around the transmitter components in Paulraj that would satisfy the claimed space-time coding block. (Wilson, ¶89.)

space-time coding block in Paulraj is the output of the set of P/S+CP blocks 132 across all diversity branches. Paulraj 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*³ is a function of the outputs of the transform block 130. (Paulraj, 7:47-59.) A POSITA 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. (Wilson, ¶90.) Since Paulraj 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 to have P=N diversity branches, a POSITA 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. (Wilson, ¶90.)

³ As discussed herein, a POSITA would understand that the *collective “M+L-1 complex valued symbols” output* corresponds to a single space-time coded symbol. For readability, the phrase *collective “M+L-1 complex valued symbols” output* has been italicized and bolded so that this collective output can more easily be understood as a single symbol.

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:



(Paulraj, FIG. 1 (annotated); Wilson, ¶91.)

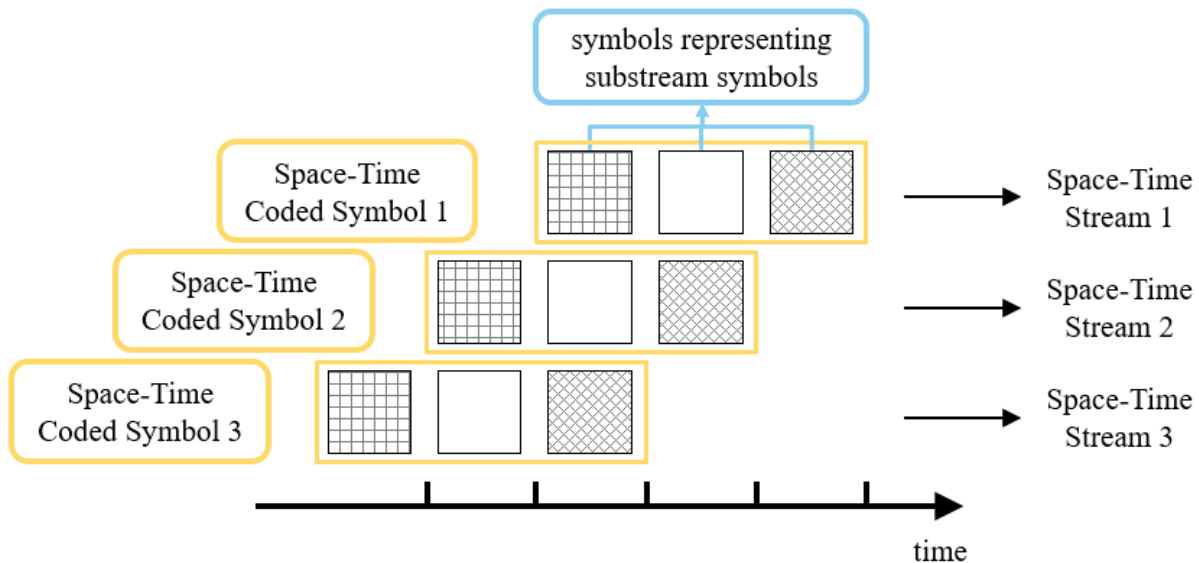
Paulraj describes the *collective “M+L-1 complex valued symbols” output* from each P/S+CP block 132 as a function of:

- (i) M complex symbols formed by:
 - (a) coding the input frame of N symbols ($\{S_1, \dots, S_N\}$) (Paulraj, 5:21-7:13 (describing coding the symbols using matrix multiplication without (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, 7:16-47), and
- (ii) a cyclic prefix of $L-1$ added to the serialized M complex symbols.
(Paulraj, 7:16-47.)

A POSITA 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.
(Wilson, ¶92.)

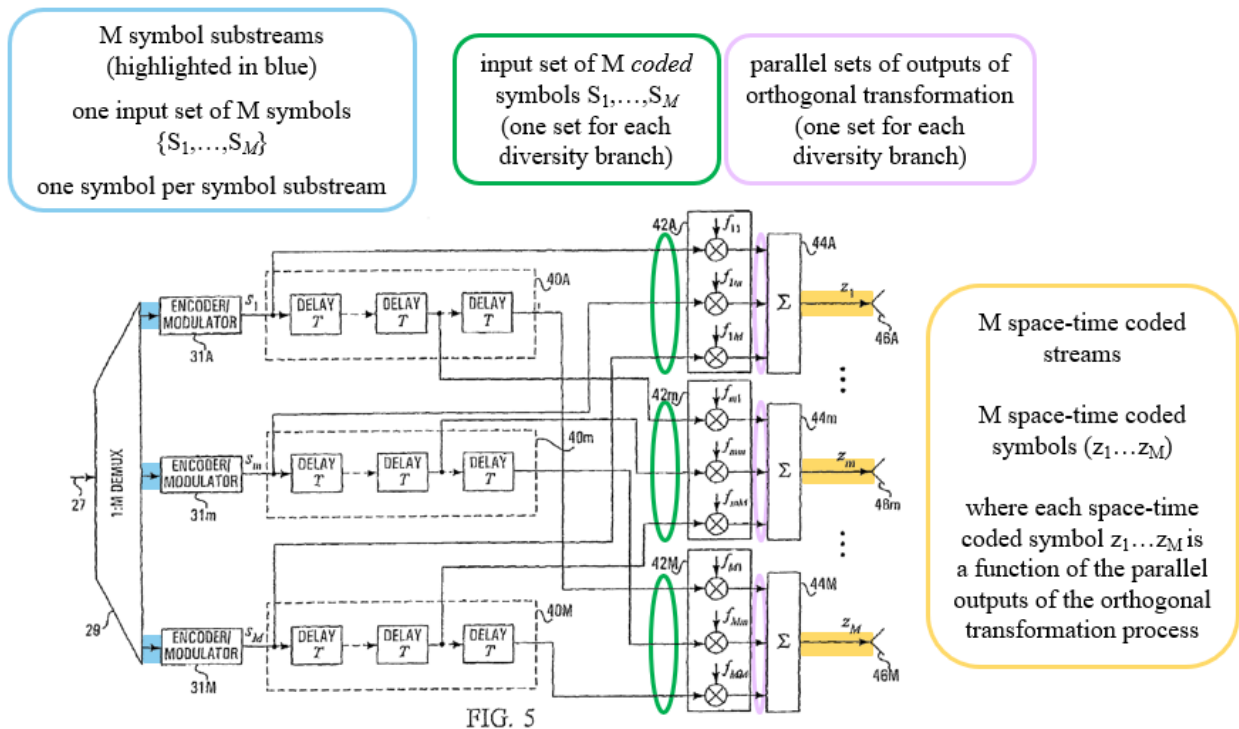
First, describing the *collective “ $M+L-1$ complex valued symbols” output* from each P/S+CP block 132 as a single “space-time coded symbol” is consistent with the use of “space-time coded symbol” in the ’305 patent claims. For example, a POSITA would understand one way to implement limitations 1[c] 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, where each space-time coded symbol comprises a series of symbols (which represent the substream symbols). (Wilson, ¶93.) 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. (*Id.*) In this example, the space-time coded symbol comprises a series of symbols in the time domain that represent the substream symbols:



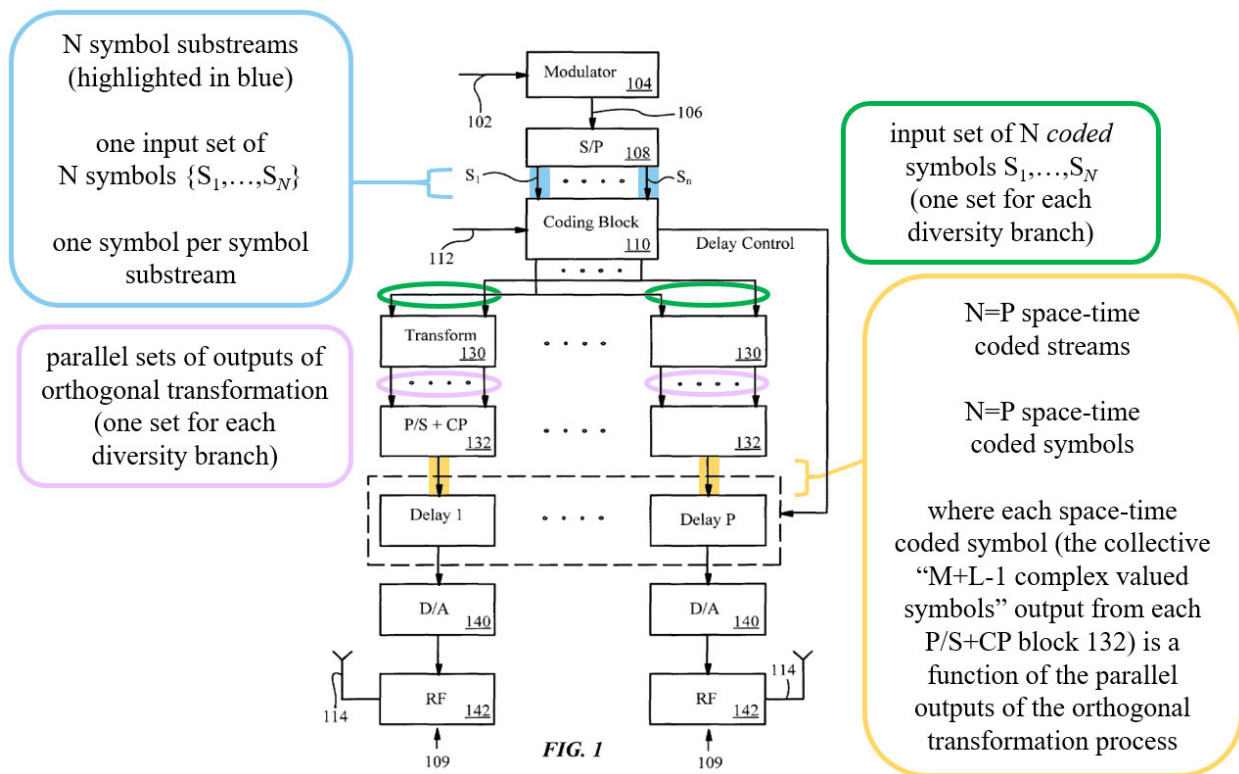
Second, describing the *collective “ $M+L-1$ complex valued symbols” output* from each P/S+CP block 132 as a single “space-time coded symbol” is consistent with the ’305 patent specification. For example, in order to implement the “space-time coder” in FIGS. 4-5 of the ’305 patent, the specification 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.) Like the ’305 patent, Paulraj teaches using orthogonal transformations such as IFFTs and Walsh-Hadamard codes. (Paulraj, 7:30-39.) And a POSITA would understand that the transformations in Paulraj encompasses orthogonal transformations. (Wilson, ¶94.) Since each *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 inputs, each ***collective “M+L-1 complex valued symbols” output*** satisfies the description of a single space-time coded symbol in the '305 patent. (*Id.*)

Comparing FIG. 5 of the '305 patent with FIG. 1 of Paulraj 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 is created by inputting a parallel group of coded symbols into the orthogonal transformation, outputting parallel outputs, and then combining the parallel outputs of the orthogonal transformation as a single function:



(’305 patent, FIG. 5 (annotated); Wilson, ¶95.) Likewise, in Paulraj FIG. 1 the **collective “ $M+L-1$ complex valued symbols” output** from each P/S+CP block 132 is created by inputting a parallel group of coded symbols into the orthogonal transformation, outputting parallel outputs, and then combining the parallel outputs of the orthogonal transformation as a single function:



(Paulraj, FIG. 1 (annotated); Wilson, ¶95.)

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 POSITA, 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 $(s_1, s_2, \dots, s_M)$. (Wilson, ¶96 (citing '305 patent, 4:13-42).) Accordingly, the embodiment in '305 patent FIG. 4 supports the 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—can be considered as a single space-time coded symbol.

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. 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. (EX1013, p.265; Wilson, ¶¶52, 97.) 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. (EX1013, pp.297-300, Wilson, ¶¶53, 97.) Instead, the Applicant amended the claims to distinguish the prior art on other grounds and neglected to respond to the Examiner's statements that the feature that distinguished the claims

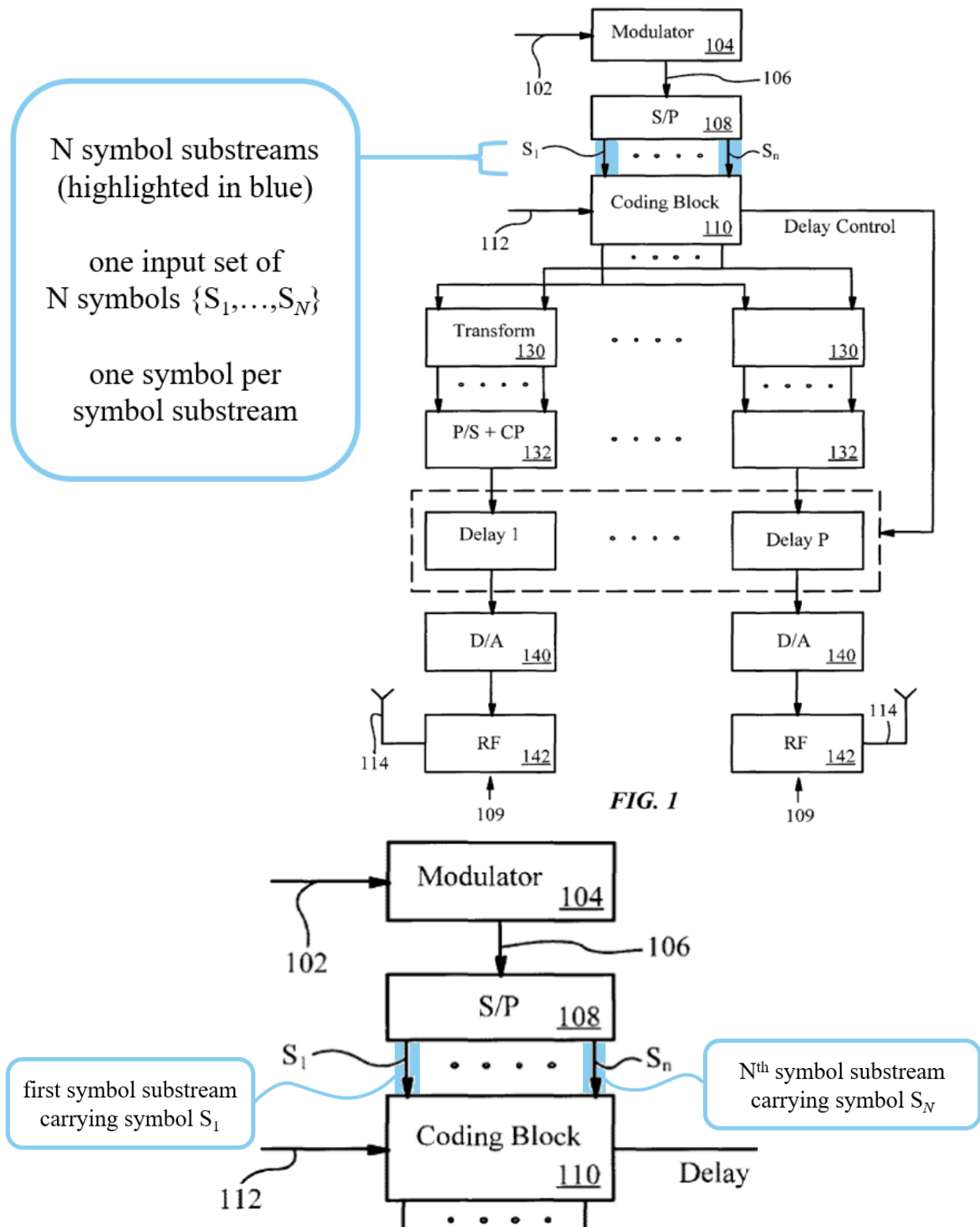
over the prior is the timing of the “space-time coded symbols” and not that each series of symbols in the prior art should not be considered a “space-time coded symbol.” (EX1013, pp.309, 316-17; Wilson, ¶¶54, 97.)

Fourth, PO has argued that a sequence of symbols should be considered a symbol. For example, in its infringement contentions, PO cites to the disclosure in IEEE 802.11(2012) reciting that “[t]he sequence of N_{ST} complex numbers...*constitutes an OFDM symbol*[.]” (EX1019, p.024.) PO’s purported reliance on an OFDM symbol (which is a sequence of symbols) as a “space-time coded symbol” confirms that PO also believes the plain-and-ordinary meaning of symbol includes a series of values. (Wilson, ¶98.) Moreover, the cited portion of the 802.11 Standard confirms that a POSITA would understand that a sequence of symbols can correspond to a symbol. (*Id.*)

Fifth, contemporaneous literature confirms that the serialized output described in Paulraj was commonly considered a single symbol. When discussing a system that serializes the complex values (sometimes referred to as samples) output from an IFFT, those skilled in the art commonly referred to the serialized samples as a single symbol. (Wilson, ¶99 (citing EX1020, p.002 (“the serial OFDM samples $S_{n,m}$ composing the n th OFDM symbol”); EX1021, 2:44-45; EX1022, p.001; EX1023, p.002).)

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

This element is anticipated and/or obvious over Paulraj. Paulraj 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). (Wilson, ¶¶101-103.) As discussed for the preamble, a POSITA would recognize that the frame of symbols $\{S_1, \dots, S_N\}$ in Paulraj corresponds to a plurality N of symbol substreams, where each symbol $S_1, \dots, S_N$ is on a separate substream:

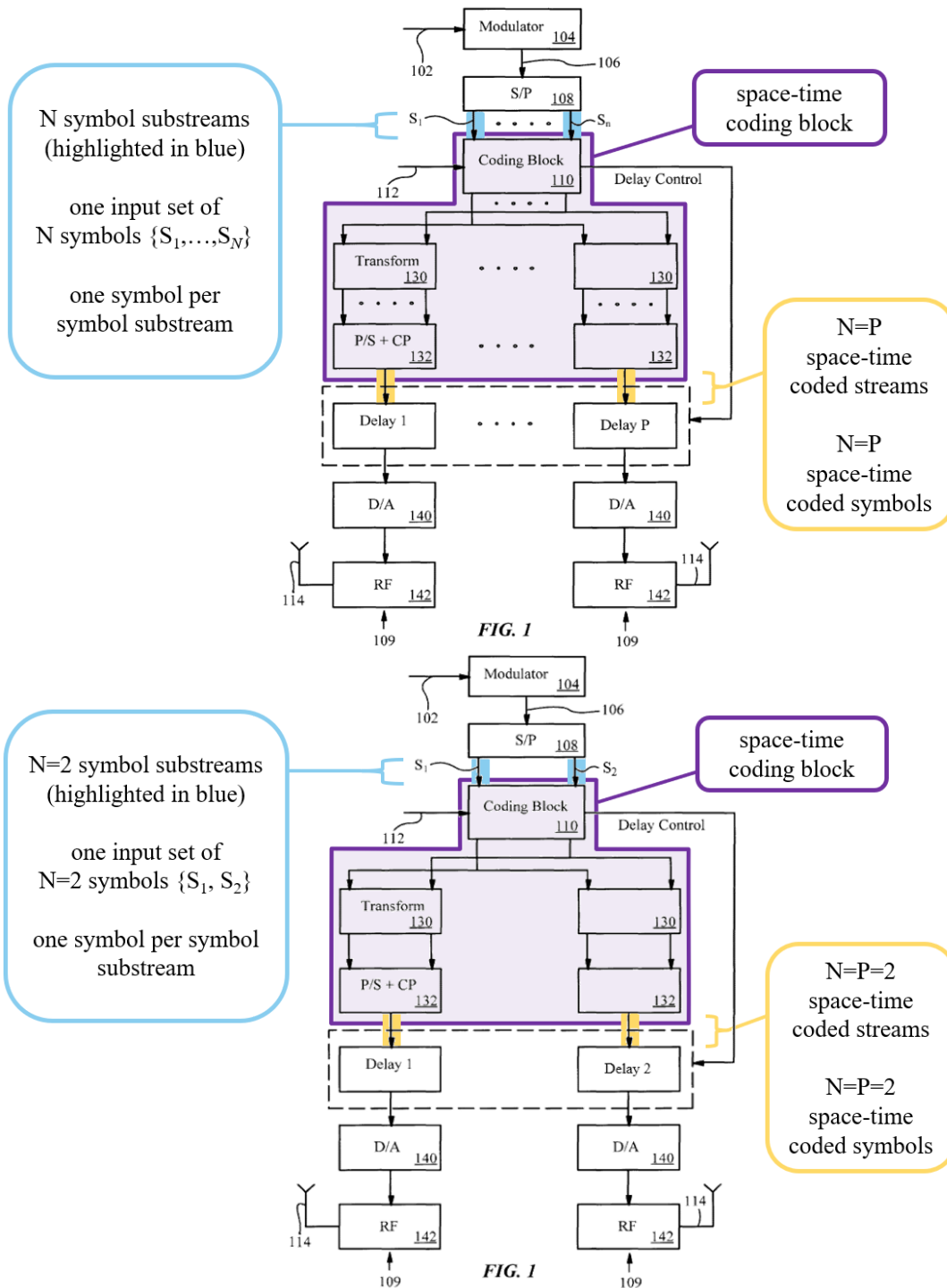


(Paulraj, FIG. 1 (annotated); Wilson, ¶102.)

- 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])

This element is anticipated and/or obvious over Paulraj. Paulraj 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). (Wilson, ¶¶104-106.) As discussed above, Paulraj 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, 7:47-59 (“M+L-1 complex valued symbols of each diversity branch”).)

Paulraj teaches there is a P/S+CP block 132 for each diversity branch. Paulraj discloses and renders obvious the number of diversity branches being equal to the number of symbol substreams, including $N=P=2$:



(Paulraj, FIG. 1 (annotated and modified for $N=P=2$); Wilson, ¶105.)

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

This element is anticipated and/or obvious over Paulraj. Paulraj 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). (Wilson, ¶¶107-110.) Paulraj teaches that it is preferable that symbols ($S_1, \dots, S_N$) are transmitted from all the available diversity branches. (Paulraj, 3:6-40.) Paulraj 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, 3:32-40.)

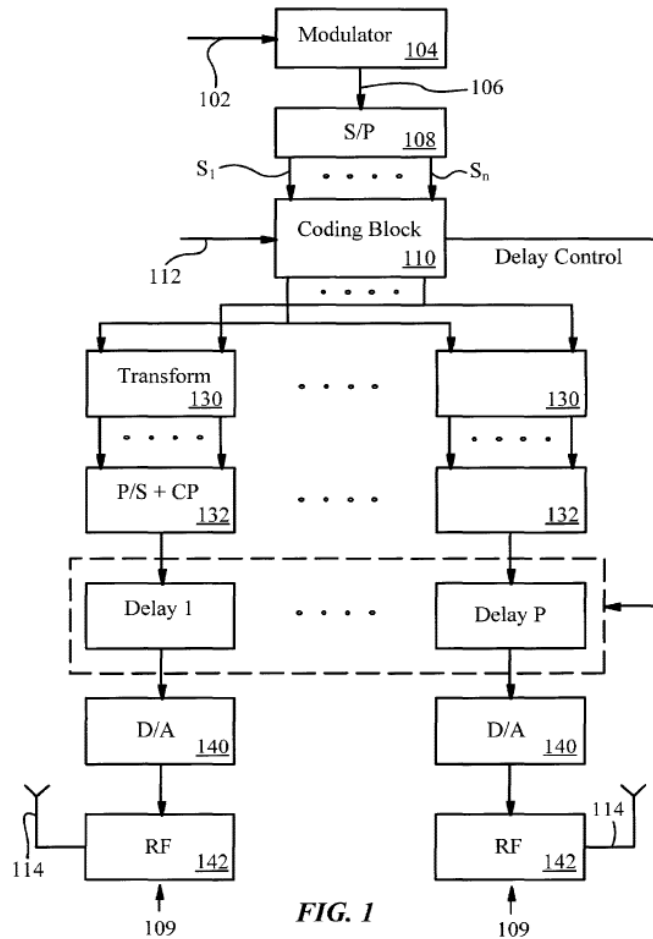
Moreover, even to the extent Paulraj recognizes there may be situations when substream symbols ($S_1, \dots, S_N$) are transmitted from less than the full set of diversity channels, a POSITA would understand that it is preferable that substream symbols are transmitted from the full set of diversity channels. (Wilson, ¶109 (citing Paulraj, 3:14-15, 3:38-40).) Moreover, a POSITA 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. (Wilson, ¶109.)

- 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])**

This element is anticipated and/or obvious over Paulraj. Paulraj discloses 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). (Wilson, ¶¶111-116.)

Petitioner has argued 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.) PO has argued this limitation is broader and includes additional forms of delays such as phase delays. (*Id.*) Paulraj discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies PO’s broader construction.

Paulraj teaches including a time delay in each diversity branch to “improve the effect of diversity as well as reduce the overhead resulting in a higher throughput.” (Paulraj, 7:62-67.) Paulraj further teaches it is beneficial to include delay diversity “when there is considerable fading (low K-factor) and delay spread in the channel.” (Paulraj, 2:29-31.) As shown in FIG. 1, Paulraj teaches adding a delay in each branch 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:

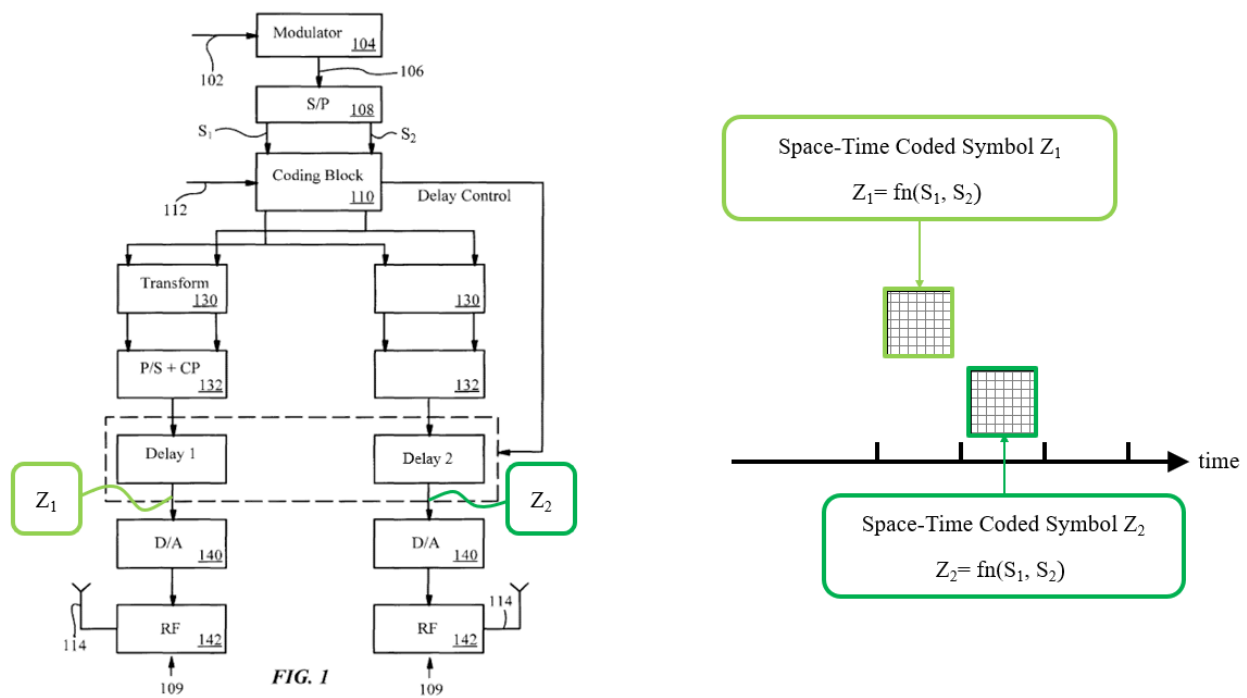


(Paulraj, FIG. 1.)

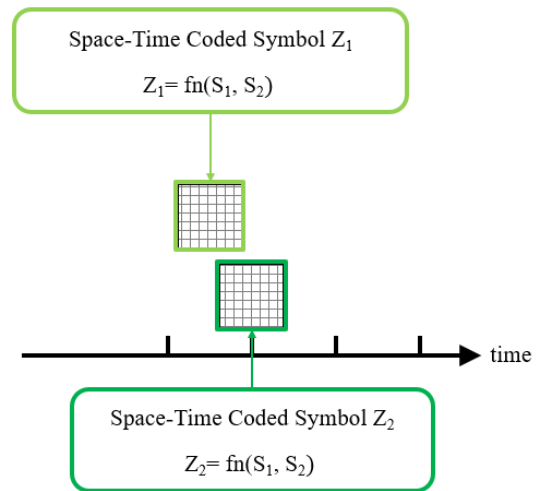
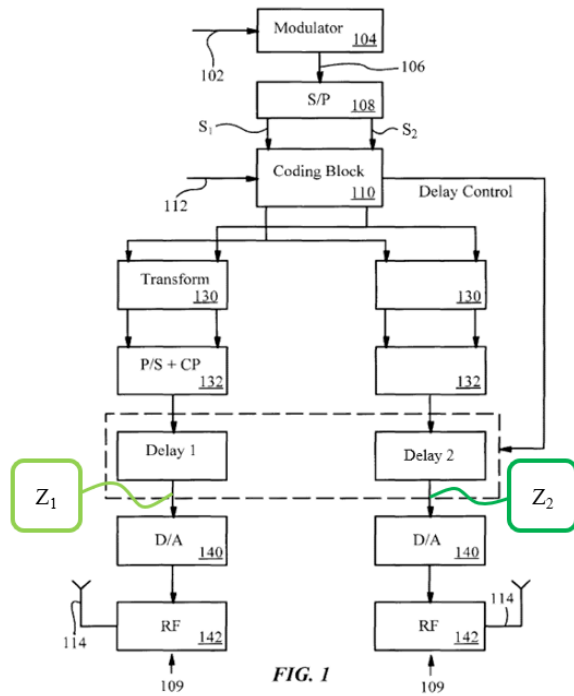
Paulraj teaches “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted.” (Paulraj, 4:65-5:5.) And that the amount of delay can be controlled by coding block 110 based on feedback regarding the channel length if available. (Paulraj, 7:57-61.)

In accordance with Paulraj’s disclosure that “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted,” a POSITA would understand the delays would cause the symbols in each diversity path to be

transmitted at different times. (Wilson, ¶¶113-115.) 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 , the “unique amount of delay” taught by Paulraj 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). (*Id.*) As shown 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:



(Paulraj, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-time coded symbols for a full symbol delay); Wilson, ¶115.)



(Paulraj, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-time coded symbols with a partial symbol delay); Wilson, ¶115 (citing Paulraj, 4:65-5:5 for teaching that amount of delay may vary).)

Either example 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.

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

This element is anticipated and/or obvious over Paulraj. Paulraj 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 $\{S_1, \dots, S_N\}$). (Wilson, ¶¶117-119.)

As discussed above, in Paulraj 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 teaches the “M” complex valued symbols are created by coding and transforming the input frame of symbols $\{S_1, \dots, S_N\}$. (Paulraj, 5:22-7:2 (coding) and 7:16-47 (transformation).) As shown in FIG. 1, Paulraj teaches 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, 7:16-21.) Paulraj 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, 7:19-39.) 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. (Wilson, ¶118.)

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

This element is anticipated and/or obvious over Paulraj. Paulraj teaches “a plurality M of transmit antennas each adapted to transmit a respective one of the M space-time coded streams.” (Wilson, ¶¶120-122.) As shown in FIG. 1, Paulraj 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 respective antennas for transmission.” (Paulraj, FIG. 1, 7:57-61, 8:28-33.) Paulraj further teaches “[e]ach diversity branch 109 has an antenna 114 for transmitting a signal.” (Paulraj, FIG. 1, 4:65-66.)

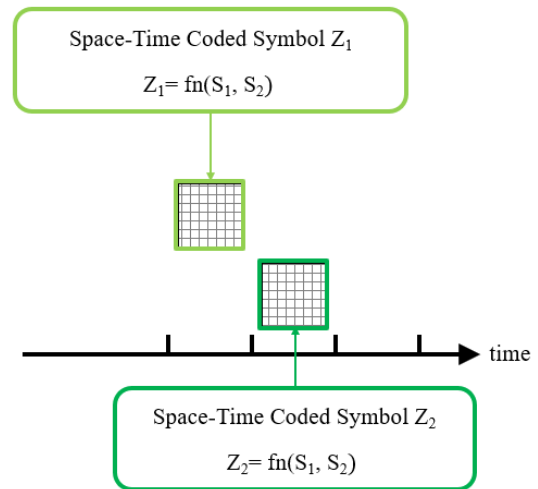
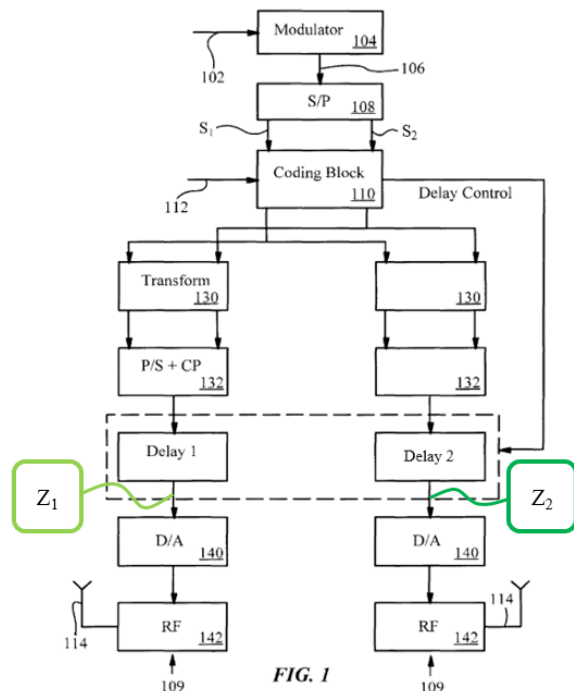
- i. “such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.” (claim 1[f])**

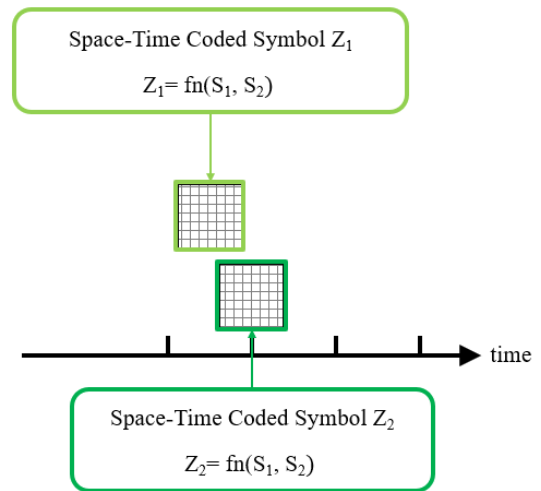
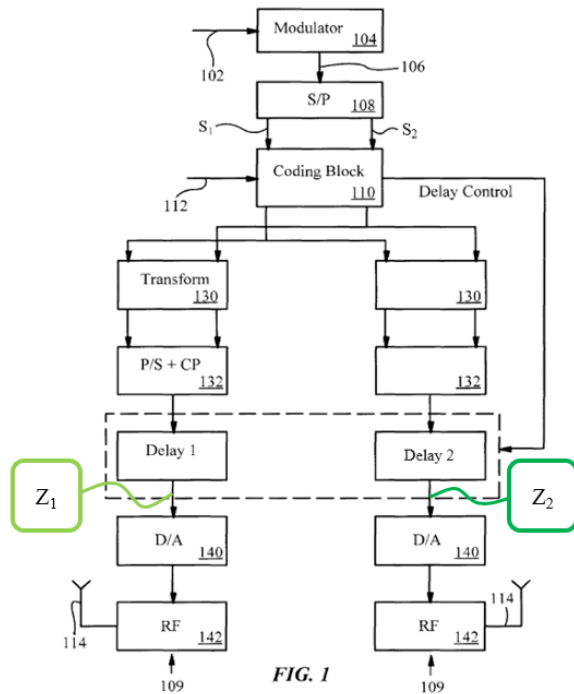
This element is anticipated and/or obvious over Paulraj. Paulraj teaches and renders obvious “such that for each symbol of each input set of M symbols, the M space-time coded symbols that contain a representation of the symbol are transmitted at different times.” (Wilson, ¶¶123-126.)

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 further teaches “[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, 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. (Wilson, ¶124.)

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:





(Paulraj, FIG. 1 (modified for $N=P=2$, and annotated to show timing of space-time coded symbols); Wilson, ¶125.)

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.”

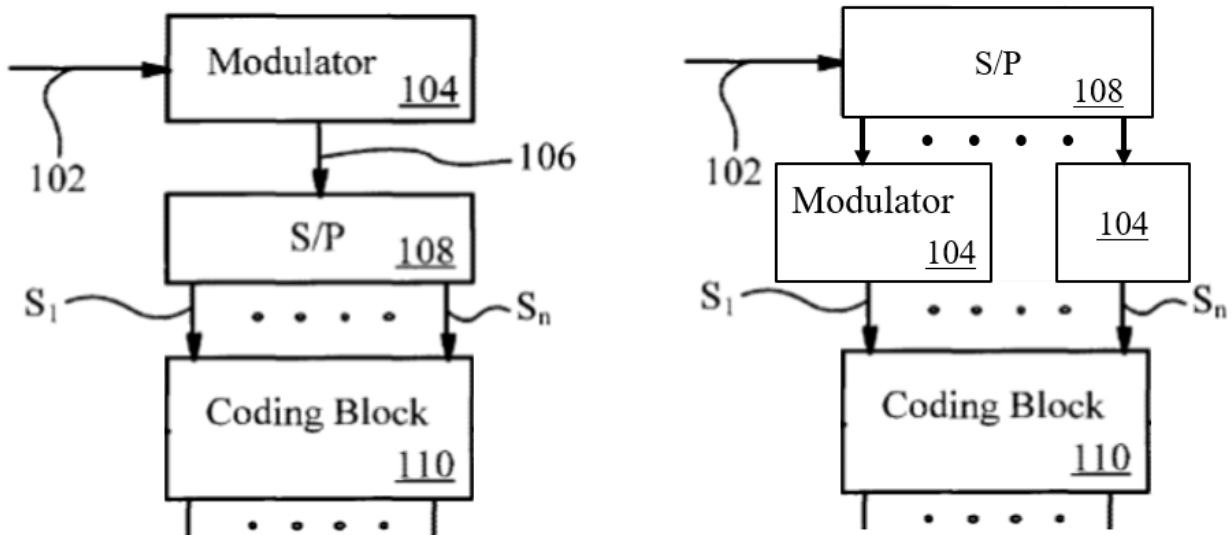
a. Ground 1 – Paulraj Alone

Paulraj alone renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj’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 connected to each output of the serial-to-parallel). (Wilson, ¶¶127-129.)

Paulraj teaches the same operations recited in claim 2, merely in a different order. (Wilson, ¶128.) But the ample 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. (*Id.* (citing EX1026 (Schilling), FIG. 1 v. 2, 6:1-15 (“In FIG. 1, the data are first forward-error-correction (FEC) encoded by FEC encoder 21..., 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).)

FIG. 1 of Paulraj 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, 4:55-60.) It was obvious to perform the same steps, to achieve the same result, but simply modify the order of the steps, as shown in the figure below to achieve the same result:



(Paulraj, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised); Wilson, ¶128.) The order of operations of these steps was an obvious modification. (Wilson, ¶128.)

a. Ground 2 – Paulraj in view of Jalali

Paulraj in view of Jalali renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj's serial-to-parallel converter arranged prior to (rather than after) modulation, as shown by Jalali'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 connected to each output of the serial-to-parallel converter, as taught by Jalali's encoders which are each connected to an output of the demultiplexer). (Wilson, ¶¶130-132.)

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. (Wilson, ¶131.) Jalali teaches a demultiplexer that 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:

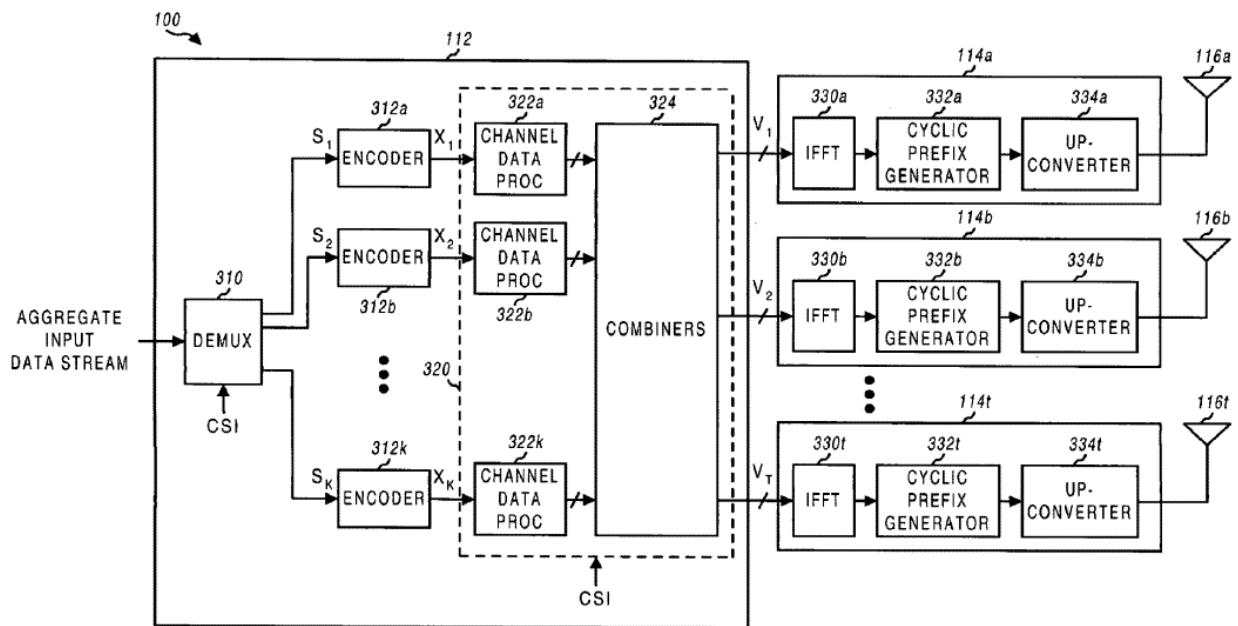
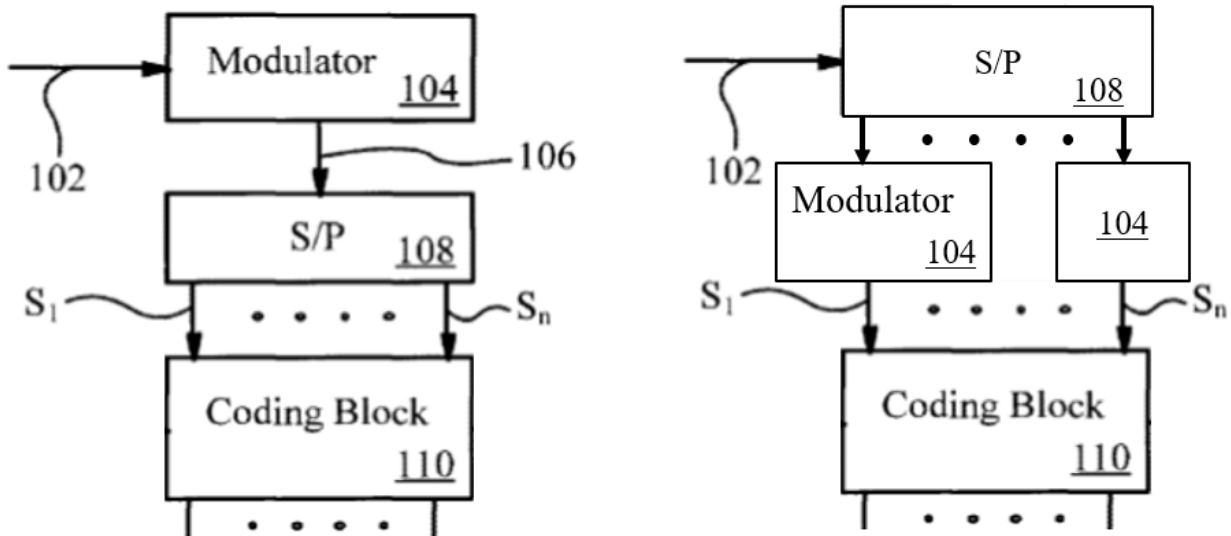


FIG. 3

(EX1027 (Jalali), FIG. 3, 16:23-58.) Substituting the modulator and S/P converter in Paulraj with a demultiplexer and then encoders as taught in Jalali merely involves the simple substitution of one known element for another to obtain predictable

results. (Wilson, ¶131.) Following Jalali's teaching that it is an acceptable alternative to demultiplex and then encode, a POSITA would have considered it obvious to modify Paulraj such that modulation occurs after serial-to-parallel conversion:



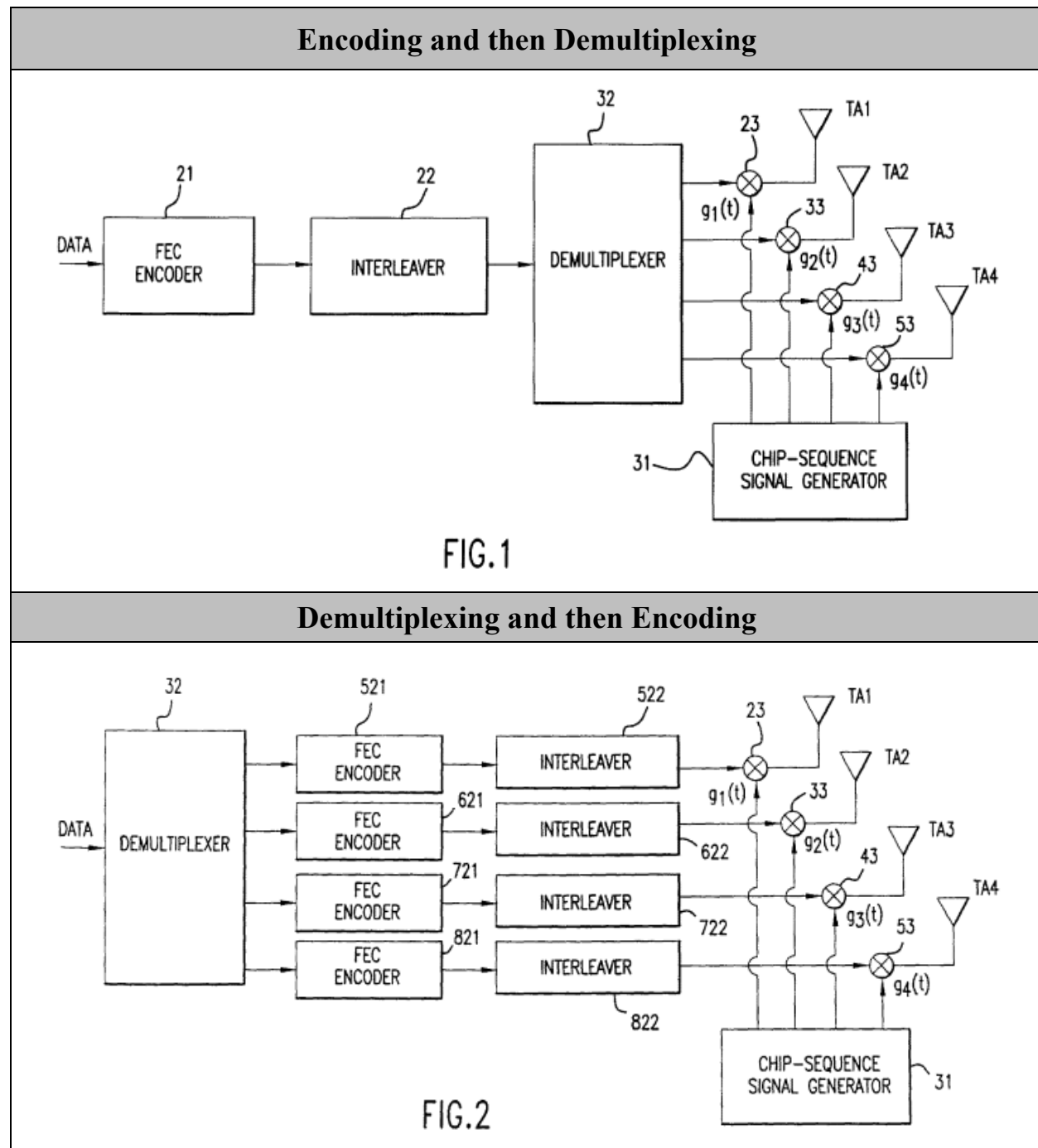
(Paulraj, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised based on Jalali); Wilson, ¶131.) There is no material difference between (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, and a POSITA would have every expectation of success in this modification. (Wilson, ¶131 (citing EX1026 (Schilling), FIG. 1 v. 2, 6:1-15).)

b. Ground 3 – Paulraj in view of Schilling

Paulraj in view Schilling renders obvious the transmitter further comprising a demultiplexing and encoding block comprising a demultiplexer having M outputs (Paulraj's serial-to-parallel converter arranged prior to (rather than after)

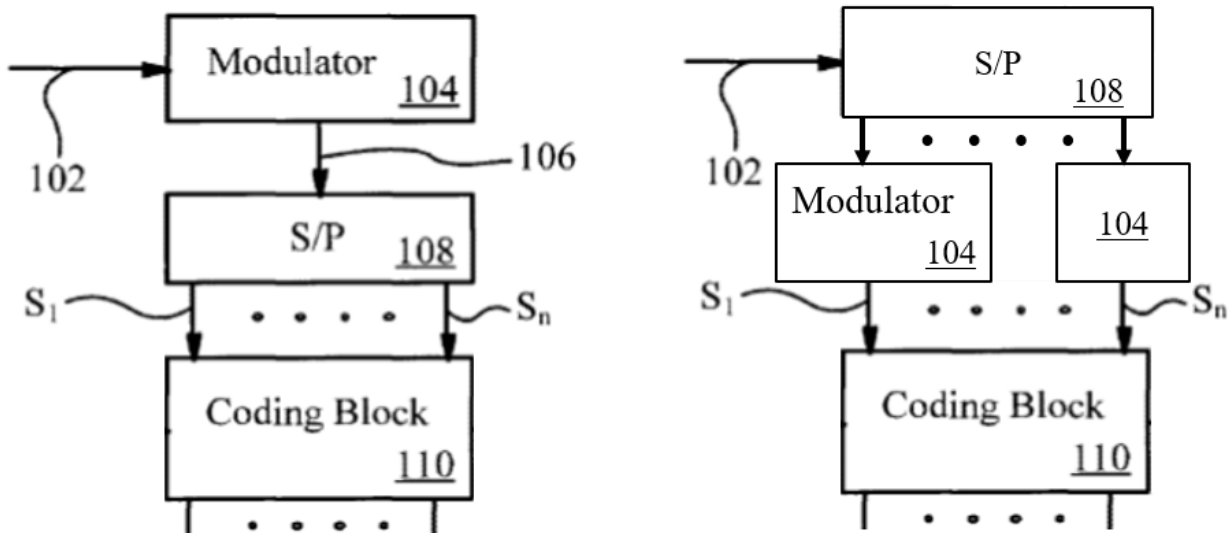
modulation, as Schilling teaches is an alternative), and M encoder/modulators each producing a respective one of the M symbol substreams, with each of the M encoder/modulators connected to receive a respective one of the demultiplexer outputs (a modulator as taught in Paulraj connected to each output of the serial-to-parallel converter, each configured to produce a respective one of the substream symbols ($S_1, \dots, S_N$)). (Wilson, ¶¶133-135.)

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



(EX1026 (Schilling), FIG. 1 v. 2, 6:1-15; *see also id.* at 12:30-57.) Following Schilling's teaching that it is an acceptable alternative to demultiplex and then encode, it was obvious to modify Paulraj such that modulation occurs after serial-to-

parallel conversion:



(Paulraj, FIG. 1 (left, excerpted) and FIG. 1 (right, excerpted and revised based on Schilling); Wilson, ¶134.) A POSITA 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) showed it was an acceptable design option to demultiplex prior to encoding. (Wilson, ¶134 (citing EX1027 (Jalali), FIG. 3, 16:23-58).)

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.”

Paulraj alone (Ground 1) and/or Paulraj in view of Jalali (Ground 2), and/or Paulraj in view of Schilling (Ground 3) renders obvious the demultiplexing and encoding block is adapted to produce the M symbol substreams from an input stream. (Wilson, ¶¶136-140.)

Ground 1: As discussed for claim 2, it was well-known in the art that when parallel streams are desired (such as in Paulraj) it would be obvious to either (i) encode/modulate and then demultiplex (as in Paulraj), or (ii) demultiplex and then encode/modulate. (EX1026 (Schilling), FIG. 1 v. 2, 6:1-15; Wilson, ¶137.) Regardless of the operation of these steps, Paulraj teaches that the parallel M symbol substreams are produced from “bitstream 102 of information.” (Paulraj, 4:55-60.)

Ground 2: If a POSITA modified Paulraj in view of Jalali (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 and Jalali teach starting with a single input stream. (Wilson, ¶138.) As shown below, Jalali teaches the input is an aggregate input data stream:

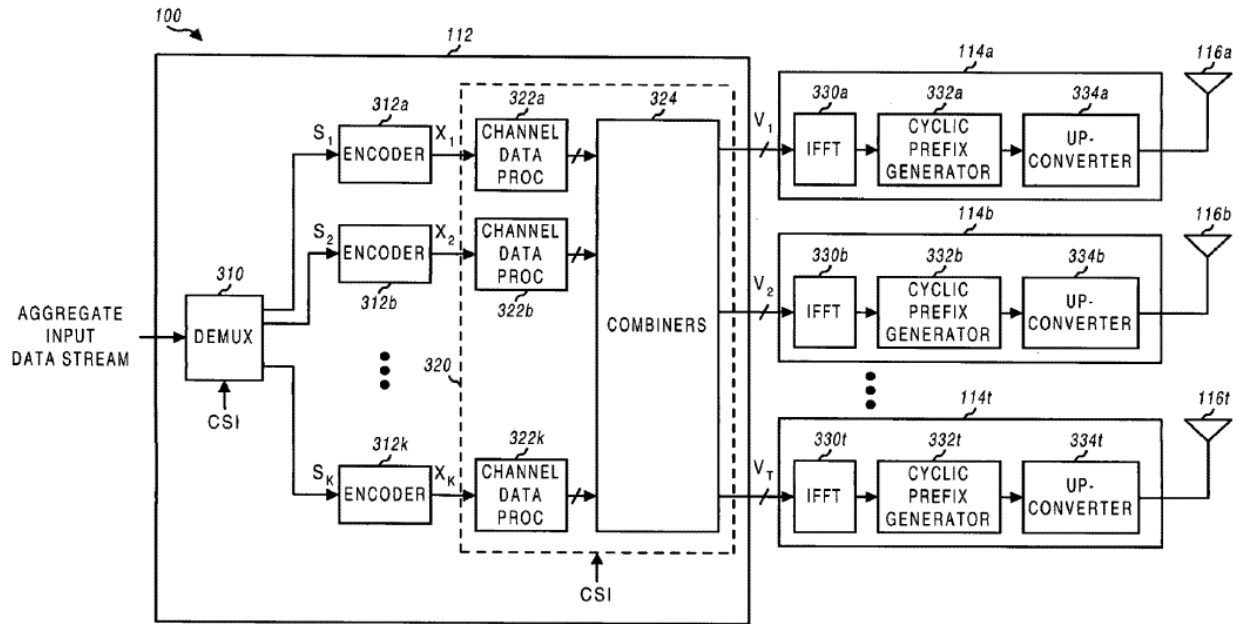
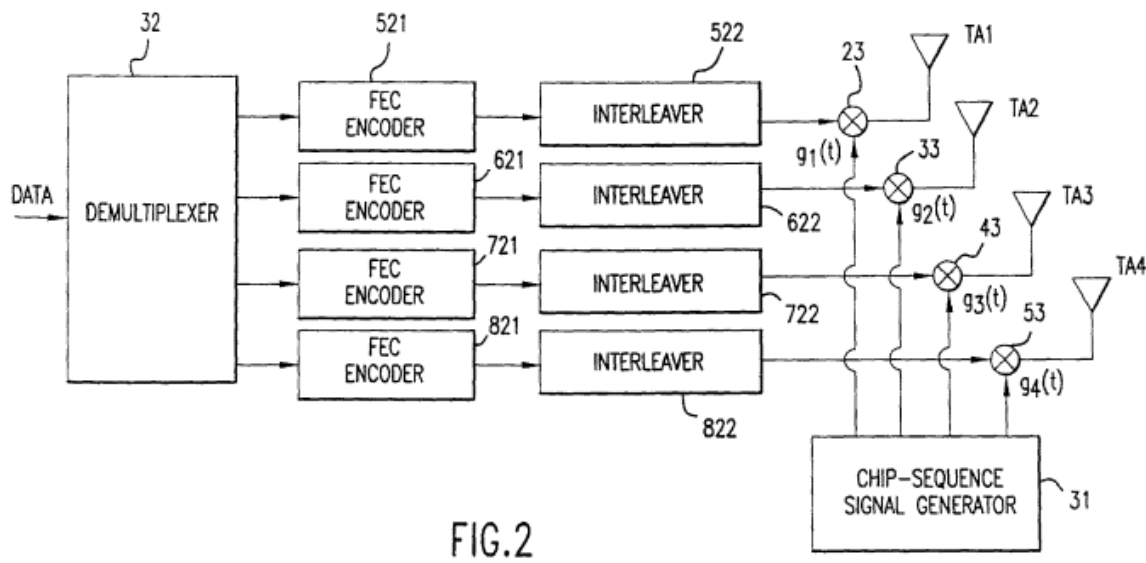


FIG. 3

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

Ground 3: If a POSITA modified Paulraj in view of Schilling (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 and Schilling teach starting with a single input stream. (Wilson, ¶139.) As shown below, Schilling teaches the input is a single data stream:



(EX1026 (Schilling), FIG. 2.)

4. Claim 6: (Depending on Claim 1)

Paulraj alone anticipates and renders obvious claim 6 (Ground 1), and Paulraj in view of Schilling renders obvious claim 6 (Ground 3).

- 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])**

Paulraj alone anticipates and renders obvious (Ground 1) and/or Paulraj in view of Schilling (Ground 3) 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

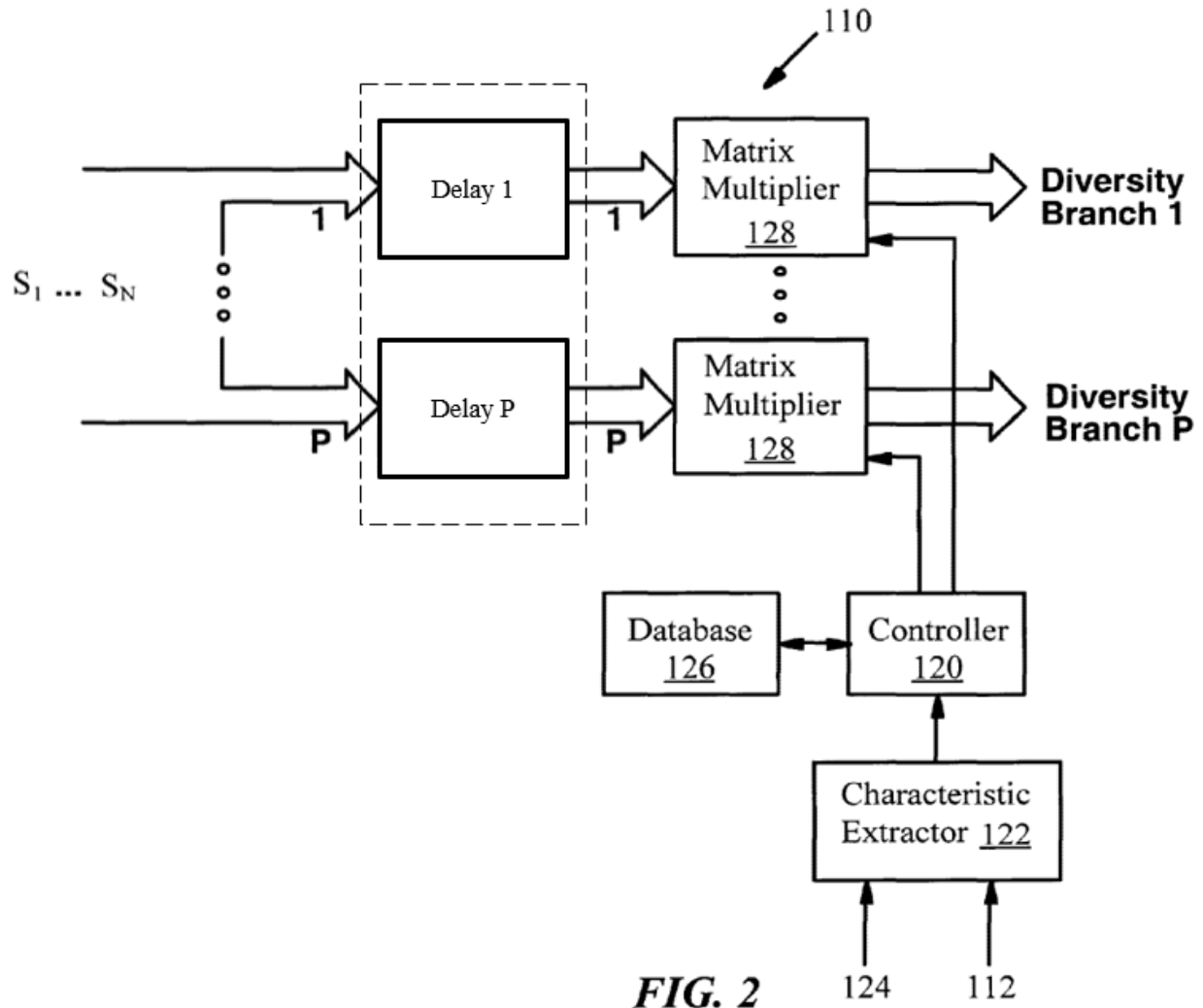
inserts a different amount of time delay in the substreams going to Diversity Branch

2). (Wilson, ¶¶142-147.)

Petitioner and PO agree that “the M substreams” refers to “the M symbol substreams.”

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.) PO has argued this limitation is broader and includes additional forms of delays such as phase delays. (EX1043, ¶44.) Paulraj discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies PO’s broader construction.

As discussed for claim 1, Paulraj discloses a time delay in each diversity branch to “improve the effect of diversity as well as reduce the overhead resulting in a higher throughput.” (Paulraj, 7:62-67.) In Paulraj, the delays are shown after the P/S + CP blocks. However, a POSITA 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, FIG. 2 (modified to include Delays 1-P); Wilson, ¶145.) 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:

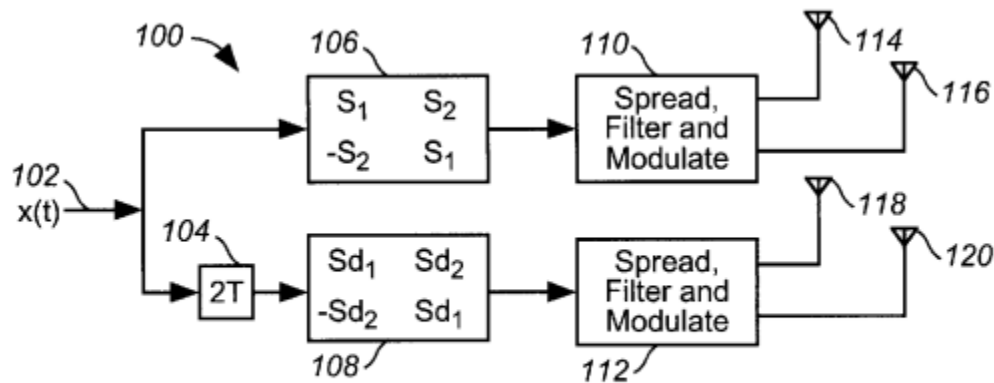


FIG. 1

(EX1032, FIG.1, 4:3-5 (“Offset block 104 causes a 2 symbol period delay.”).) In addition, the prior art confirms a POSITA would understand adding delays prior to the matrix multipliers is mathematically equivalent to adding the delays after the P/S + CP block. (Wilson, ¶145.) 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):

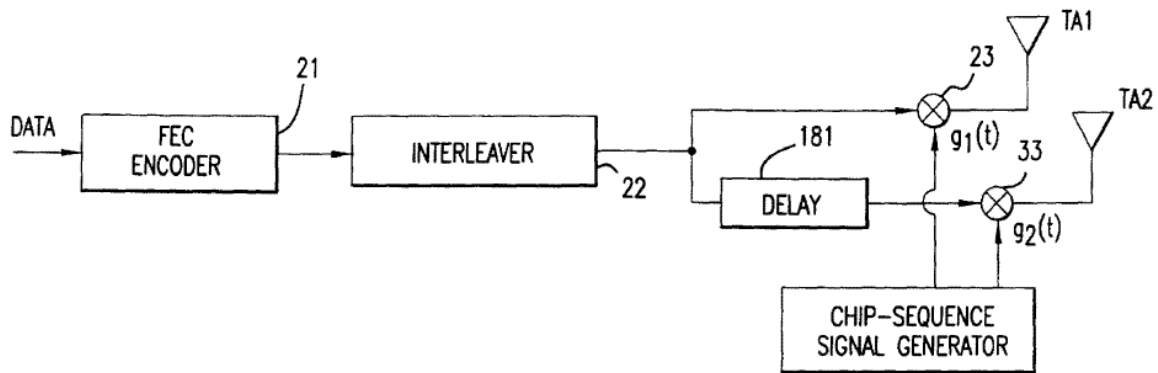


FIG. 4

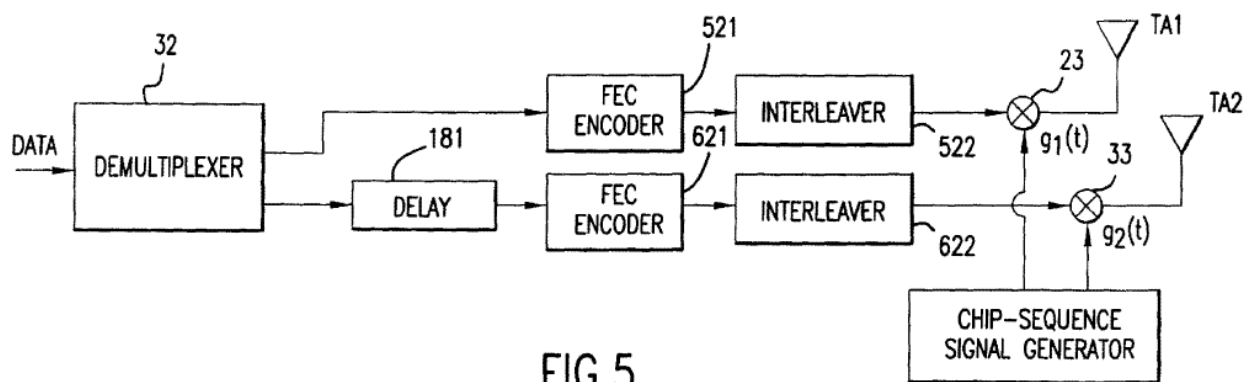


FIG. 5

(Schilling, FIG. 4 v. FIG. 5, 12:30-57; Wilson, ¶145.)

Ground 3: To the extent necessary, it would have been obvious to combine Paulraj with Schilling for this limitation. As discussed above, Schilling teaches it was a known alternative to place the delay before encoding/interleaving (FIG. 5). Following Schilling's teaching, modifying Paulraj 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. (Wilson, ¶146.)

- 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])**

Paulraj alone (Ground 1) and/or Paulraj in view of Schilling (Ground 3) 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 mth orthogonal output being a function of the M symbol substreams delayed in said delay elements by $m-1$ symbol periods. (Wilson, ¶¶148-157.)

Petitioner and PO agree that “the space-time coding function” refers to “the space-time coding block.”

PO argues 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.) 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 discloses and renders obvious this limitation obvious under either construction.

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

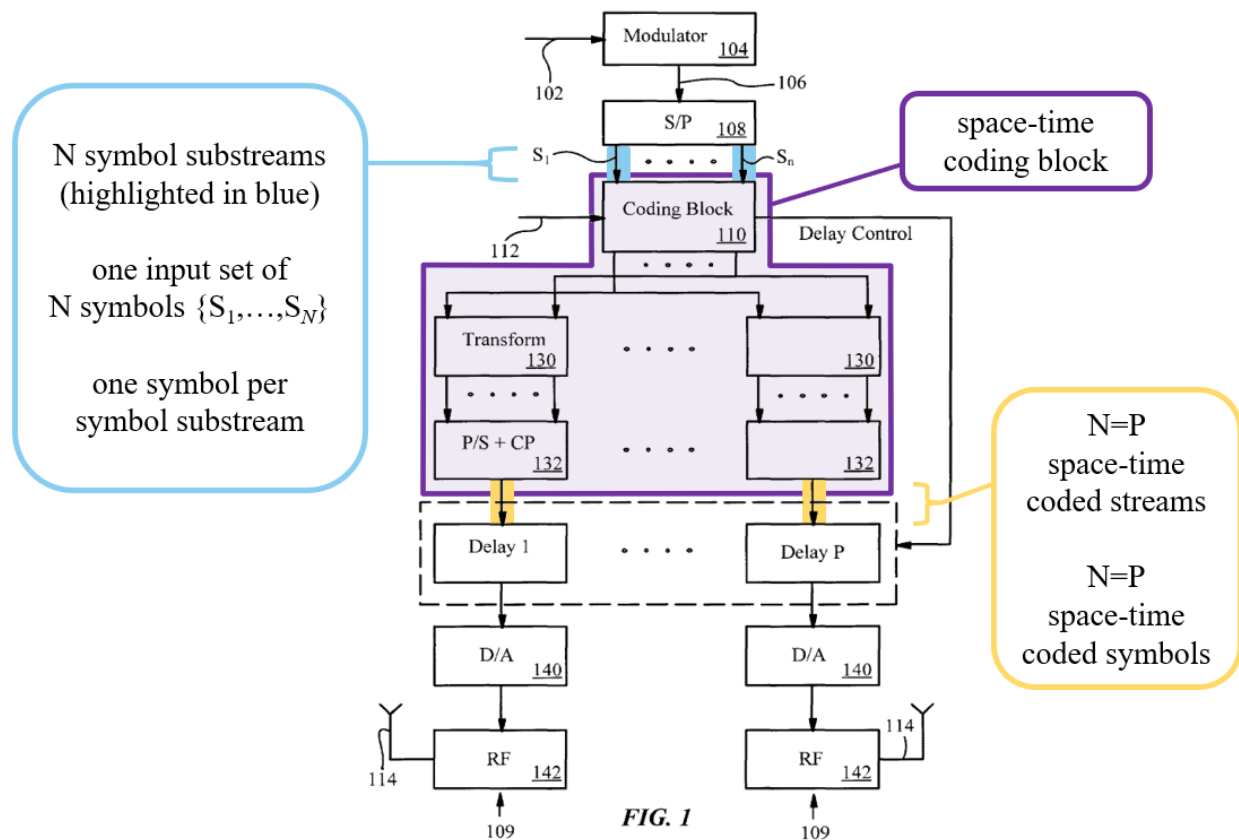
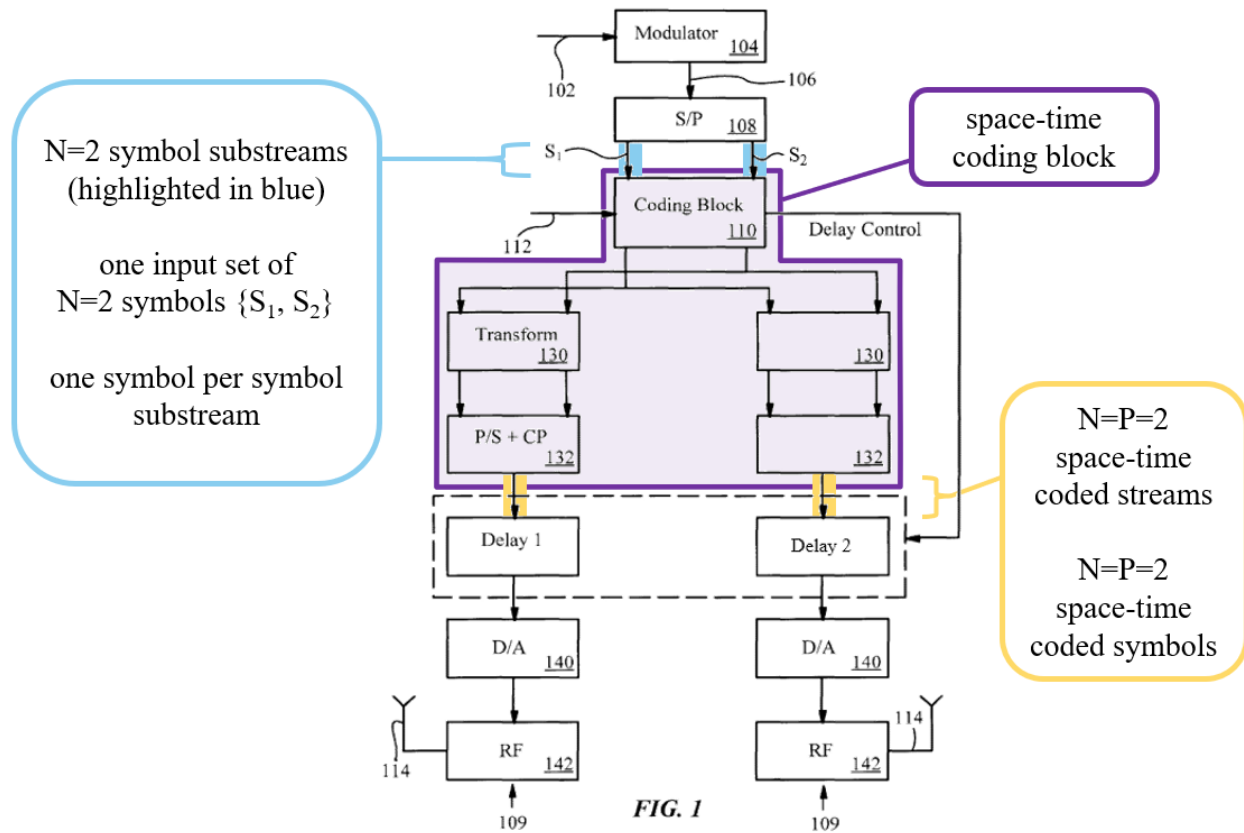
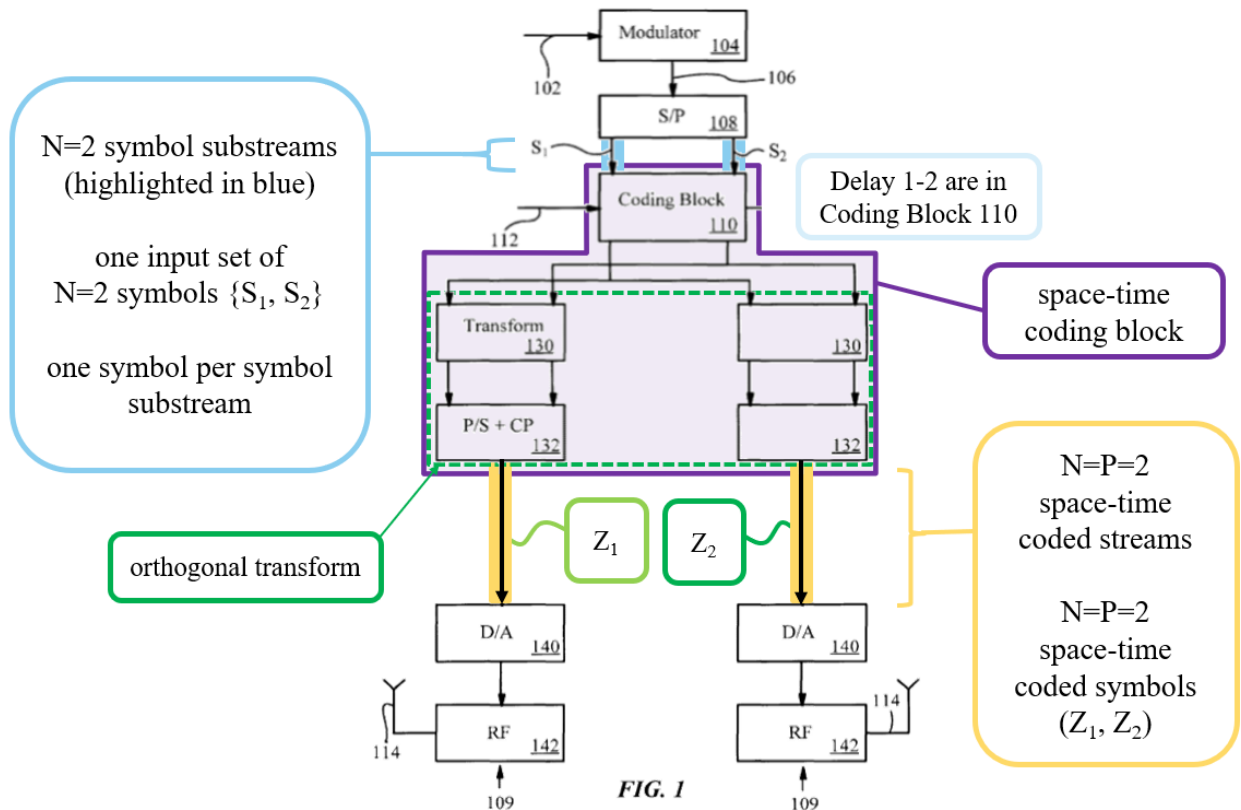


FIG. 1

(Paulraj, FIG. 1 (annotated).)



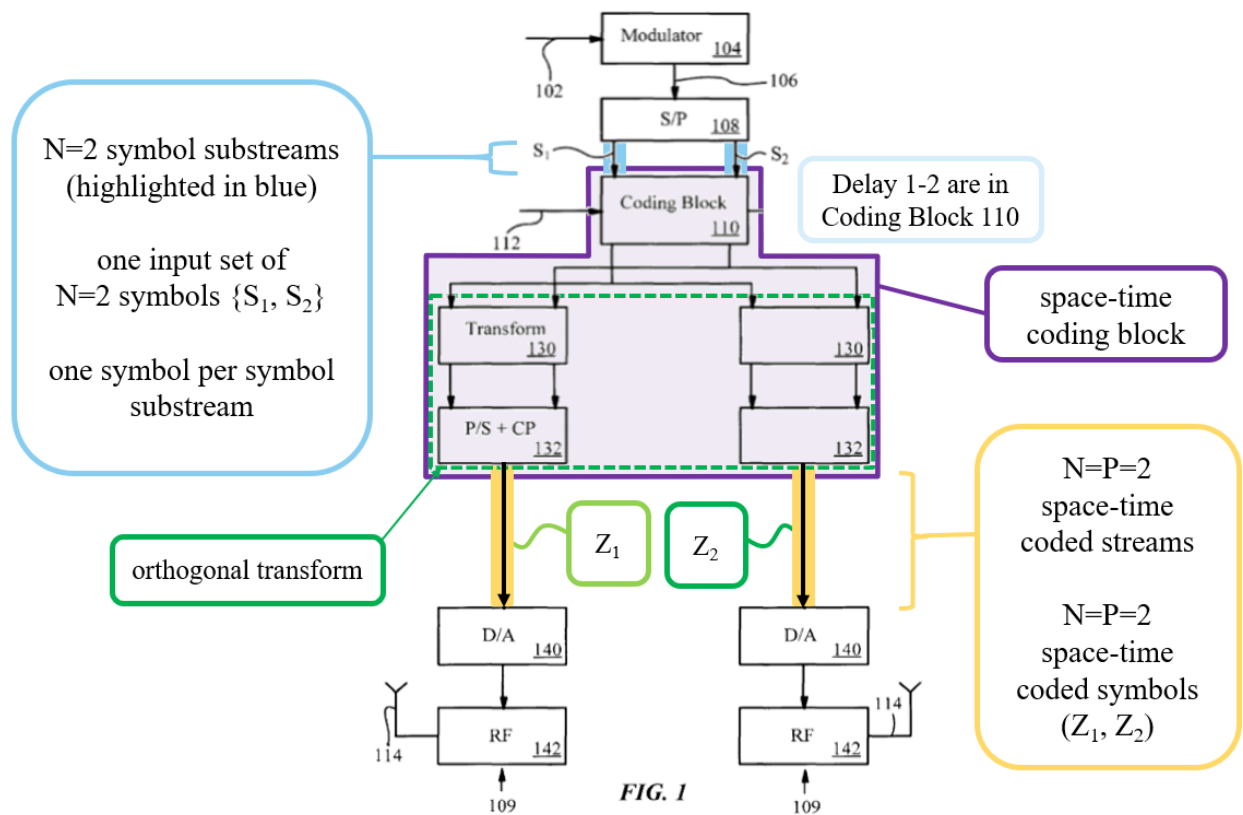
(Paulraj, FIG. 1 (modified for $N=P=2$, and annotated); Wilson, ¶151.) In addition, because for claim 6 the delays are moved within the coding block, below is an annotated figure for $N=P=2$ with the delays included in coding block 110:



(Paulraj, FIG. 1 (modified for $N=P=2$, modified to move Delay 1 and Delay 2 to within the coding block, and annotated); Wilson, ¶151.)

Paulraj discloses 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, 7:15-22.) Each IFFT is an orthogonal transform. (Wilson, ¶152.)

For claim 6, a POSITA 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, FIG. 1 (modified for $N=P=2$, modified to move Delay 1 and Delay 2 to within the coding block, and annotated); Wilson, ¶152.) 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 "orthogonal output," the outputs of each IFFT (and P/S+CP block) in Paulraj would be considered an "orthogonal output" because each output is the output of an orthogonal function. (Wilson, ¶152.) 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. (*Id.*)

Under PO's construction, this claim is satisfied because a POSITA would understand that when Delay 1 is added before the matrix multiplier 128, Delay 1 would not insert any delay. (Wilson, ¶153.) This is because the purpose of Delay 1 and Delay 2 is to create a difference in time delay between the two diversity branches. (*Id.*) 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. (*Id.*) 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. (*Id.*)

Under Petitioner's construction, 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. (Wilson, ¶154.) Using a delay of 1 symbol period 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. (*Id.*) In fact, space-time coding prior art at that time encouraged the use of "delays of the order of symbol period." (EX1035, p.003.)

Paulraj also discloses that the invention applies to "any kind of access techniques such as TDMA, FDMA, CDMA, OFDMA." (Paulraj, 9:46-49.) And

Paulraj 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, 5:3-5.) Following Paulraj’s teaching of a time delay “at least equal” to the delay spread, this would result in a delay of 1 symbol period when the delay spread is approximately equal to the symbol period—which is a practical occurrence. (Wilson, ¶155.) For example, contemporaneous proposed data rates for Fixed Wireless Access ranged from 1-20 Mbps depending on the channel conditions. (*Id.* (citing EX1036, p.004).) For a low-rate Rayleigh channel (e.g., 1 Mbps, which is approximately equal to 1 bits/μs) where diversity could be used to improve the performance, a POSITA would understand the symbol period to be approximately 1 μs. (Wilson, ¶155.) Channel length for Fixed Wireless Access ranged from at least 0 to 1 μs depending on different factors such as the antenna directionality, distance from the transmitter to receiver, etc. (*Id.* (citing EX1037, pp.003-10.)⁴ Accordingly,

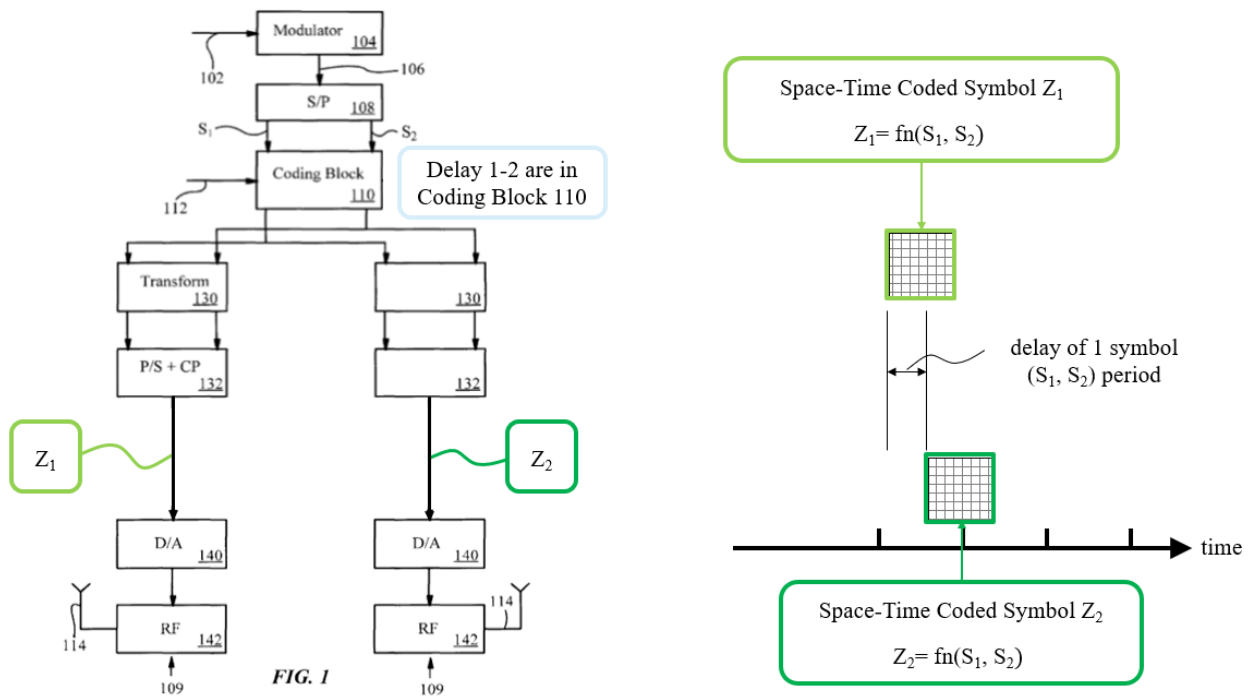
⁴ EX1037 reports root-mean-square (average) delay spreads ranging from 0-0.5 μs, and indicates delay spreads of at least up to 1 μs. (EX1037, pp.003-10.) Paulraj discusses delay spread in terms of channel length. (Paulraj, 5:3-5.) A POSITA would understand that an rms delay spread is approximately half of the channel length. (Wilson, n.6.) Accordingly, to convert (i) rms delay spread to (ii) delay

since the low-rate data rate symbol period ($1\ \mu\text{s}$) 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, 5:3-5) would increase the delay diversity of the channel. (Wilson, ¶155.) As the symbol periods become smaller (for higher data rates), this is also encompassed by known delay spreads. (*Id.*) 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. (Wilson, ¶155.) 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, 5:3-5. (*Id.*)

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

spread in terms of channel length, the rms delay spread is approximately doubled. (*Id.*)

in said delay elements by 1 ((m=2)-1) symbol period. (Wilson, ¶156.) An example is below:



(Paulraj, FIG. 1 (modified for N=P=2, modified to move Delay 1 and Delay 2 to within the coding block, and annotated); Wilson, ¶156.)

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

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

Rowitch teaches a transmitter adapted to process a plurality M of symbol substreams (M=2 complex symbol streams, Y_{EVEN} and Y_{ODD}). (Wilson, ¶¶160-162.)

Rowitch discloses a transmitter unit 110 that includes modulator 116. (Rowitch, 4:32-43.) As shown in FIG. 2, in modulator 116 the input data symbols Y are demultiplexed into two complex symbol streams, Y_{EVEN} and Y_{ODD} :

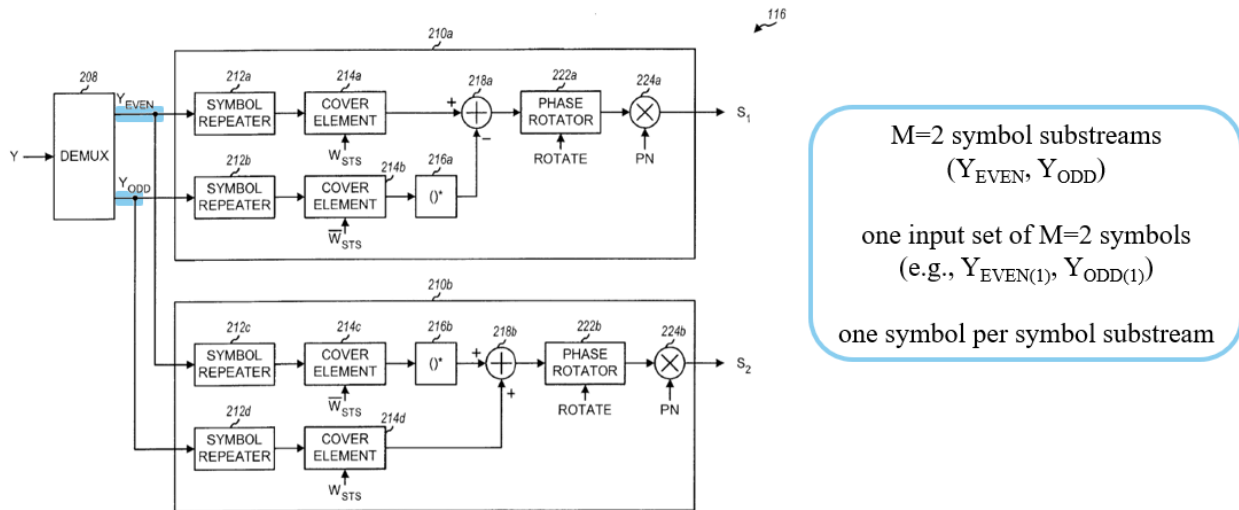


FIG. 2

(Rowitch, FIG. 2 (annotated), 5:46-51; Wilson, ¶161.)

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

Rowitch 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 $Y_{\text{EVEN}(1)}$ and $Y_{\text{ODD}(1)}$). (Wilson, ¶¶163-168.)

Rowitch teaches modulator 116 “process[es] a downlink data transmission in a Space-Time Spreading transmit diversity mode[.]” (Rowitch, 5:43-47.) As shown

in FIG. 2 and described in Rowitch, for a given time period $T=(1)$ there will be a complex symbol $Y_{EVEN(1)}$ in substream Y_{EVEN} and a complex symbol $Y_{ODD(1)}$ in symbol substream Y_{ODD} . (Wilson, ¶164.) For each set of $M=2$ symbols (e.g., $Y_{EVEN(1)}$ and $Y_{ODD(1)}$) the transmitter produces $M=2$ space-time coded symbols ($S_{1(1)}$ and $S_{2(1)}$):

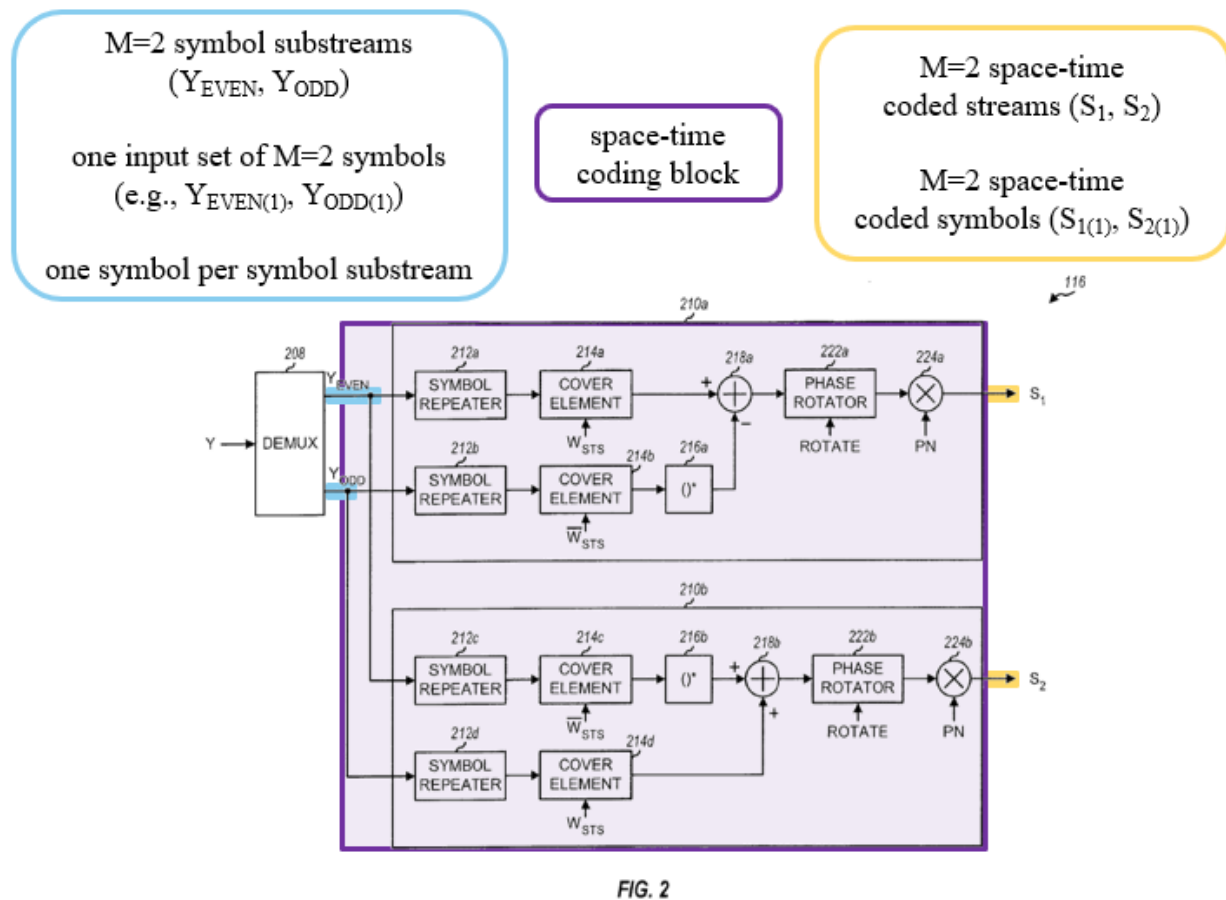
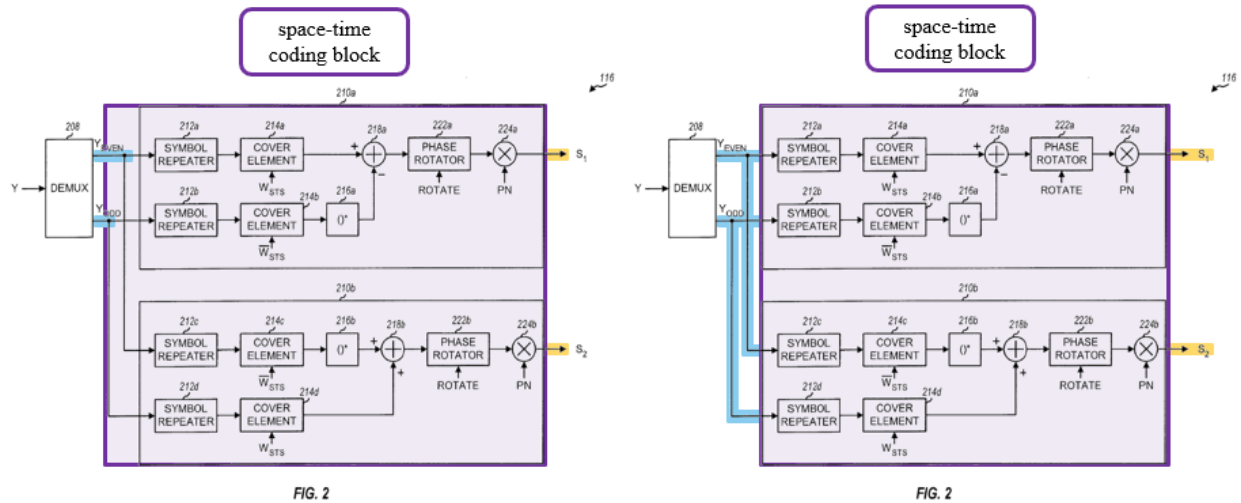


FIG. 2

(Rowitch, FIG. 2 (annotated); Wilson, ¶164.)

There are multiple ways to draw a box around the transmitter components described and shown in Rowitch that would satisfy the requirements for the space-

time coding block. (Wilson, ¶¶165-166.) For example, two alternatives are shown below:



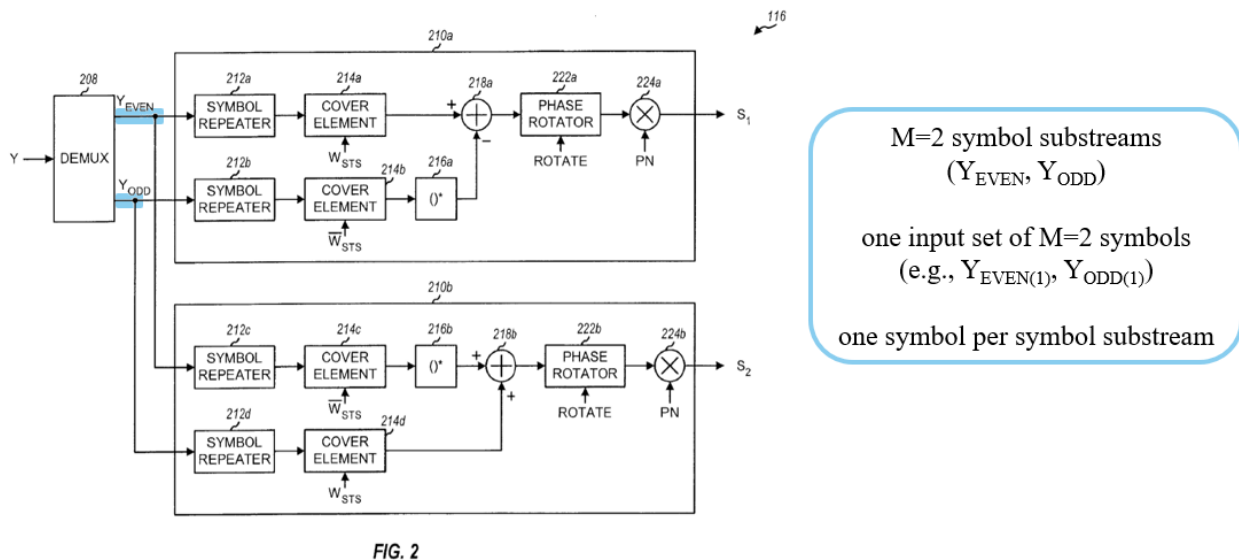
The present analysis refers to the space-time coding block in Rowitch to be comprised of modulators 210a/b. Using this example, the output of the space-time coding block in Rowitch is symbol streams S_1 and S_2 , which for the given time period $T=(1)$ corresponds to symbols $S_{1(1)}$ and $S_{2(1)}$. (Wilson, ¶166.)

Symbols $S_{1(1)}$ and $S_{2(1)}$ are each a space-time coded symbol. (Wilson, ¶167.) For example, Rowitch teaches modulator 116 “process[es] a downlink data transmission in a Space-Time Spreading transmit diversity mode[.]” (Rowitch, 5:43-47.) And within modulators 210a/b, Rowitch teaches cover elements 214a/c and 214b/d cover the data symbols using a Walsh space-time spreading symbol (W_{STS} or

$\bar{W}_{STS}$). (Rowitch, 5:44-6:21.) Those skilled in the art recognized that STS is a form of space-time coding. (Wilson, ¶167 (citing EX1012, p.006).)

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

Rowitch discloses 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 $Y_{ODD(1)}$). (Wilson, ¶¶169-171.) As discussed for the prior limitations, a POSITA 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:



(Rowitch, FIG. 2 (annotated), 5:46-51 (data symbols Y are “demultiplexed into two complex symbol streams, Y_{even} and Y_{odd} ”); Wilson, ¶170.)

- 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])

Rowitch teaches 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). (Wilson, ¶¶172-174.)

As shown in FIGS. 1-2, Rowitch discloses that “complex output symbol streams, S_1 and S_2 , are subsequently provided to two respective processing paths in transmitter 118.” (Rowitch, 7:40-55 (further noting that S_1 goes to antenna 1 and S_2 goes to antenna 2).) “In the STS mode, two complex data symbols are transmitted in parallel over two antennas[.]” (Rowitch, 5:65-66.)

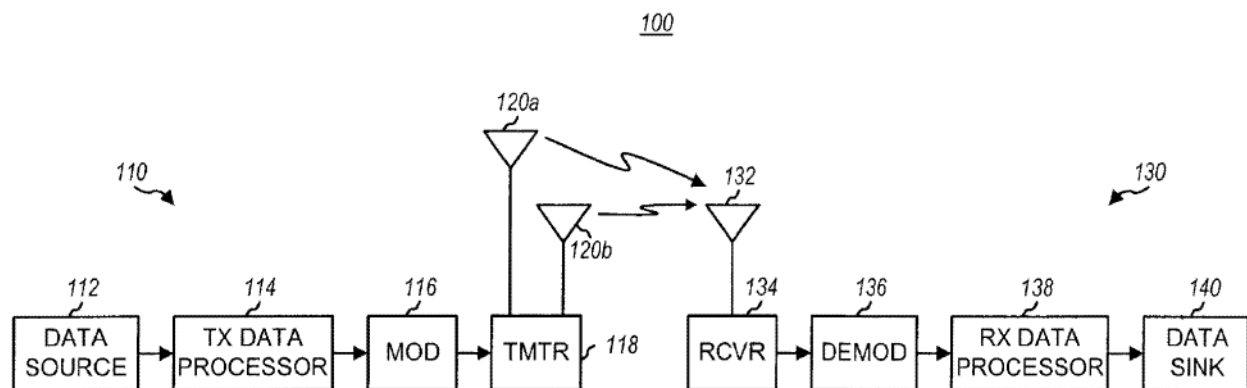


FIG. 1

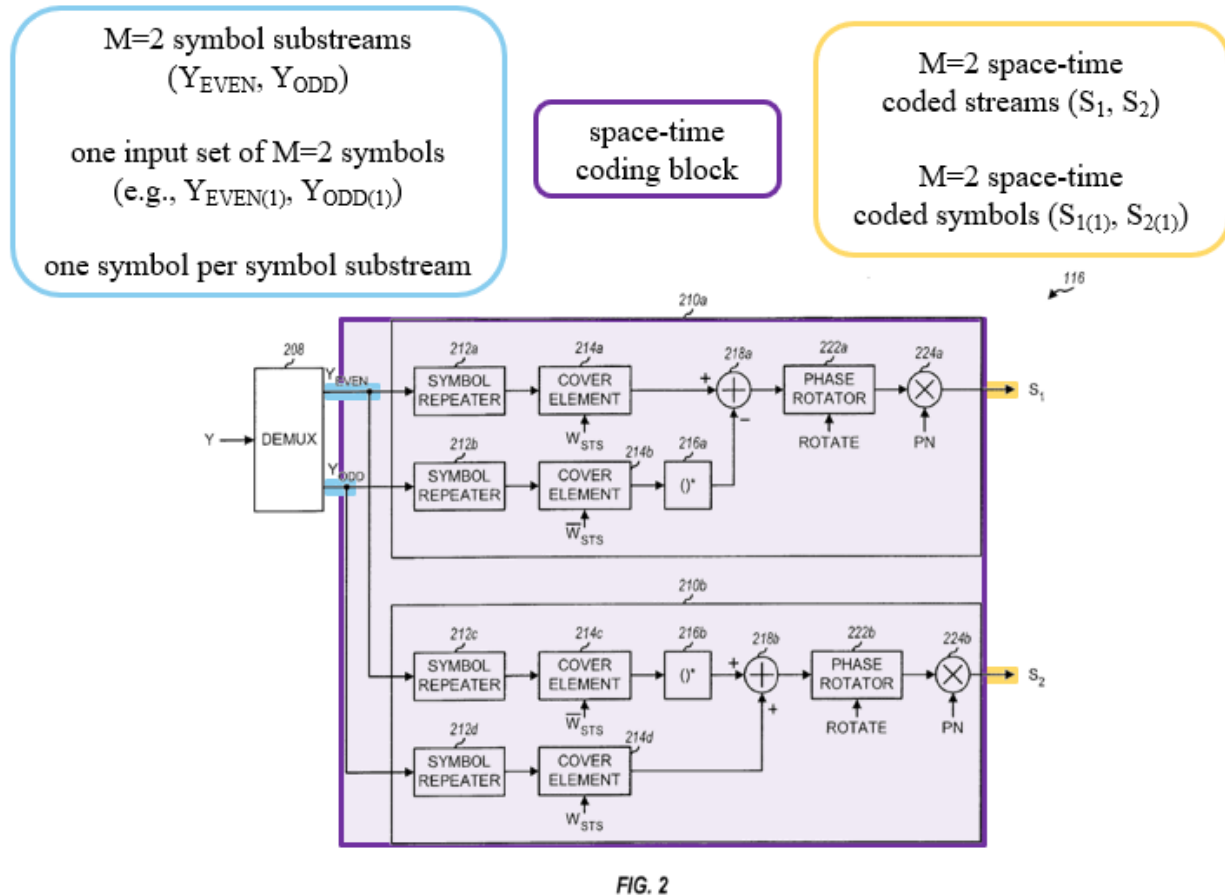


FIG. 2

(Rowitch, FIG.1 and FIG. 2 (annotated); Wilson, ¶173.)

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

Rowitch discloses 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). (Wilson, ¶¶175-178.)

As shown in Eq(4) and Eq(5) of Rowitch, 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 40
(i.e., ignoring the PN spreading, phase rotation, transmit
gain, pulse shaping, and other signal processing), the com-
plex 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 opera-
tion. 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, 7:40-52.) For example, based on the above, for the given time period
T=(1) each symbol $S_{1(1)}$ and $S_{2(1)}$ includes each corresponding substream symbol
 $Y_{EVEN(1)}$ and $Y_{ODD(1)}$:

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

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

(Wilson, ¶¶176-177.)

- 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])**

Rowitch in view of Paulraj renders obvious that the transmitter comprises a
delay arrangement (Delay 1 and Delay 2 are obvious to add based on Paulraj),
arranged such that for each symbol of the M symbol substreams (each symbol of the
two substreams Y_{EVEN} and Y_{ODD} , such as $Y_{EVEN(1)}$ and $Y_{ODD(1)}$) 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 cause $S_{1(1)}$ and $S_{2(1)}$, which each contain $Y_{EVEN(1)}$ and $Y_{ODD(1)}$, to be transmitted at different times from each antenna and therefore $Y_{EVEN(1)}$ and $Y_{ODD(1)}$ are transmitted at different times from each antenna). (Wilson, ¶¶179-186.)

Petitioner has argued 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.) PO has argued this limitation is broader and includes additional forms of delays such as phase delays. (*Id.*) Rowitch in view of Paulraj discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies PO’s broader construction.

Rowitch discloses space-time diversity but does not disclose delay diversity. Paulraj, however, teaches including a time delay in each diversity branch to “improve the effect of diversity as well as reduce the overhead resulting in a higher throughput.” (Paulraj, 7:62-67.) Paulraj further teaches it is beneficial to include delay diversity “when there is considerable fading (low K-factor) and delay spread in the channel.” (Paulraj, 2:29-31.) As shown in FIG. 1, Paulraj teaches adding a

delay that delays the groupings of symbols prior to digital-to-analog conversion and then transmission:

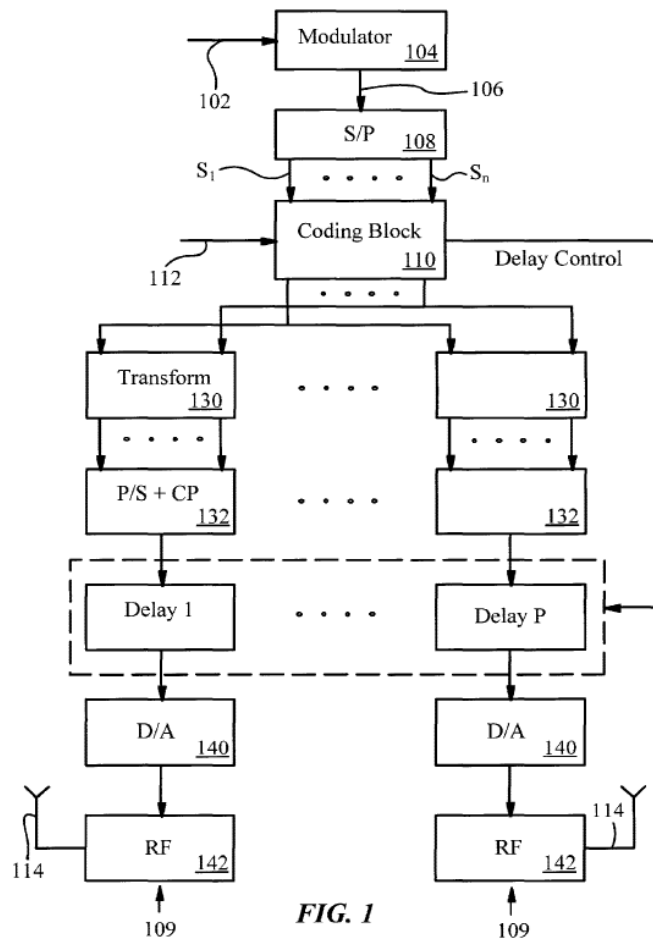


FIG. 1

(Paulraj, FIG. 1.)

Paulraj teaches “[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted.” (Paulraj, 4:65-5:5.) The amount of delay can be controlled by coding block 110 based on feedback regarding the channel length if available. (Paulraj, 7:57-61.)

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

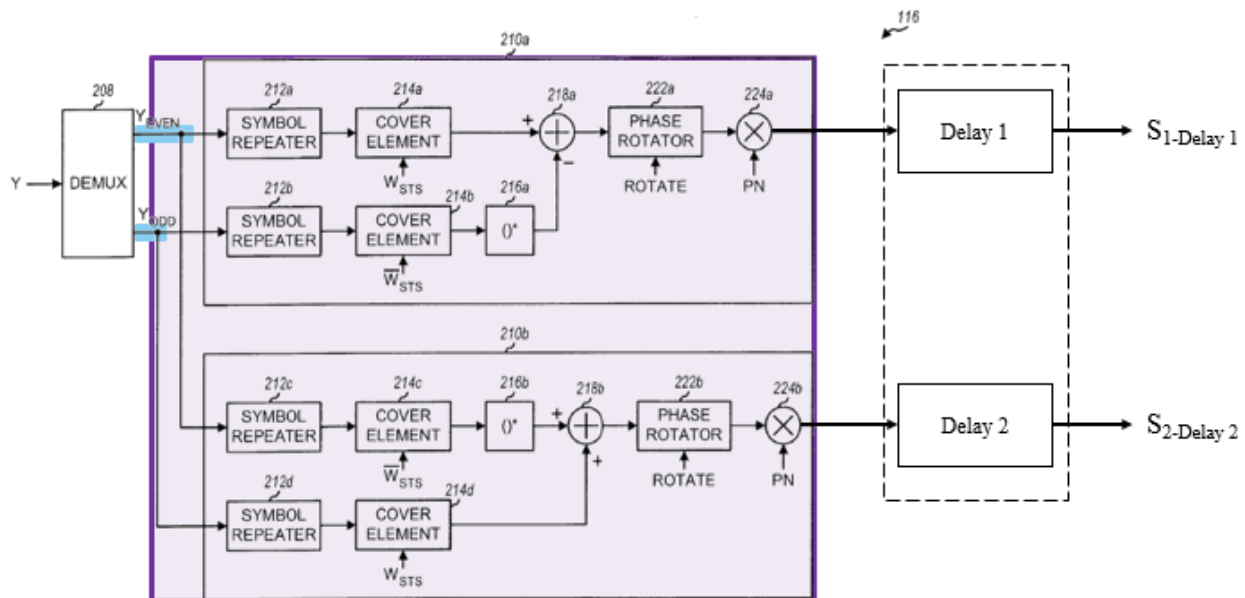


FIG. 2

(Rowitch, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj, FIG. 1 (Delay 1...Delay P); Wilson, ¶¶181-183.) In the figure above, a delay is shown for each diversity path. A POSITA 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.

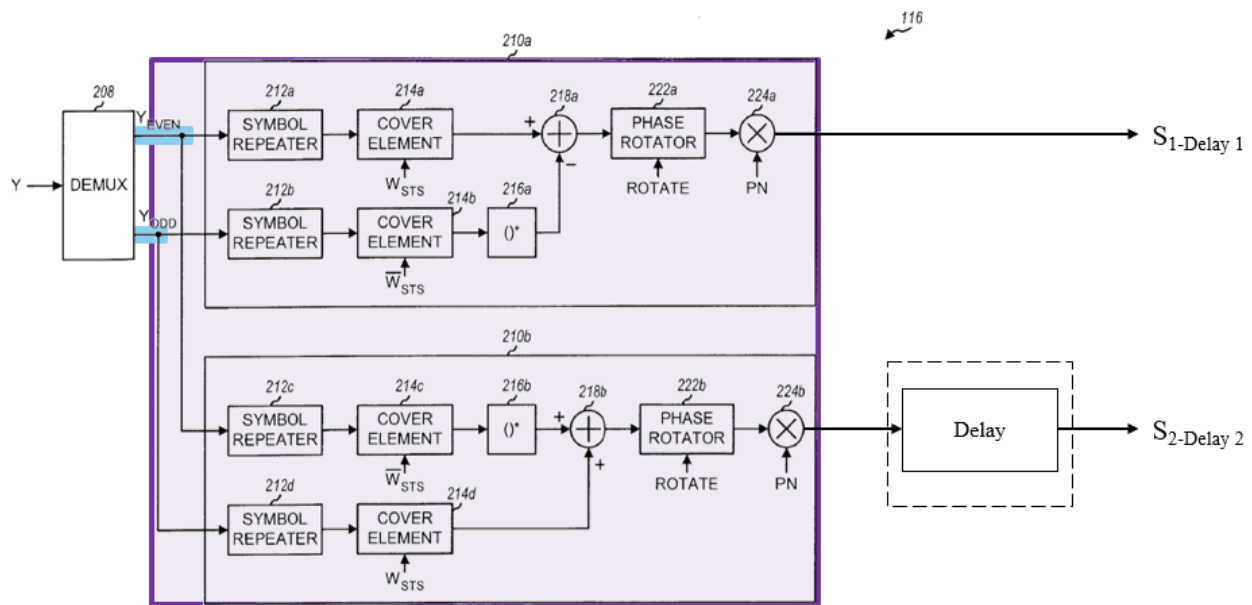
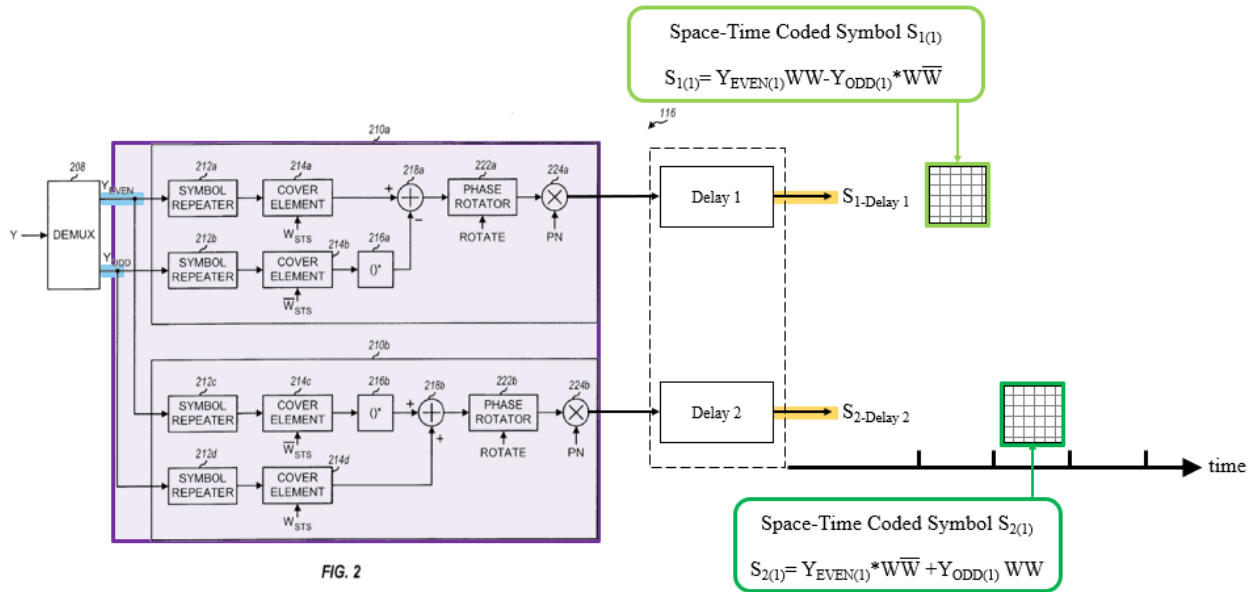


FIG. 2

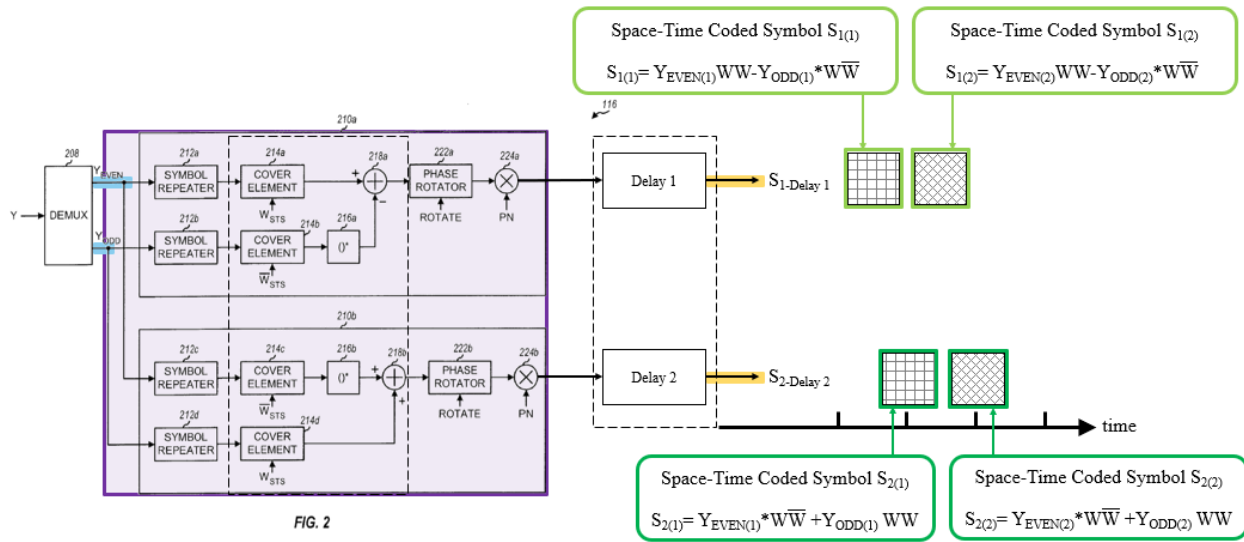
(Rowitch, FIG. 2 (annotated to add a delay as taught by Paulraj, FIG. 1); Wilson, ¶183.)

In accordance with Paulraj's disclosure that "[e]ach of the P delays imposes a particular, unique amount of delay on the symbols being transmitted," (Paulraj, 5:1-2), a POSITA would understand that Delay 1 and Delay 2 would cause the symbols in stream S_2 to be delayed as compared to the symbols in stream S_1 (or vice versa). (Wilson, ¶184.) Using the example above for the given time period $T=(1)$, a POSITA would understand that the "unique amount of delay" taught by Paulraj would results in symbols $S_{1(1)}$ and $S_{2(1)}$ being transmitted at different times. (*Id.*) 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 (S_1 and S_2) that is different:



(Rowitch, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols); Wilson, ¶184.) In the above example, Delay 2 causes a full space-time coded symbol delay as compared to Delay 1. As taught by Paulraj, however, a POSITA would understand that the amount of delay may vary. (Wilson, ¶185 (citing Paulraj, 4:66-5:5).) Accordingly, 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, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols); Wilson, ¶185.) Either example 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.

Motivation to Combine Rowitch and Paulraj: Both Rowitch and Paulraj teach diversity transmit-receive methods and devices. (Rowitch, 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, Abstract (“A method and apparatus for wireless transmission of a digital bit stream. The present method employs diversity techniques to minimize multipath fading.”).)

Rowitch and Paulraj teach similar methods and devices such that a POSITA 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. (Wilson, ¶187.)

In both Rowitch and Paulraj, signals are space-time coded and then converted from digital to analog prior to transmission. (Wilson, ¶189 (citing Rowitch, 4:41-43 and 5:43-47; and Paulraj, Title and 8:28-33).) Paulraj adds to the methods and devices in Rowitch by further teaching that it may be beneficial to add a time delay to each diversity branch. (Wilson, ¶190 (citing Paulraj, 4:66-5:5).) Paulraj discloses that controlling the time delay using information about the channel characteristics can improve the effect of diversity. (Paulraj, 7:63-67.) For example, Paulraj teaches that delay diversity is particularly suitable when there is considerable fading and delay spread in the channel. (Paulraj, 2:25-31.)

Those skilled in the art encouraged the combination of space-time diversity (as in Rowitch) and delay diversity (provided by Delays 1-P in Paulraj) to improve the performance of wireless communication systems. (*See, e.g.*, EX1032, Abstract, 2:74-57; EX1003, pp.001-02 (“When possible, cellular systems should be designed to encompass all forms of diversity to ensure adequate performance[.]”); EX1033, 7:20-40 (teaching symbol delay can be used with space-time coding); EX1030,

p.002 (teaching combination of delay and spatial diversity); EX1026 (Schilling), FIG. 5, 4:27-34, 12:10-57.) Indeed, using delay diversity with a CDMA system (such as Rowitch) had been well-known since at least the early 1990s. (EX1028, p.006.) And multiple antenna CDMA systems (such as Rowitch) 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. (Wilson, ¶192.)

Moreover, Paulraj teaches using time delays with space-time coded symbols to improve diversity for Rayleigh fading channels. (Paulraj, 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. (Wilson, ¶193 (citing EX1024, p.005).) 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 and applies to Rowitch. (Wilson, ¶193.)

Based on the teachings in Paulraj, a POSITA would have had every expectation of success in adding the time delays to Rowitch. (Wilson, ¶194.) Rowitch teaches modulator 116 transmits in “a Space-Time Spreading transmit diversity mode in accordance with the CDMA-2000 standard” (Rowitch, 5:43-47) and Paulraj teaches that its techniques apply to CDMA based systems. (Paulraj,

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.”).)

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

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

Accordingly, a POSITA would have found it obvious to combine, and would have been motivated to combine, the teachings of Rowitch and Paulraj because it merely involves using the known technique from Paulraj (of adding delays to each diversity branch) to improve the known device in Rowitch (a diversity transmitter) in the same way (improving the effect of diversity, including for Rayleigh conditions). (Wilson, ¶197.)

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

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

Rowitch 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 $Y_{\text{ODD}(1)}$). (Wilson, ¶¶199-202.)

Rowitch teaches 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} . For example, based on the 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 $Y_{\text{ODD}(1)}$:

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

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

tch, Eq(4) and Eq(5) (modified for $T=(1)$); Wilson, ¶¶200-201.)

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

Rowitch 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)). (Wilson, ¶¶203-205.)

Rowitch teaches each of the $M=2$ space time coded streams S_1 and S_2 are transmitted over a respective antenna. (See, e.g., Rowitch, 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”); Wilson, ¶204.) For example, Rowitch FIG. 1 shows that two antennas (120a, 120b) can be used:

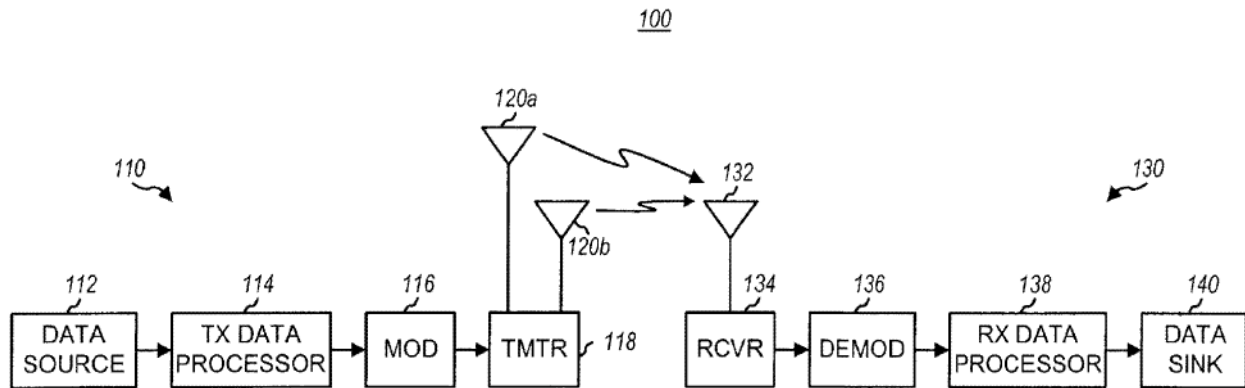


FIG. 1

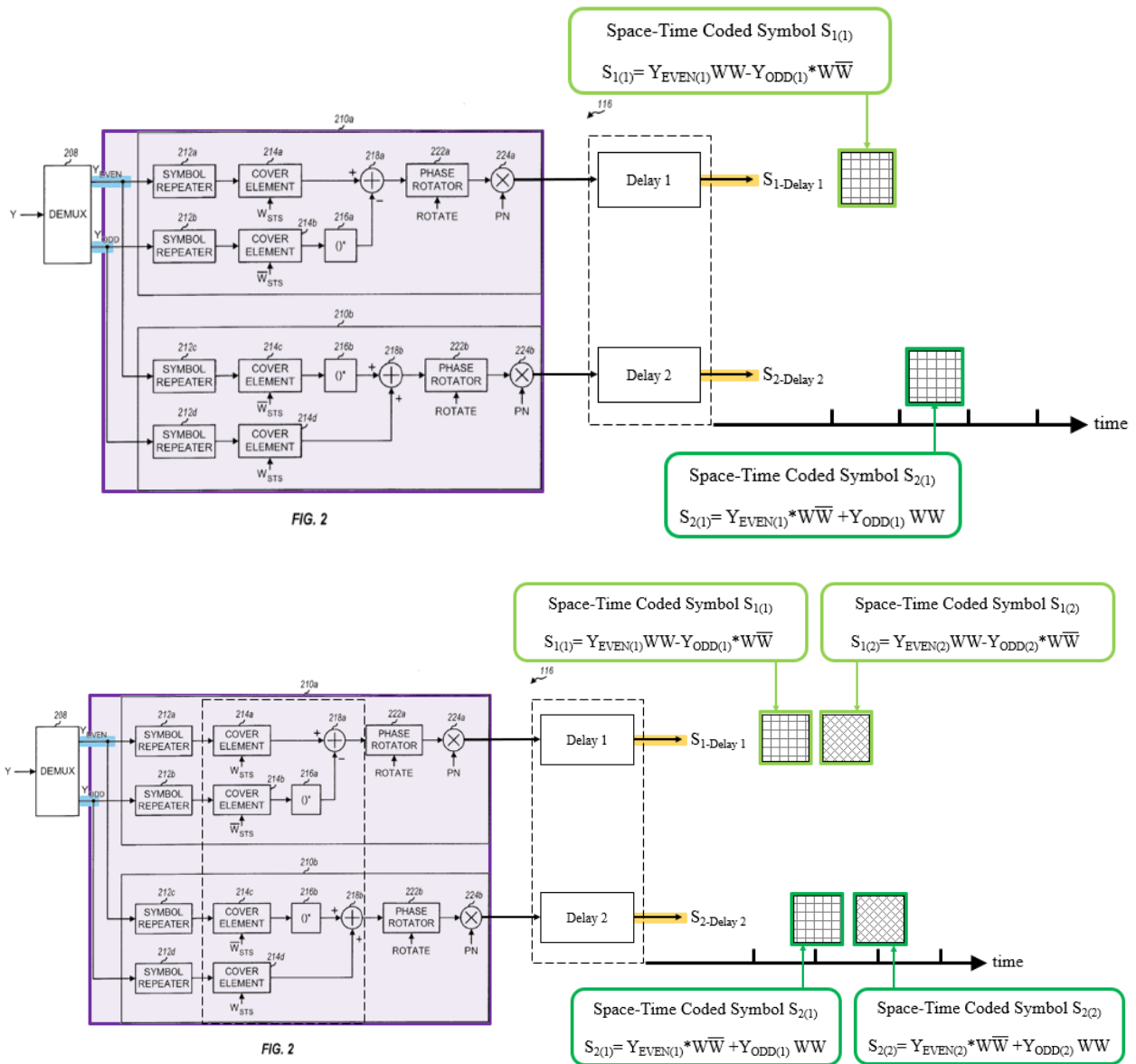
(Rowitch, FIG. 1.)

- 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])**

Rowitch in view of Paulraj 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). (Wilson, ¶¶206-208.)

As set forth above, a POSITA would have considered it obvious to add delays to each diversity branch in Rowitch to “improve the effect of diversity” (Paulraj, 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 different times:



(Rowitch, FIG. 2 (annotated to add Delays 1 and 2 as taught by Paulraj, FIG. 1 (Delay 1...Delay P), and further annotated to show timing of space-time coded symbols); Wilson, ¶207.)

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 in view of Paulraj

Rowitch in view of Paulraj 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). (Wilson, ¶¶209-212.)

Rowitch teaches that traffic data is sent to “transmit (TX) data processor 114 that formats, encodes, and processes the data” prior to modulator 116. (Rowitch, 4:34-43.) Rowitch teaches 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, 5:46-51.)

A POSITA, 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. (Wilson, ¶211.) It was furthermore well-known in the art that when parallel streams are desired (such as in Rowitch) it would be obvious to either (i) encoded/modulate and then demultiplex (as in Rowitch), or (ii) demultiplex and then encode/modulate. (*Id.* (citing EX1026 (Schilling), FIG. 1 v. 2, 6:1-15, 12:30-57).)

b. Ground 5 – Rowitch in view of Paulraj in further view of Jalali

Rowitch in view Paulraj in further view of Jalali 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). (Wilson, ¶¶213-215.)

Jalali 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):

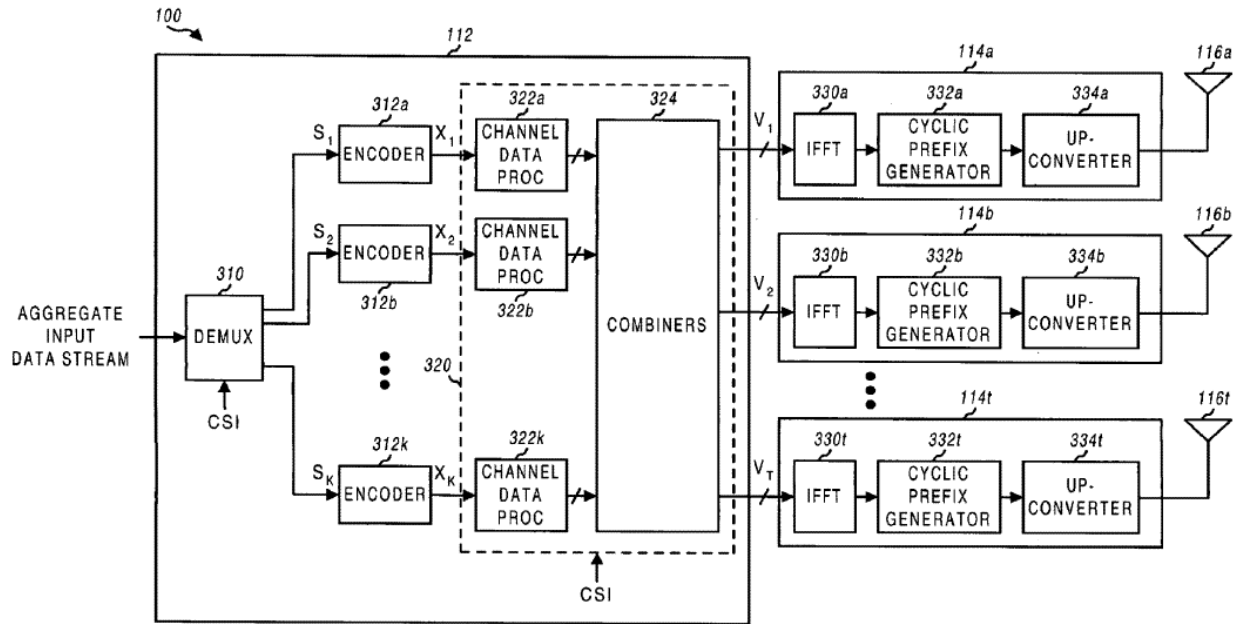


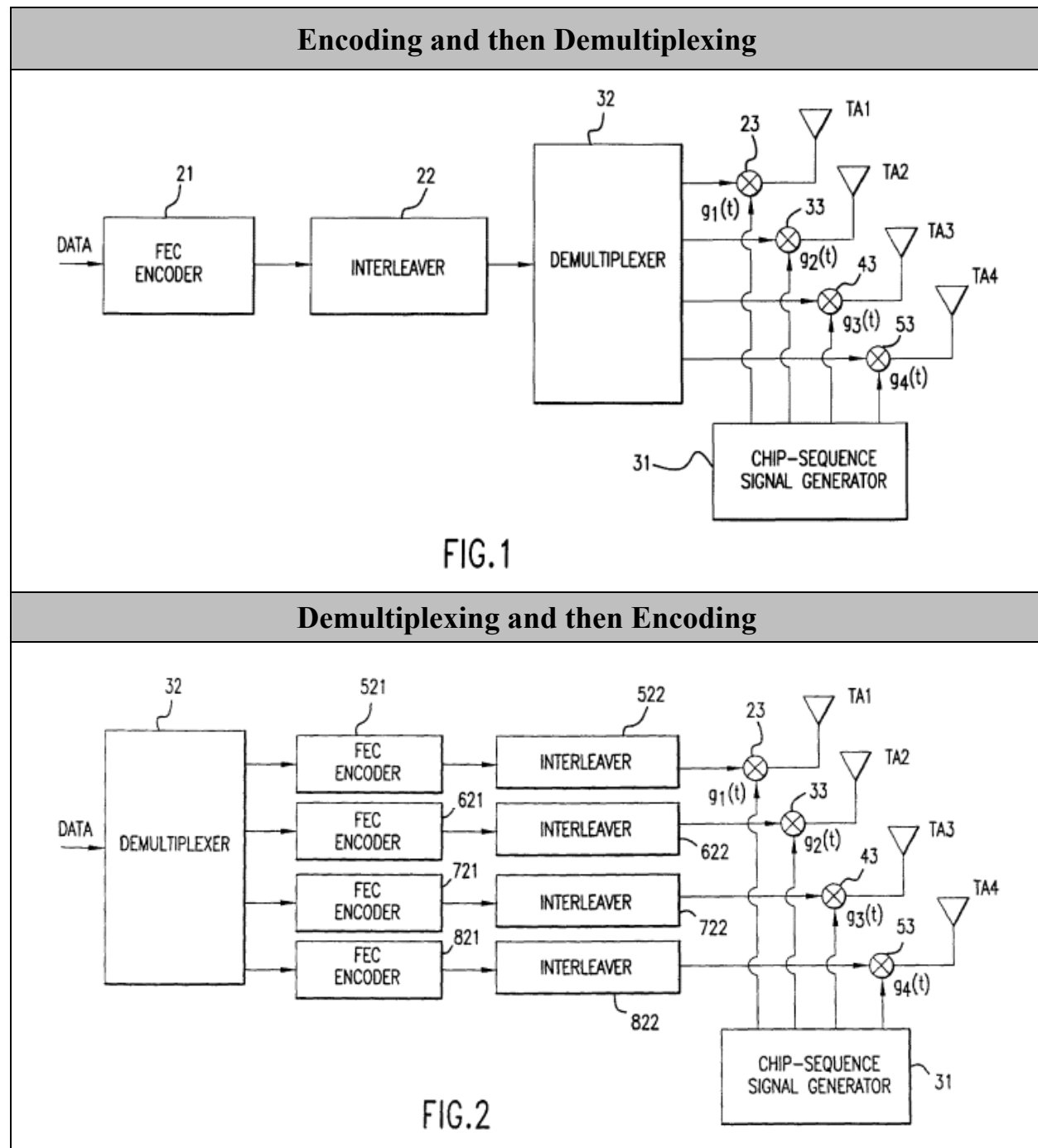
FIG. 3

(EX1027 (Jalali), FIG. 3, 16:23-58.) A POSITA would have understood that substituting (i) the encoding and then demultiplexing design in Rowitch with (ii) a demultiplexer and then encoding design as taught in Jalali, merely involves the simple substitution of one known element for another to obtain predictable results. (Wilson, ¶214.) There is no material difference between (i) encoding and then demultiplexing, and (ii) demultiplexing and then encoding, and a POSITA 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. (*Id.* (citing EX1026 (Schilling), FIG. 1 v. 2, 6:1-15).)

c. Ground 6 – Rowitch in view of Paulraj in further view of Schilling

Rowitch in view Paulraj in further view of Schilling 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). (Wilson, ¶¶216-218.)

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



(EX1026 (Schilling), FIG. 1 v. 2, 6:1-15; *see also id.* at 12:30-57 (confirming another embodiment where demultiplexing is performed prior to encoding); Wilson, ¶217.) Following Schilling's teaching that it is an acceptable alternative to

demultiplex and then encode, a POSITA would have considered it obvious to substitute the encoding and then demultiplexing design in Rowitch with a demultiplexer and then encoding design as taught in Schilling because it merely involves the simple substitution of one known element for another to obtain predictable results. (Wilson, ¶217.) A POSITA 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) showed it was an acceptable design option to demultiplex prior to encoding. (*Id.* (citing EX1027 (Jalali), FIG. 3, 16:23-58).)

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.”

Rowitch in view of Paulraj (Ground 4) and/or Rowitch in view of Paulraj in further view of Jalali (Ground 5), and/or Rowitch in view of Paulraj 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. (Wilson, ¶¶219-223.)

Ground 4: As discussed for Claim 2, it was well-known in the art that when parallel streams are desired (such as in Rowitch) it would be obvious to either (i) encoded/modulate and then demultiplex (as in Rowitch), or (ii) demultiplex and then encode/modulate. (EX1026 (Schilling), FIG. 1 v. 2, 6:1-15, 12:30-57; Wilson,

¶220.) Moreover, it was well-known to a POSITA that the demultiplexing/encoding would be adapted to produce the M symbol substreams from an input stream. (Wilson, ¶220 (citing EX1027 (Jalali), FIGS. 3, 4A, 5A; EX1026 (Schilling), FIG. 1 v. 2).)

Ground 5: In addition, if a POSITA modified Rowitch in view of Jalali (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 teaches the input is an aggregate input data stream:

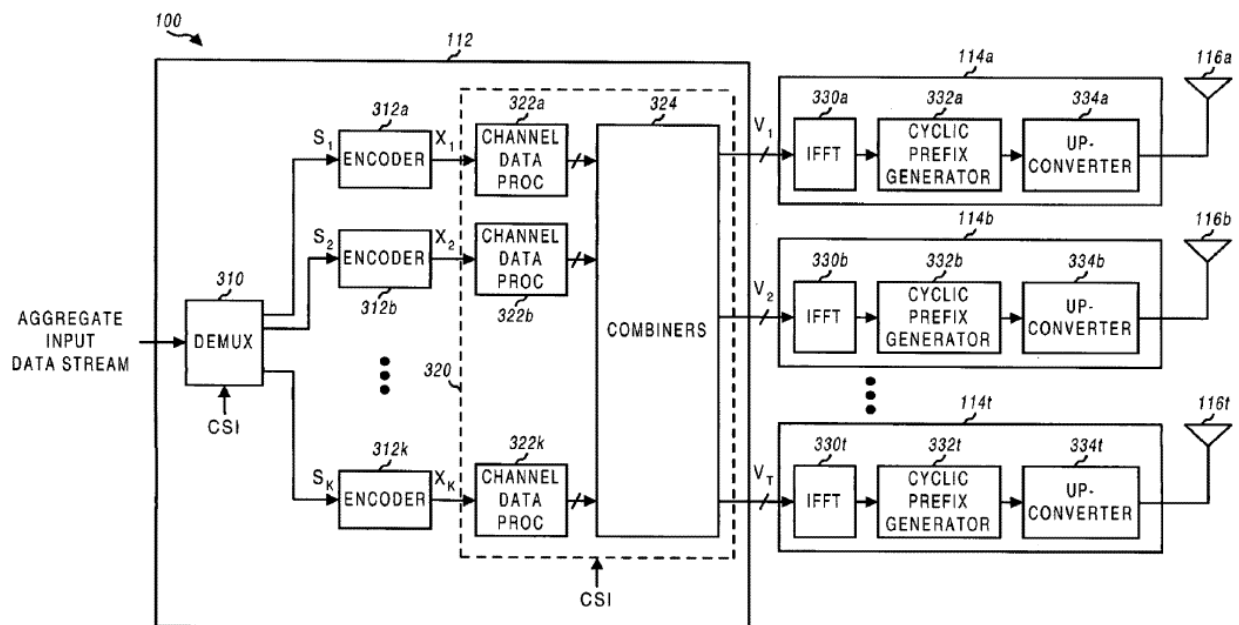
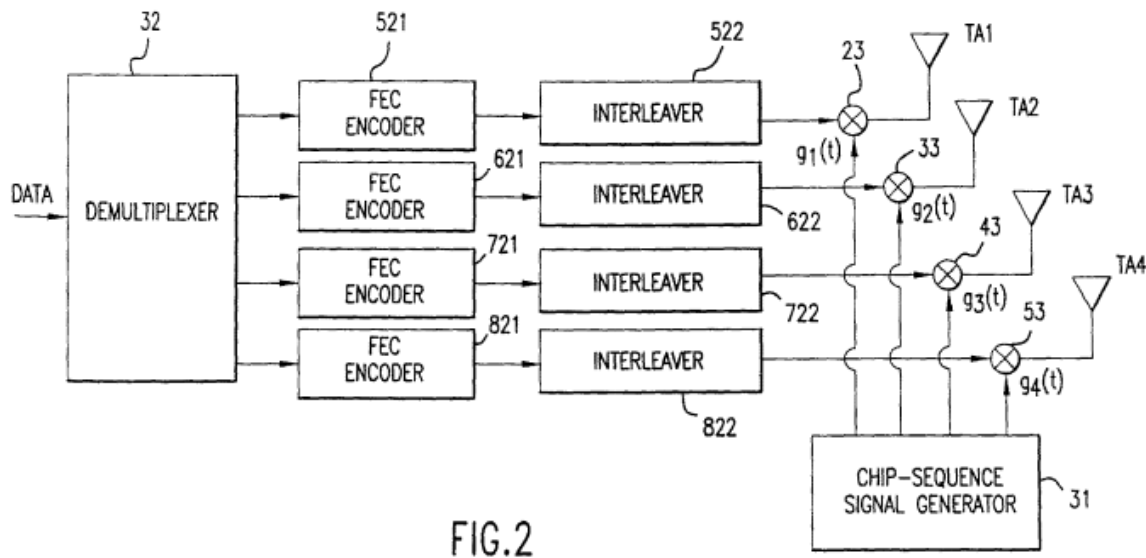


FIG. 3

(EX1027 (Jalali), FIG. 3, 16:23-58; Wilson, ¶221.) And Rowitch teaches generating the two complex streams (Y_{EVEN} and Y_{ODD}) by demultiplexing one data stream. (Rowitch, FIG. 1 and FIG. 2.)

Ground 6: In addition, if a POSITA modified Rowitch in view of Schilling (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 and Schilling teach starting with a single input stream. As shown below, Schilling teaches the input is a single data stream:



(EX1026 (Schilling), FIG. 2; Wilson, ¶222.)

4. Claim 6: (Depending on Claim 1)

Claim 6 is disclosed and rendered obvious by Rowitch in combination with Paulraj (Ground 4), and/or Rowitch in combination with Paulraj in further view of Schilling (Ground 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” (claim 6[a])**

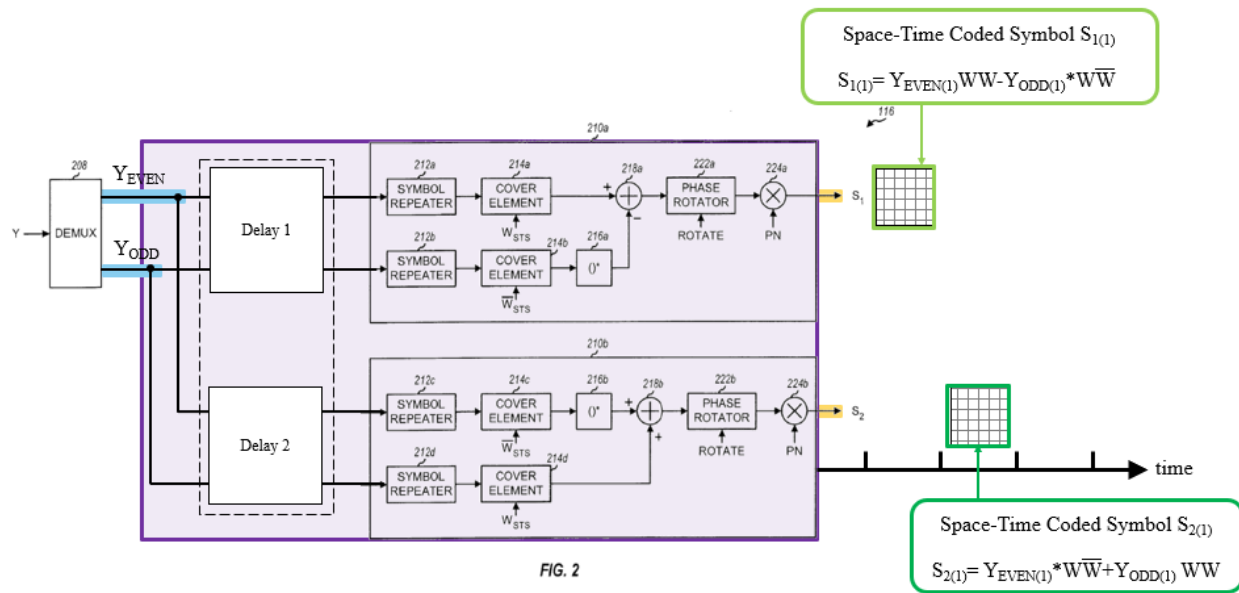
Rowitch in view of Paulraj (Ground 4) and Rowitch in view of Paulraj in further view of Schilling (Ground 6) renders obvious wherein the delay arrangement (Delay 1 and Delay 2 are obvious to add based on Paulraj) comprises: delay elements adapted to insert a delay in at least one of the M symbol substreams (when added before the modulators 210a/b the delays insert a delay in the $M=2$ substreams Y_{EVEN} and Y_{ODD}). (Wilson, ¶¶225-230.)

Petitioner and PO agree that “the M substreams” refers to “the M symbol substreams.” (EX1014.)

Petitioner argued this limitation should be limited to “delay elements adapted to insert a time delay in at least one of the M symbol substreams.” (EX1014.) PO argued this limitation is broader and includes additional forms of delays such as phase delays. (EX1043, ¶44.) Rowitch in view of Paulraj discloses this limitation under Petitioner’s narrower construction, and therefore also satisfies PO’s broader construction.

As discussed for Claim 1, a POSITA would have considered it obvious to add delays to each diversity branch in Rowitch to “improve the effect of diversity[.]” (Wilson, ¶228 (citing Paulraj, 7:62-67).) For purposes of claim 1, the delay elements

were added after modulators 210a/b. However, a POSITA would consider it obvious (and mathematically equivalent) to add the delay elements at the input of modulators 210a/b as shown below:



(Rowitch, FIG. 2 (annotated based on teachings of Paulraj); Wilson, ¶228.) It was known in the prior art to use a configuration where the delay (104) is prior to space-time diversity encoding:

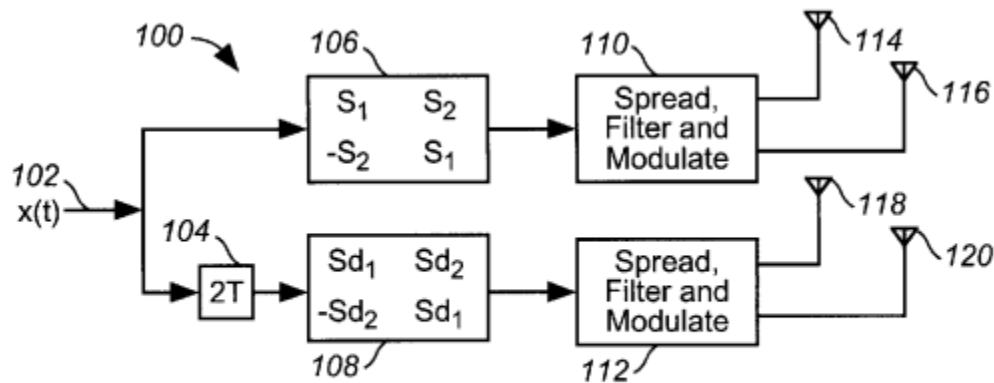


FIG. 1

(EX1032, FIG.1, 4:3-5 (“Offset block 104 causes a 2 symbol period delay[.]”).) A POSITA would understand adding delays prior to modulators 210a/b is mathematically equivalent to adding the delays after modulators 210a/b. (Wilson, ¶228.) For example, as shown 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):

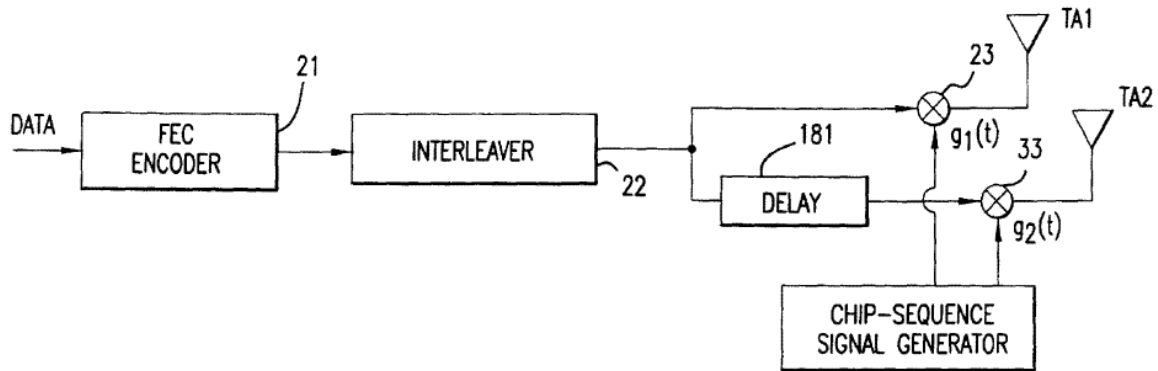


FIG. 4

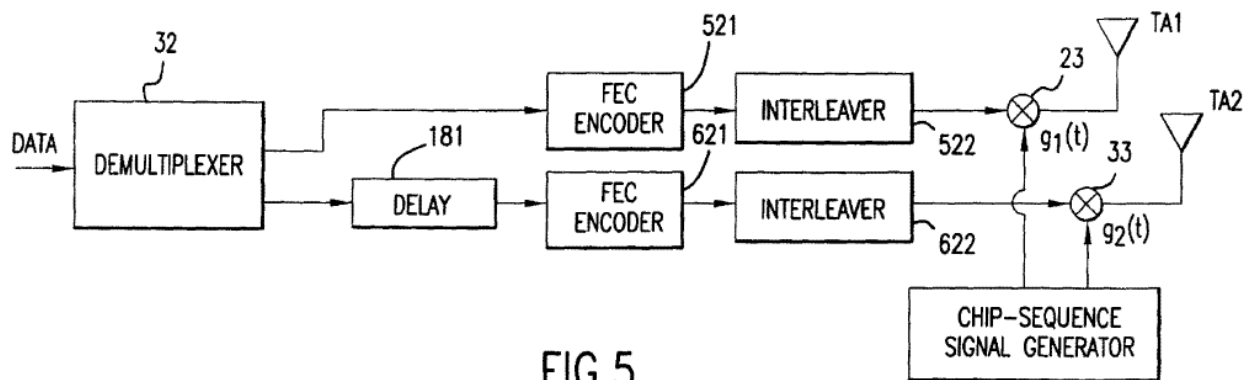


FIG. 5

(EX1026 (Schilling), FIG. 4 v. FIG. 5, 12:30-57; Wilson, ¶228.)

Ground 6: To the extent necessary, it would have been obvious to combine Rowitch and Paulraj with Schilling for this limitation. As discussed above, Schilling teaches that it was a known alternative to place the delay before encoding/interleaving (FIG. 5). Following Schilling's teaching, modifying Rowitch and Paulraj 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. (Wilson, ¶229.)

- 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])**

Rowitch in view of Paulraj (Ground 4) and Rowitch in view of Paulraj in further view of Schilling (Ground 6) renders obvious this limitation. (Wilson, ¶¶231-237.)

Petitioner and PO agree that “the space-time coding function” refers to “the space-time coding block.”

PO argues 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.) 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, this limitation is obvious under either construction.

Rowitch discloses modulators 210 which perform an orthogonal transformation function to produce M orthogonal outputs (S_1 and S_2 are orthogonal outputs). (Wilson, ¶234 (explaining why the vectors $S_1 = Y_{\text{EVEN}}WW - Y_{\text{ODD}}*W\bar{W}$ and $S_2 = Y_{\text{EVEN}}*W\bar{W} + Y_{\text{ODD}}WW$ are orthogonal by construction).)

Under PO’s construction, a POSITA would understand that when Delays 1 and 2 are added to Rowitch (as discussed above), it would be obvious for Delay 1 to not insert any delay. (Wilson, ¶235.) This is because the purpose of Delay 1 and

Delay 2 is to create a difference in time delay between the two diversity branches. (*Id.*) 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. (*Id.*) 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. (*Id.*)

Under Petitioner's construction, a POSITA would understand that when Delays 1 and 2 are added to Rowitch (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. (Wilson, ¶236.) 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. (*Id.*) Indeed, space-time coding prior art at that time encouraged the use of "delays of the order of symbol period." (EX1035, 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. (Wilson, ¶236.) Paulraj 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, 5:3-5.)

Following Paulraj'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. (Wilson, ¶237.) For 3G technologies (such as CDMA-2000 and WCDMA discussed in Rowitch), data rates could vary between 4 chips per bit to 256 chips per bit. (*Id.* (citing EX1044, pp.005-06; EX1045, p.010).) For a chip rate of 3.84 Mchips/s, the symbol period (corresponding to symbols on substreams Y_{EVEN} and Y_{ODD}) would vary from approximately 4 to 64 μs . (*Id.* (citing EX1044, p.005; EX1045, p.010).) 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. (Wilson, ¶237 (citing EX1034, p.002 (reporting urban delay spread from NYC of 1300 ns avg., and urban delay spread for San Francisco of 25 μs ; which further cites EX1038-1041)).)⁵ Accordingly, since the potential symbol periods (4-64 μs) overlaps

⁵ Paulraj discusses delay spread in terms of channel length. (Paulraj, 5:3-5.) A POSITA would understand that an rms delay spread is approximately half of the channel length. To convert (i) rms delay spread to (ii) delay spread in terms of channel length, the rms delay spread is approximately doubled. (Wilson, n.8.) Note

substantially with the practical delay spread (2.6-50 μ s), Paulraj'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. (Wilson, ¶237.) Indeed, when the delay spread is near the symbol period length, a POSITA 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. (*Id.*)

VII. SECONDARY CONSIDERATIONS

There is no objective evidence of non-obviousness that might warrant a finding that the petitioned claims are patentable. Indeed, PO has not identified any secondary considerations evidence.

VIII. CONCLUSION

Petitioner respectfully requests institution of review on claims 1-3, and 6.

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). (*Id.*)

Petition for *Inter Partes* Review of
U.S. Patent No. 7,529,305 B1

Dated: October 8, 2025

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CERTIFICATE OF COMPLIANCE WITH WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), I certify that this petition complies with the type-volume limits of 37 C.F.R. § 42.24(a)(1)(i) because it contains 13,988 words, according to the word-processing system used to prepare this petition, excluding the parts of this petition that are exempted by 37 C.F.R. § 42.24(a) (including the table of contents, a table of authorities, mandatory notices, a certificate of service or this certificate word count, appendix of exhibits, and claim listings).

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CERTIFICATE OF SERVICE

I hereby certify, pursuant to 37 C.F.R. Sections 42.6 and 42.105, that a complete copy of the attached **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 7,529,305 B1**, including all exhibits (**Nos. 1001-1052**) and related documents, are being served via Priority Mail Express on the October 8, 2025, the same day as the filing of the above-identified document in the United States Patent and Trademark Office/Patent Trial and Appeal Board, upon the PO by serving the correspondence address of record with the USPTO as follows:

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And, via Federal Express upon lead counsel of record for the PO in the litigation pending before the U.S. District Court for the Western District of Washington entitled *Malikie, et al. v. Nintendo, et al.*, No. 2:24-cv-01490-JLR (W.D. Wash.) as follows:

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