

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS AMERICA, INC.,
SAMSUNG ELECTRONICS CO., LTD.,
Petitioner,

v.

COLLISION COMMUNICATIONS, INC.
Patent Owner.

Case No. IPR2024-01249
U.S. Patent No. 6,947,505

**DECLARATION OF GIUSEPPE CAIRE REGARDING PATENT
OWNER'S PRELIMINARY RESPONSE FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 6,947,505**

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I, Dr. Giuseppe Caire, hereby declare as follows:

I. Introduction

1. My name is Giuseppe Caire. I have been retained in the above-referenced *inter partes* review proceeding by Collision Communications, Inc., to evaluate United States Patent No. 6,947,505 (the “’505 patent”) against certain references that are presented by the Petitioner. As detailed in this report, it is my opinion that the Petition does not establish that any of the challenged claims are anticipated or rendered obvious by the references presented by the Petitioner. If requested by the Patent Trial and Appeal Board, I am prepared to testify at trial about my opinions expressed herein.

II. Qualifications

2. I have over thirty years of experience in the field of electrical engineering. For the past nine years I have held a Full Professorship and faculty position as the Chair of Communications and Information Theory at Technische Universität Berlin. In my work and research, I have researched and written about Information Theory, Communication Theory and Coding Theory, Wireless Communication Systems, Signal Processing and Statistics.

3. Prior to my appointment at the Technische Universität, Berlin I was a tenured Full Professor at the University of Southern California, Los Angeles from 2005-2016. Although I am currently at the Technische Universität Berlin, I have

retained the title of Adjunct Research Professor at the University of Southern California, Los Angeles since 2016. Prior to my tenure at the University of Southern California, Los Angeles, I spent seven years as a Professor at Eurecom Institute, and held various Assistant Professorships from 1995-1998.

4. I studied Electrical Engineering and received my Ph.D. in 1994 from the Politecnico di Torino, my Master's Degree in 1992 from Princeton University, and my Bachelor of Science Degree in 1990 from the Politecnico di Torino. In addition to my studies at undergraduate and graduate levels and academic qualifications, I have held industrial research positions such as my current role as the Director of the Huawei-TU Berlin Joint Innovation Center, which has a focus on fundamental research in wireless technology.

5. I have authored or co-authored over four hundred publications in the areas of computer networks, and telecommunications. My publication and patents are listed on my curriculum vitae, which is attached hereto as EX2002.

6. In 2021, I was awarded the Leibniz Price, which is awarded to "exceptional scientists and academics for their outstanding achievements in the field of research" and known as the most important research award in Germany. In 2022, I was elected a Member of the Berlin Brandenburg Akademie der Wissenschaften (BBAW). Further, I served as President of the Institute of Electrical and Electronics Engineers (IEEE) Information Theory Society in 2011.

7. I am thanked in the preface of S. Verdu, *Multiuser Detection*, Cambridge University Press 1998, which is submitted by the Petitioner as EX1007.

8. As a result of my background in information and communication theory, I have extensive knowledge regarding the state of the technical art in this area at the time of filing of the '505 patent.

9. I am co-author of an article titled "Bit-Interleaved Coded Modulation" which was published in IEEE Transactions on Information Theory, Vol. 44, No. 3, May 1998 at pp. 927-946. This paper has been cited in other publications over thirty-three hundred (3300) times (Google Scholar).

10. In addition, I am co-author of an article titled "Iterative Multi-User Joint Decoding: Unified Framework and Asymptotic Analysis," which was published in IEEE Transactions on Information Theory 48, No. 7 (2002): 1772-1793. This paper has been cited 409 times, which makes it one of the most referenced papers on turbo multiuser joint decoding. In this paper, we presented the idea of feeding back to the MUD the soft-estimations of the symbols produced by the soft-output decoders and do partial interference cancellation in order to clean up the signal from interfering along the iterations.

III. Materials Considered

11. In preparing this declaration, I have reviewed the specification and claims of the '505 patent (EX1001) and the file history of the '505 patent (EX1002).

I understand the '505 patent was issued on September 20, 2005, from U.S. Patent Application No. 09/943,770.

12. I have also reviewed the Petition, declaration of Dr. Paul S. Min (EX1003) and all publications and exhibits cited in the Petition and declaration of Dr. Paul S. Min including:

- U.S. Patent No. 5,995,499 to Hottinen et al (“Hottinen” EX1004).
- WIPO Publication No. 1994/00918 to Zimmerman et al. (“Zimmerman” EX1005).
- U.S. Patent No. 5,905,946 to Lillebergr et al. (“Lilleberg” EX1006).
- S. Verdu, *Multiuser Detection*, Cambridge University Press 1998 (“Verdu” (EX1007)).
- S. Verdu, “Computational Complexity of Optimum Multiuser Detection,” *Algorithmica* (1989) (EX1008).
- Infringement Contentions – Chart for U.S. Patent No. 7,593,492 (EX1009).

13. I have also reviewed relevant parts of the publications and exhibits cited in this declaration, including the following publications:

- U. Madhow, *Fundamentals of Digital Communication*, Cambridge University Press 2008 (“Madhow” (EX2003));

- R.G. Gallagher, *Principles of Digital Communication*, Cambridge University Press 2008 (“Gallagher” (EX2004)); and
- Markman order (EX2005).

IV. Wireless Communication Background

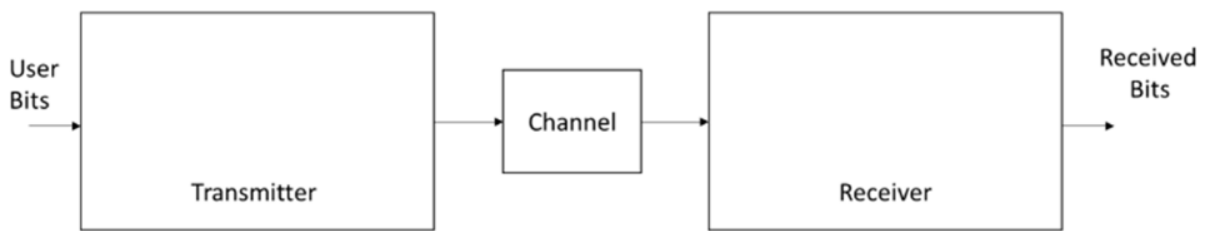
14. The challenged claims generally concern wireless communication systems with multiple, so that the different signals interfere with one another. More specifically, the claims are directed to improved “parameter estimation,” which is to help separate one signal from other interfering signals.

15. To provide context for the claimed subject matter and Samsung’s Petition, the following brief background addresses the following topics:

- wireless channels;
- detectors;
- parameter estimation; and
- prior art parameter estimation approaches.

A. Wireless Channels

16. A wireless communications system typically includes a transmitter that sends information to a receiver over a wireless channel. (EX2003 at 2-4; EX2004 at 1-5, 95, 181-183, 208-209).



17. As illustrated in the above overview, information in the form of bits (sequences of 0s and 1s) is input to the transmitter, which first converts those bits into a high-frequency wave signal and then transmits that signal over the wireless channel to the receiver. (EX2003 at 2-4; EX2004 at 1-5, 95, 181-183, 208-209).

18. This wireless channel is the medium through which the signal is transmitted. For example, in a wireless cell phone communication, the channel could be affected by the relay towers used to transmit the waves and the physical spaces between those towers, including all buildings and other surfaces that may reflect, refract, or absorb parts of the travelling waves.

19. By the channel's very nature, as the electromagnetic wave signal passes through the channel, noise is introduced and information can be lost or corrupted. (EX2001 at XXX; EX2003 at 2-4; EX2004 at 1-5, 95, 181-183, 208-209).

20. Thus, when a receiver receives the electromagnetic signal and attempts to convert it back into bits, the noise must be accounted for and can affect the accuracy of the conversion and reproduction of the original signal. (EX2004 at 1-5, 95, 181-183, 208-209).

B. Detectors

21. Each receiver includes a “detector” that tries to recover the desired transmitted signal. A detector can fall into two categories: (1) single-user detectors or (2) multi-user detectors.

22. Regardless of the number of users or interferers, the goal of a single-user detector is to recover the signal from only a single user. Accordingly, instead of attempting to recover all signals from all users, a single-user detector uses algorithm that focuses on the signal from just one user and treats all other user signals as noise.

23. In contrast, the goal of a multi-user detector is to recover signals from two or more users. Thus, instead of treating and discarding the other user’s signals as noise, a multi-user detector uses an algorithm designed to detect each such signal.

C. Parameter Estimation

24. Parameter estimation is a technique used by detectors to help isolate one signal from other interfering signals. Generally, this technique derives “parameters” which can distinguish the characteristics of each signal regardless of the fact that the signals exist in the same frequency band at the same time.

25. Such individual signal parameters can include the received power, the phase, the timing offset, frequency offset, and the structure of multipath replicas.

26. However, prior art approaches to parameter estimation struggle where these parameters are constantly changing. In the mobile phone setting, for example, the parameters can change with every transmission burst.

27. These parameter changes over time can be further magnified by variations in the physical environment in and from which a signal is sent. To again use mobile phones as the example, mobile phones are just that, mobile. As a result, the location from which they are communicating with a base station can change drastically over time, which again significantly affects signal parameters, including the channel transfer functions.

D. Prior Art Parameter Estimation Approaches

28. Prior art approaches to parameter estimation do not adequately account for and address the dynamic nature of the signal parameters and channel transfer functions. The parameter tracking of prior art systems may have blanks or blackout periods during which some of the simultaneously occurring signals are being ignored or are not being tracked due to the serial nature of the calculation. (EX1001 at 1:53-57). Blank periods or incorrect values of parameters lead to the inability to separate signals, which causes loss of interfering users' information bit sequences. (EX1001 at 3:5-10).

29. This problem is exacerbated in cellular environments where power level adjustments can be made as often as 800 times a second. (EX1001 at 1:63-67).

Not only does this make parameter estimation (and channel estimation) much more difficult, but this also results in invalid parameter estimations due to the power level change at the handset. (EX1001 at 1:65-2:2).

30. As such, prior art systems are not adequate for shared traffic channels with multiple interfering signals in which power level adjustments are frequent. (EX1101 at 1:53-57).

V. The '505 Patent's "Parameter Tracking Unit"

31. In light of the foregoing issues, there was an unmet need for parameter estimation that could reflect what is happening in a real-world scenario and do so in real time. (EX1001 at 5:40-49). The '505 patent discloses and claims just such a parameter estimation unit, one that utilizes an inventive and improved "parameter tracking unit" that allows for parameters to be initially calculated and then consistently updated as they change over time.

32. An example of this parameter tracking unit is outlined in blue in the Petitions' following annotated Figure 3 from the patent:

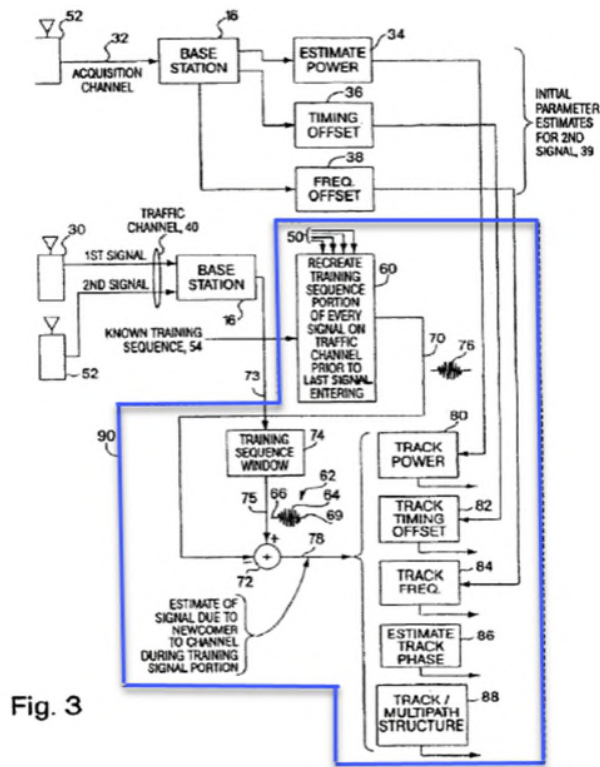


Fig. 3

(Pet. at 21; EX1001 at 7:55-59, Fig. 3).

33. For purposes of this response, three key aspects of this claimed parameter tracking unit are:

- (1) tracking a first signal's parameters (e.g., its power, timing offset, frequency offset, and phase);
- (2) isolating, estimating, and tracking those parameters for each new signal (e.g., each signal to be tracked) in the channel using training sequences, training sequence recreation 60, training sequence window 74, and summing junction 72; and

(3) updating and tracking each signal's estimated parameters in real time by averaging.

A. Initial Parameter Tracking

34. The '505 patent discloses and claims a "parameter estimation unit" that comprises an inventive and improved "parameter tracking unit." For each signal in a channel, the "parameter tracking unit" tracks the signal's (1) power, (2) timing offset, (3) frequency offset, (4) phase, and (5) multipath structure. (*E.g.*, EX1001 at 5:28-33, 6:4-22, 7:22-29, 7:46-8:6). Collectively, these parameters are the "channel transfer function parameters." (*E.g.*, EX1001 at 1:24-32, 5:21-33).

35. When a receiver having this parameter tracking unit initially receives a first signal, it estimates certain parameters of that first signal, namely the signal's power, timing offset, frequency offset, and multipath structure. (*E.g.*, EX1001 at 5:28-33, 5:55-63).

36. The "parameter tracking unit" then begins tracking these parameters, using the parameter' tracking algorithms, including its power tracking algorithm, timing offset tracking algorithm, frequency tracking algorithm, and multipath tracking algorithm. These algorithms are respectively identified at elements 80, 82, 84, and 88 of Petitioner's annotated Figure 3:

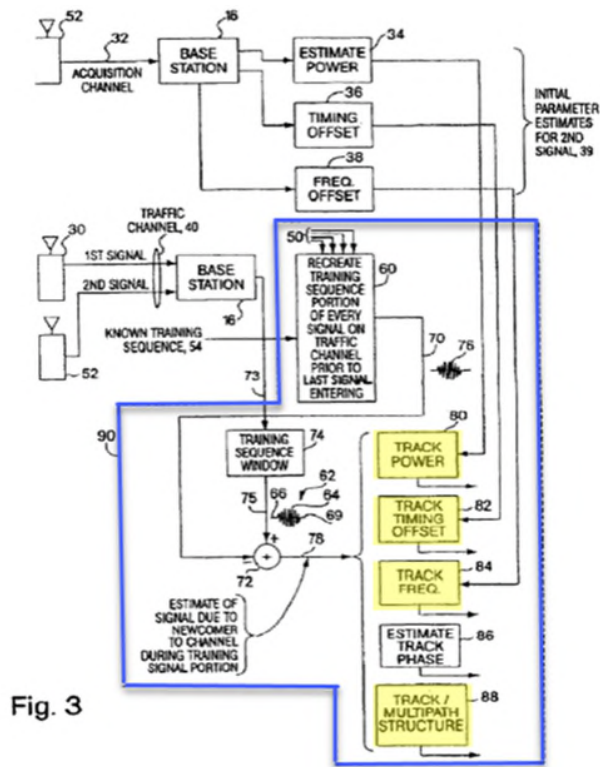
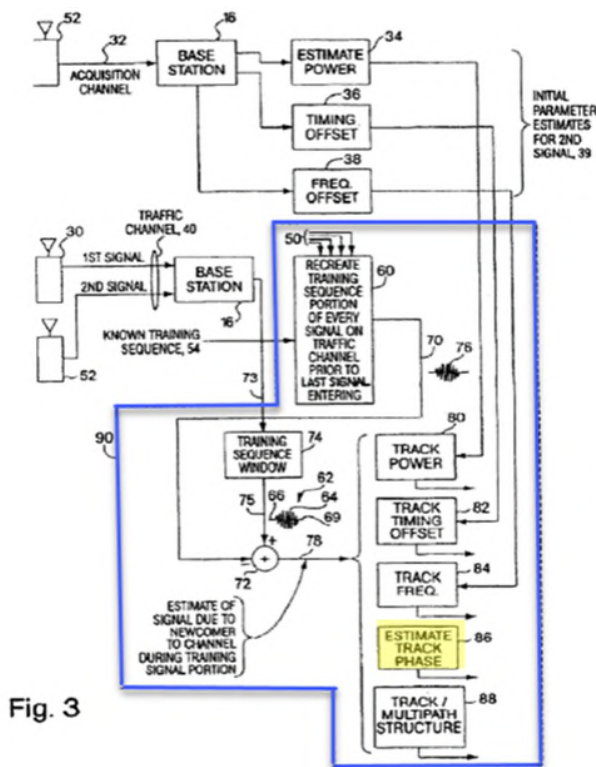


Fig. 3

(Pet. at 21 (highlighting added); EX1001 at 6:4-8, 7:22-29, 7:60-8:6).

37. In addition, the disclosed “parameter tracking unit” also estimates and tracks the signal’s phase, using its unit 86 highlighted below.



(Pet. at 21 (highlighting added); EX1001 at 6:9-22, 7:22-29, 7:60-8:6).¹

B. Training Sequences, Training Sequence Recreation 60, Training Sequence Window 74, And Summing Junction 72

38. After a receiver (such as a mobile device) receives the initial signal, subsequent signals may exist at the same time as the first signal. (*E.g.*, EX1001 at 2:8-32, 5:8-20, 6:23-7:30). The disclosed parameter tracking unit further provides a way to isolate (and then track parameters for) subsequent signals, which it does using:

- training sequences;

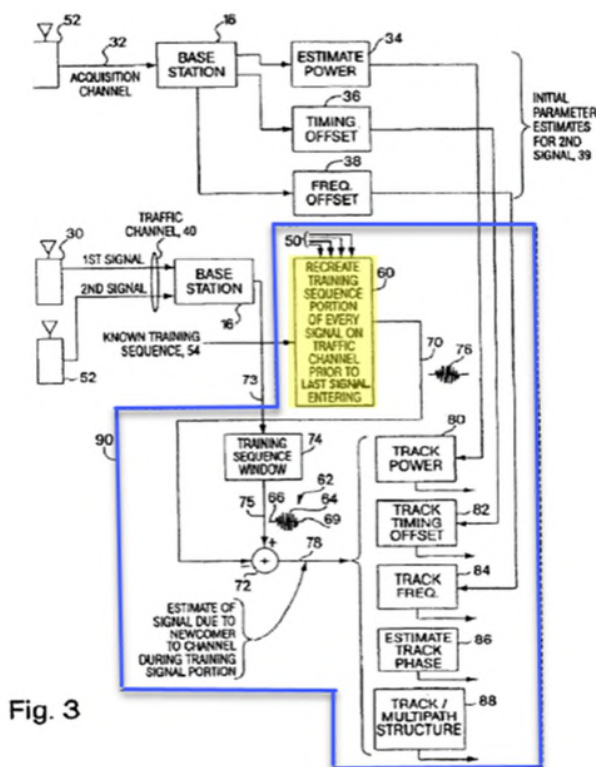
¹ The foregoing algorithms and units are similarly depicted in Figure 2 at blocks 42, 44, 46, 48, and 49. (EX1001 at 4:34-43, 6:3-22, 7:22-29, 7:60-8:6).

- the parameter tracking unit's training sequence recreation 60;
- the parameter tracking unit's training sequence window 74; and
- the parameter tracking unit's summing junction 72.

(*E.g.*, EX1001 at 6:23-7:30).

39. ***Training Sequences:*** Each transmitted signal includes a “training sequence,” that identifies the transmitter and permits communications from the transmitter to the receiver/bases station, and vice versa. (EX1001 at 4:60-5:7). The '505 patent further describes a “training sequence” that includes known bits or a symbol sequence used to obtain estimates of the signal's parameters. (EX1001 at 3:19-25). When a received signal's estimated parameters are tracked as described above, its training sequence may also be stored. (*E.g.*, EX1001 at 6:23-37).

40. ***Parameter Tracking Unit's Training Sequence Recreation Unit 60:*** Recall the scenario described above, where a first signal has been received by the base receiver. When other signals are present with the first signal, the training sequence portions of interfering signals are recreated at the parameter tracking unit's training sequence recreation unit 60:



(Pet. at 21 (highlighting added); EX1001 at 6:38-65).

41. In this simple example, the only signal that was in the channel prior to the second signal entering the channel is the first signal, so only the first signal's training sequence portion is recreated. If there were additional previously processed signals already in the channel, their previously stored training sequences would be added together with the first signal's and recreated at the parameter tracking unit's training sequence recreation unit 60. (EX1001 at 6:53-61).

42. Conversely, since the newly added second signal was not previously in the channel, its training sequence is not recreated at the parameter tracking unit's training sequence recreation unit 60. (EX1001 at 6:46-52).

43. ***Parameter Tracking Unit's Training Sequence Windowing Unit 74:***

The training sequence portions of the signals are created by and at the parameter tracking unit's training sequence windowing unit 74:

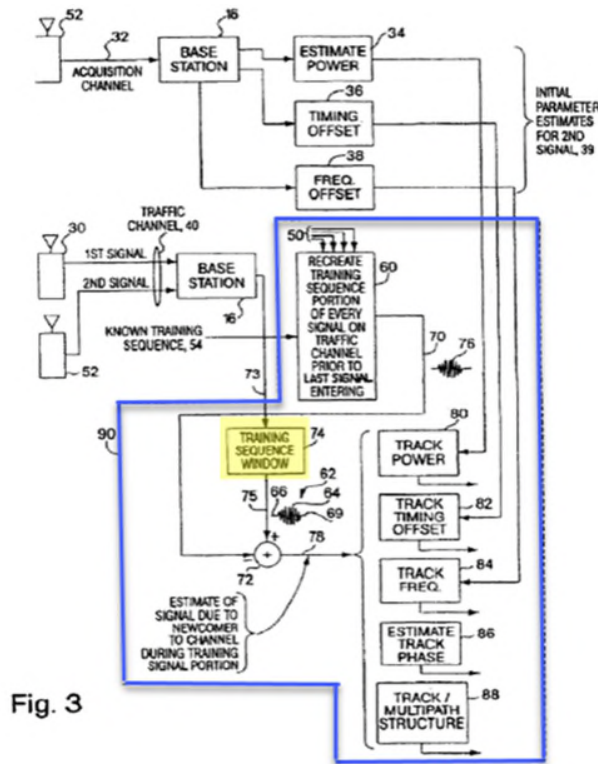


Fig. 3

(Pet. at 21 (highlighting added); EX1001 at 6:66-7:12).

44. In the present simple example, the only signals in the channel are the first and second signals, so the combination of their training sequences would be created at the parameter tracking unit's training sequence windowing unit 74. If additional signals also already existed in the channel, their training sequences would likewise be included. (EX1001 at 6:66-7:12).

45. **Parameter Tracking Unit's Summing Junction 72:** Each of the foregoing collections of training sequence portions is delivered to the parameter tracking unit's summing junction 72:

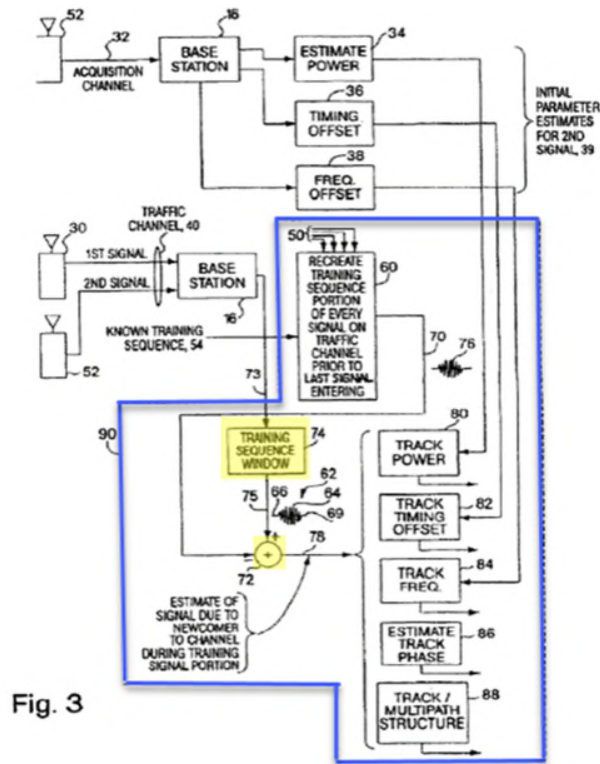


Fig. 3

(Pet. at 21 (highlighting added); EX1001 at 7:10-29).

46. At the summing junction 72, the collection of training sequence portions received from the training sequence recreation unit 60 (the recreated training sequence portions) is subtracted from the collection of training sequence portions received from the training sequence windowing unit 74. (EX1001 at 7:10-22). The result is the estimated training sequence portion for the target signal. (EX1001 at 7:10-22).

47. The parameter tracking unit can then use this isolated training sequence portion to track the foregoing parameters for the target signal. (EX1001 at 7:20-29). The disclosed parameter tracking unit can isolate and track parameters for each signal despite the presence of other interfering. (EX1001 at 7:20-29).

C. Averaging

48. After estimating and tracking each signal's parameters in the foregoing ways, the disclosed parameter tracking unit updates and tracks those estimated parameters in real time by averaging. (*E.g.*, EX1001 at 2:50-67, 7:46-8:9).

49. As the '505 patent describes, a signal's parameters can vary from burst to burst because of, for example, the transmitter's movement in a physical environment and/or constant power level adjustments. (*E.g.*, EX1001 at 1:33-667). To account for this, the '505 patent describes that the parameter tracking unit can estimate and track a signal's parameters. (*E.g.*, EX1001 at 2:57-64, 7:60-8:9). To increase the quality of the estimated parameters, the parameter tracking unit can utilize averaging on the current and previously estimated parameters. (*E.g.*, EX1001 at 2:50-67, 7:60-8:9).

50. This averaging is based on the premise that a weighted average of at least some previously calculated parameters will produce high quality estimates. (EX1001 at 2:50-56). What this means is that, for example, as each burst arrives

and the parameter tracking unit performs a parameter estimation on each burst, the weighted average produces better estimates. (*E.g.*, EX1001 at 2:50-67, 7:60-8:9).

VI. The Petition Should Be Denied Because Each Asserted Ground Fails To Establish The Required Reasonable Likelihood Of Success

51. I understand that Samsung’s Petition asserts the following Grounds:

Ground	References	Basis	Challenged Claims
1	<i>Hottinen</i> and <i>Lilleberg</i>	§ 103	1, 3, 4, 5, 7, 8, and 9
2	<i>Zimmerman</i> and <i>Lilleberg</i>	§ 103	1, 3, 4, 5, 7, 8, and 9

52. I understand that the primary reference relied upon in Ground 1 is *Hottinen*, and *Zimmerman* is the primary reference relied upon in Ground 2. The secondary reference relied upon in both Grounds is *Lilleberg*. As discussed below *Lilleberg* does not disclose the claimed parameter tracking unit.

A. All Asserted Claims Require The ‘Estimates Means’

53. I understand that each Ground challenges the same claims: independent claim 1 (and its dependent claims 3, 4, 5, 7, 8) and independent claim 9.

54. I further understand that each challenged claim is directed to a “parameter estimation unit” that includes a “means . . . for providing uninterrupted estimates of the channel transfer function parameters on a real time basis . . .” (*E.g.*, EX1001 at claims 1 and 9). For example, this limitation is present and bolded in the exemplary claim 1:

1. In a multi-user detection system in which interfering signals are purposely allowed to exist, a parameter estimation unit for use in conjunction with a signal separation unit, in which each received signal has associated channel transfer functions, comprising:

a signal processor for determining said channel transfer functions for each received signal; and,

means coupled to said channel transfer function determining signal processor **for providing uninterrupted estimates of the channel transfer function parameters on a real-time basis** by first deriving the estimated channel transfer function for each of said interfering signals.

55. (EX1001 at claim 1, *see also* claim 9 at 14:8-12).

B. Construction Of The Claimed ‘Means’

1. Petitioner Concedes That The Claimed ‘Means’ Should Be Construed Under 35 U.S.C. § 112, ¶ 6

56. I understand Petitioner asserts that the claimed “means” is a means-plus-function limitation. (*E.g.*, Pet at 15-22). In this declaration, I am applying this construction, but I have no opinion whether the Petitioner’s assertion correct or not.

2. Petitioner Concedes That The Corresponding Structure Is The “parameter tracking unit” Described In The ’505 Patent

57. I understand when correctly construed, a mean-plus-function limitation covers the corresponding structures disclosed in the specification for performing the claimed functions, and equivalents thereof. *Williamson*, 792 F.3d at 1351. I further understand that a structure disclosed in the specification is a corresponding structure

if the specification links or associates the structure to the function recited in the claim. *Id.* at 1352.

58. Here, I understand Petitioner concedes that the corresponding structure is the “parameter tracking unit” described in the ’505 patent. (*E.g.*, Pet. at 15-22; EX1001 at 5:20-40, 6:9-23, 7:45-8:40, FIGs. 1, 3-4). (Indeed, the entire Petition is premised upon this construction and provides no alternative theories or grounds under any other constructions. Therefore, if the corresponding structure is not the described “parameter tracking unit” as Petitioner concedes and alleges, the Petition has no remaining grounds and should be denied for that reason alone.)

59. ***Training Sequence Recreation Unit 60, Training Sequence Windowing Unit 74, and Summing Junction 72:*** I understand Petitioner also alleges that this corresponding structure includes the parameter tracking unit’s Training Sequence Recreation Unit 60, Training Sequence Windowing Unit 74, and Summing Junction 72. (*See, e.g.*, Pet. at 20-22). For example, Petitioner annotated Figure 3 with a blue box as reproduced below, arguing that the blue box identifies the “parameter tracking unit” that is the relevant corresponding structure. As depicted and annotated by Petitioner, this corresponding structure encompasses and includes the parameter tracking unit’s Training Sequence Recreation Unit 60, Training Sequence Windowing Unit 74, and Summing Junction 72.

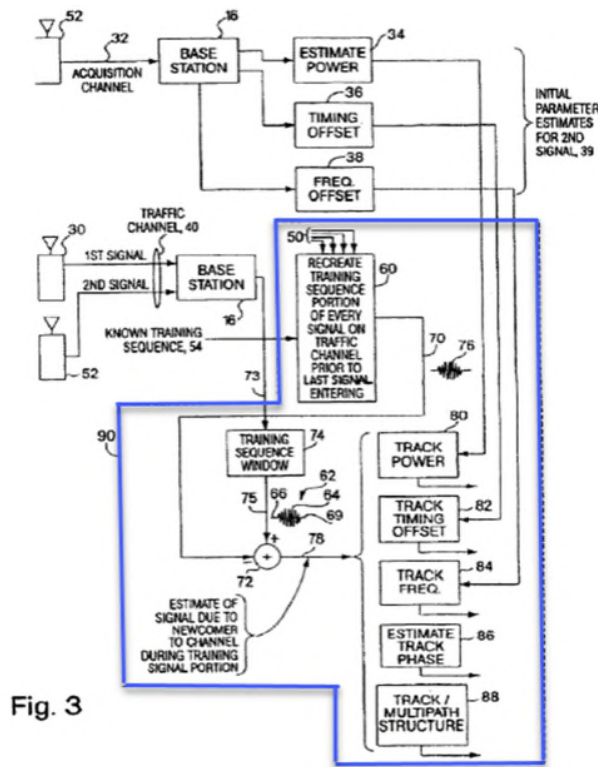


Fig. 3

(Pet. at 21; EX1001 at 7:55-59, Fig. 3).

60. And Petitioner's annotation and admission is consistent with the '505 specification, which describes the "parameter tracking unit" as "including all of the elements [in] dotted box 90" in Figure 3. (*E.g.*, EX1001 at 7:55-59). These elements include each of the Training Sequence Recreation Unit 60, Training Sequence Windowing Unit 74, and Summing Junction 72. (*E.g.*, EX1001 at Fig. 3, 6:39-7:21, 7:55-59).

61. Indeed, as established above (and consistent with Figure 3 and Petitioner's admissions), the patent describes that the parameter tracking unit features and uses each of the Training Sequence Recreation Unit 60, Training

Sequence Windowing Unit 74, and Summing Junction 72 to perform part of the claimed function, e.g., to estimate channel transfer function parameters for each of the interfering signals.

62. The patent also describes that the parameters could be tracked either conventionally or by “tracking the entire channel transfer function from a known transmitted signal where the separate estimation of the power, timing offset, phase, frequency offset, and multipath structure is not necessary.” (*E.g.*, EX1001 at 6:9-22).

63. **Averaging:** When identifying which specification language describes the “parameter tracking unit” corresponding structure, Petitioner identifies and cites 7:45-8:40 (Pet. at 20-22), wherein the specification describes the parameter tracking unit 90 as averaging the currently determined parameter estimate with the older parameter estimates: “Having thus calculated an interference free signal, the parameter estimates are calculated again as shown in FIG. 3 and averaged with older parameter estimates for this user as described in the FIG. 3 discussion above.”

64. And even absent Petitioner’s admissions, the described averaging is a necessary part of the corresponding structure. The claimed function does not merely recite providing estimates of the channel transfer function parameters, it recites “providing **uninterrupted** estimates of the channel transfer function parameters **on a real time basis.**” The foregoing “averaging” is how the patent describes the

parameter tracking unit providing uninterrupted estimates of the channel transfer function parameters on a real-time basis, and this requirement cannot be read out of the claimed function or its identified corresponding structure.

C. Each Ground Fails To Identify The Described “parameter tracking unit”

65. I understand each Ground relies solely on the *Lilleberg* reference as supposedly disclosing the disclosed “parameter tracking unit.” (*E.g.*, Pet. at 38, 63). But the Petition identifies no such “parameter tracking unit” in *Lilleberg*. Instead, the Petition simply asserts that *Lilleberg* discloses the “parameter tracking unit” described in the ’505 patent, without saying or showing how. (*E.g.*, Pet. at 38, 63).

66. For example, although the Petition admits the described “parameter tracking unit” includes (and to perform the claimed function, requires) its Training Sequence Recreation Unit 60, Training Sequence Windowing Unit 74, and Summing Junction 72, the Petition does not allege that any of these components—much less all of them—are disclosed in *Lilleberg*. (*E.g.*, Pet. at 38, 63). It cannot because *Lilleberg* is silent to such features; indeed, *Lilleberg* does not even mention training sequences.

67. Likewise, although the ’505 patent describes the disclosed “parameter tracking unit” as using averaging the parameter estimates in real time—and the

Petition cites to that description as describing the claimed parameter tracking unit—the Petition does not even allege, much less prove that the purported *Lilleberg* parameter tracking unit features such averaging. (*E.g.*, Pet. at 38, 63)

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

Dated: November 14, 2024



Dr. Giuseppe Caire