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. IPR2025-00011
U.S. Patent No. 7,920,651

DECLARATION OF GIUSEPPE CAIRE REGARDING PATENT OWNER'S PRELIMINARY RESPONSE FOR *INTER PARTES REVIEW* OF U.S. PATENT NO. 7,920,651

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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. 7,920,651 (the "'651 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 Berline 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 EX1012.

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 ’651 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 ’651 patent (EX1001) and the file history of the ’651 patent (EX1002).

I understand the ’651 patent was issued on April 5, 2011, from U.S. Patent Application No. 12/491,332.

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. 6,931,052 to Fuller et al (“Fuller” EX1004).
- U.S. Patent No. 6,724,809 to Reznik (“Reznik” EX1005).
- U.S. Patent Pub. No. 2003/0035469 to Frank et al. (“Frank” EX1006).
- Zha et al., “Soft-Decision Successive Interference Cancellation CDMA Receiver with Amplitude Averaging and Robust to Timing Errors,” in Proc. IEEE Global Telecommunications Conference, 2001 (GLOBECOM ’01), vol. 2, 2001, pp. 743-747 (EX1010).
- S. Verdu, “Computational Complexity of Optimum Multiuser Detection,” Algorithmica (1989) (EX1011).
- S. Verdu, *Multiuser Detection*, Cambridge University Press 1998 (“Verdu” EX1012).
- Shimon Moshavi, “Multi-User Detection for DS-CDMA Communications,” in IEEE Communications Magazine, Oct. 1996, pp. 124-136 (EX1013).

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

IV. Background Technology for the Claimed Iterative Amplitude Estimations

14. The '651 Patent generally concerns wireless communication systems comprising a wireless channel that includes not just one, but multiple transmitted signals. (*E.g.*, EX1001 at 1:53-63). The patent discloses multiple improved devices and methods for detecting a signal transmitted from one user among other interfering signals sent from other users (e.g., interference cancellation). (*E.g.*, EX1001 at 8:58-9:6, 9:65-10:11). The challenged claims concern such improved devices and methods, ones that may be used to help separate one signal from other interfering signals using iterative amplitude estimates. (*E.g.*, EX1001 at claims 1 and 6).

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

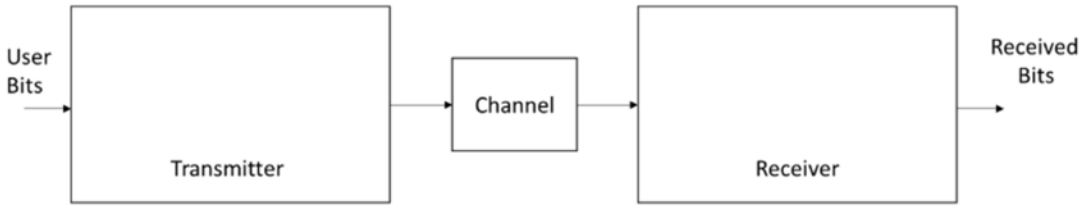
- wireless channels;
- wave amplitudes versus wireless symbols and signals;
- multiple-user channels; and

- successive interference cancellation versus parallel interference cancellation.

A. Wireless Channels

16. A typical wireless transmission generally involves a transmitter and receiver at opposite ends of a wireless channel, wherein an original signal is input at the transmitter and a recovered signal is calculated at the receiver.

17. As illustrated in the simplified figure below, an original information signal in the form of user bits (sequences of 0s and 1s) is input to the transmitter, which first converts those bits into an analog carrier wave and then transmits that carrier wave over the wireless channel to the receiver. (EX2003 at 2-4; EX2004 at 1-5, 95, 181-183, 208-209). The receiver receives the wave and attempts to recover the original signal by converting the received wave into received bits. These received bits are the recovered signal. (EX2003 at 2-4; EX2004 at 3-5).



(Based on FIG. 1.1 of EX2003).

18. By the channel's very nature, as the wave passes through the channel, noise is introduced, and information can be lost or corrupted. (EX2003 at 2-4;

EX2004 at 1-5, 95, 181-183, 208-209). Thus, when a receiver receives the wave 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. (EX2003 at 2-4; EX2004 at 1-5, 95, 181-183, 208-209).

B. Amplitude vs. Symbols and Signals

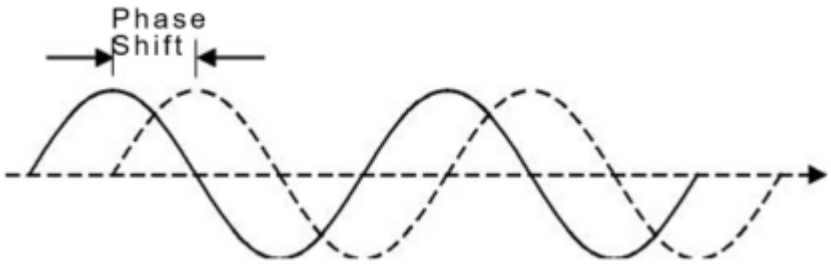
19. Although the challenged claims all require specific and detailed types of iterative amplitude estimations, Ground 1's primary reference, *Fuller*, does not even mention amplitudes at all, much less amplitude estimations, iterative amplitude estimations, or the specific iterative amplitude estimations claimed here.

20. Unable to identify even a mention of amplitude in *Fuller*, the Petition instead resorts to pointing to symbol and signal estimations. But symbols and signals (and estimations thereof) are very different from amplitude and amplitude estimations.

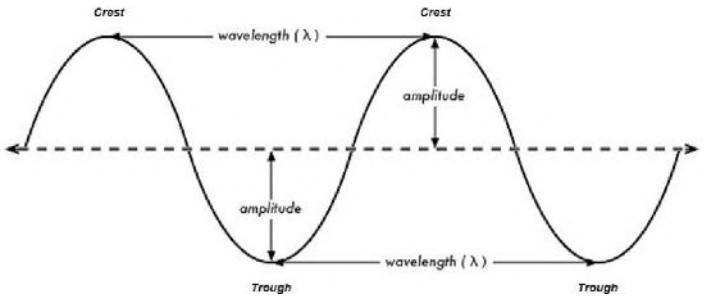
1. Amplitude

21. Sound and radio waves have numerous properties, including amplitude, wavelength, frequency, and phase. For example, a wave's phase is equal to the shift in time between two waves measured in degrees. The phase shift can be to the left (leading) or to the right (lagging) and typically has a value between 0 degrees and ±360 degrees. The phase shift can be between two different waves or the shift of a

single wave. The following figure shows a phase shift of 90 degrees from the solid wave to the dashed wave:



Amplitude is another wave property. As illustrated below, a wave's amplitude is the distance from the wave's midpoint to its crest or trough:



2. Wireless Symbols and Signals

22. In contrast, in a wireless system, the input and recovered signals are a series of user bits (sequences of 0s and 1s), while symbols are (usually) smaller unique sequence of 0s and 1s that can be used to more efficiently transmit and recover the input signal.

23. To illustrate (using a much-simplified example), suppose that the input signal is the following series of eight bits: "10000111." This signal can be treated

as comprising four different symbols, each two bits in length: the symbol "10," followed by the symbols "00," "01," and "11."

24. To transmit the "10000111" input signal, instead of transmitting a wave containing information for every bit, a wireless system can instead send a wave having information for the relevant symbols. For example, in Ground 1's *Fuller*, the disclosed system uses phase-based symbols, where each sequence of symbols is associated with a different wave phase. (*See, e.g.*, EX1004 at 7:16-17 (describing a "sequence of Binary Phase Shift (BPSK) symbols").

25. In our simplified example, the transmitter could send a wave having variable phases, first a phase for the "10" symbol, then a different phase for the "00" symbol, a phase for the "01" symbol, and, finally, a phase for the "11" symbol. The receiver then receives a version of that wave, plus associated noise and less any information lost during transmission. The receiver attempts to identify the correct phases and use them to identify their associated symbols.

26. Because of the noise and lost information, the phase values identified by the receiver may not correspond to the correct intended symbols. Accordingly, once the receiver initially estimates symbols, it may employ error correction to try to identify the correct symbols based on those originally estimated symbols. For example, a receiver may calculate probabilities as to whether the initial symbol estimates are correct. If the probabilities are good enough, the estimated symbols

are used. If they are not, the symbols are modified and the probabilities are again calculated. This iterative process can be repeated until the receiver is satisfied that the most-recently modified symbol estimates are accurate enough to use.

27. Once the receiver calculates these symbols, they are used to recover the original signal. To finish our simplified example, once the receiver has received a transmitted wave and identified its associated phases, it would use those phases to initially estimate symbols. The receiver would then apply error correction to modify those initial symbol estimates until, hopefully, it calculates the symbols "10," "00," "01," and "11." It can then use those symbols to construct the recovered signal "10000111."

C. Multiple-User Channels

28. For a variety of reasons, a wireless channel may include not just one signal from one user, but multiple signals from multiple users. For example, signals from other channels may crossover into the channel and interfere with the signal intended for that channel.

29. In addition, a channel may be intentionally overpacked with multiple signals. As described in the '651 Patent, in such systems, multiple users can use the same channel to each send their own signals. (*E.g.*, EX1001, 1:53-58). Although this overpacking allows more signals to be sent within a limited bandwidth, it also raises a number of problems. One such problem is how to identify and isolate the

different signals sent on the same channel, sometimes called Multi-User Detection ("MUD"), interference suppression, or interference cancellation. (*E.g.*, EX1001 at 1:66-2:14).

D. Successive Interference Cancellation vs. Parallel Interference Cancellation

30. There at least two distinct approaches to interference cancellation: (1) successive interference cancellation; and (2) parallel interference cancellation. The Petition highlights and relies on the material differences between the two approaches because its sole argument for combining Ground 2's *Frank* and *Zha* references is its assertion that they both use the successive approach to interference cancellation. (*E.g.*, Pet. at 44-46). Momentarily putting aside the baselessness of Samsung's conclusion (which is akin to arguing it is obvious to import any and all features from a gas engine into an electric engine because they both drive a vehicle's wheels), the entire premise for this obviousness argument is demonstrably false: while *Zha* does indeed use **successive** interference cancellation, every *Frank* embodiment that Samsung seeks to combine with *Zha* is explicitly and expressly **parallel** interference cancellation. (*E.g.*, EX1006 at ¶¶ [0012]-[0015]). Unable to assert, much less support, how these disparate approaches would and could be combined, the Petition just pretends they both use successive interference

cancellation and does not address the distinct differences between the two. The following provides that missing information.

31. ***Successive Interference Cancellation*:** As the name suggests, successive interference cancellation ("SIC") attempts to identify and isolate the channel's multiple signals one after the other. For example, if there were ten signals present in a channel's information stream, the receiver would first try to identify and isolate just one of those signals, ignoring the remaining nine signals as interfering noise. Once this first signal is recovered (using, for example, the error-corrected phased-based symbol approach discussed above), its information is subtracted (cancelled) from the original information stream.

32. The receiver then attempts to recover a second signal from the resulting smaller residual information stream, again ignoring the remaining (now eight) signals as interfering noise. Once this second signal is recovered, it, too is subtracted (cancelled) from the information stream.

33. This successive process continues, with a third signal being recovered and subtracted, a fourth signal being recovered and subtracted, etc., until the information stream comprises only information for the last (tenth) signal. This information is then used to recover that final signal, completing the successive interference cancellation process.

34. SIC can also be done iteratively. In this scenario during the first iteration, the first user signal is detected and then canceled from the multiple signals. Then the next user signal is detected and subtracted from the multiple signals. This process is continued until all the user signals have been detected and canceled, and then the process starts over again at the next iteration.

35. ***Parallel Interference Cancellation*:** In contrast, in a parallel interference cancellation process, the receiver does not attempt to recover signals one at a time, one after the other. Instead, the receiver attempts to recover all of the signals at the same time.

36. Consider again our example of ten user signals present in a single channel's information stream. In parallel interference cancellation, the receiver will attempt to isolate and recover all ten signals at the same time. For example, the receiver may try to simultaneously subtract from each signal the interfering information for the other nine signals. For each of the ten resulting sets of information, the receiver will then attempt to reconstruct its corresponding signal.

37. Because the reliability of these initial cancellations and reconstructions is typically low, the process will continue iteratively, with the receiver repeatedly recalculating and subtracting from each signal the interfering information for the other nine signals, until reliable cancellations, symbols, and signals are achieved.

38. In contrast to the iterative SIC discussed above, iterative PIC does not process the user signals sequentially during each iteration and instead processes all of the user signals in parallel at each iteration.

V. The Challenged ’651 Patent

39. The challenged ’651 Patent discloses and details a number of improved systems and methods for identifying and isolating different user signals in a single channel’s information stream.

40. As explained below, the disclosed systems and methods include (1) a unit that computes initial amplitude estimates, (2) a unit that computes symbol estimates, and (3) a unit that computes updated amplitude estimates. (*E.g.*, EX1001 at 8:58-9:6, 9:65-10:11). The challenged claims are directed to the computation of updated amplitude estimates. (*E.g.*, EX1001 at claims 1 and 6).

A. Exemplary Architecture

41. An exemplary receiver architecture illustrated in ’651 Patent Figure 2 includes an initial amplitude estimator 110 (highlighted below in red), a symbol estimator 105 (blue), a bank of decoders 130 (yellow), and a joint amplitude estimator 120 (green).

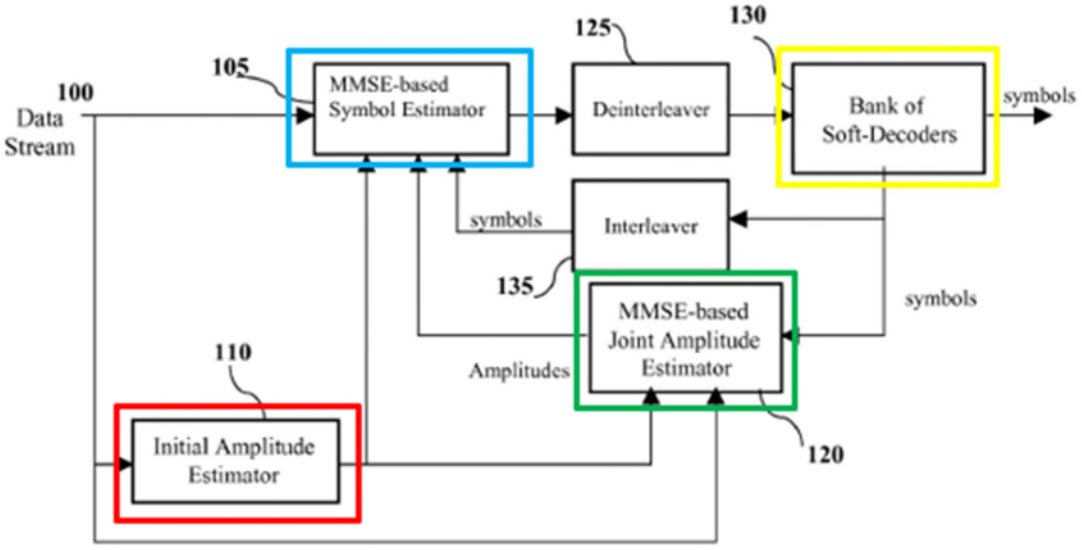


Figure 2

(EX1001 at Figure 2).

42. For a high-level overview (as illustrated above in Figure 2 and described in more detail below), this architecture works as follows:

(1) the received multi-user data stream 100 is provided to the initial amplitude estimator 110, which detects active users and calculates an initial estimate of the amplitude of each user signal in the stream (EX1001 at 15:25-42);

(2) these initial amplitude estimates are provided (along with the data stream) to the symbol estimator 105, which uses that data to estimate symbols for each user (EX1001 at 15:43-49, 16:1-4, 16:42-47);

(3) those symbol estimates are provided to the bank of error-correcting decoders 130, which calculate probabilities for the symbol estimates (in other words, how likely those symbols are correct) (EX1001 at 9:2-4, 16:7-12, 16:38-40);

(4) the symbol likelihoods from the decoder are passed to the joint amplitude estimator, which uses that information to calculate updated amplitude estimates, which are provided to the symbol estimator so that it can use them to calculate updated symbol estimates (EX1001 at 16:38-40, 18:63-20:51); and

(5) the symbol estimator, decoders, and joint amplitude estimator continue this cycle to iteratively calculate and provide information to one another (the joint amplitude estimator providing updates amplitude estimates to the symbol estimator, which in turn provides updated symbol estimates to the decoders, which in turn provides symbol likelihoods to the joint amplitude estimator, starting the cycle all over again) until some criteria is met, such as reaching a maximum number of iterations or a desired error rate (EX1001 at 16:16:38-51, 20:41-51).

43. ***Initial Amplitude Estimator:*** As illustrated below, the exemplary initial amplitude estimator 110 receives the multi-user data stream 100:

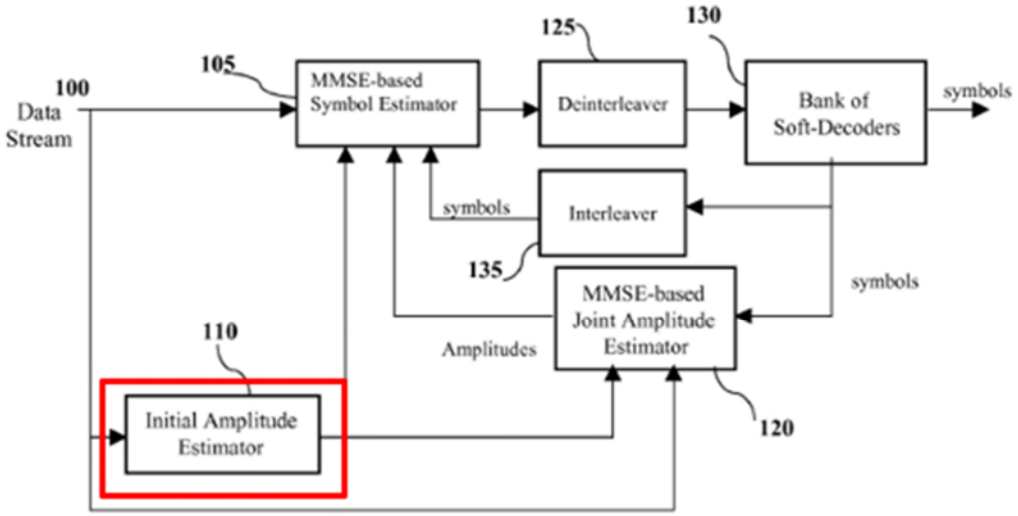


Figure 2

(EX1001 at Figure 2, 15:25-26). This initial amplitude estimator uses energy detection to identify which users are active within the channel's data stream. (EX1001 at 15:35-42). It then integrates the energy out of a filter for all active users to compute an initial estimate for the amplitude of each active user's signal. (EX1001 at 15:26-32).

44. As illustrated above, the initial amplitude estimates are passed to the exemplary symbol estimator 105 and to the joint amplitude estimator 120.

45. ***Symbol Estimator:*** During the first iteration of the process, exemplary symbol estimator 105 receives the data stream 100 and the initial amplitude estimator 110's initial amplitude estimates:

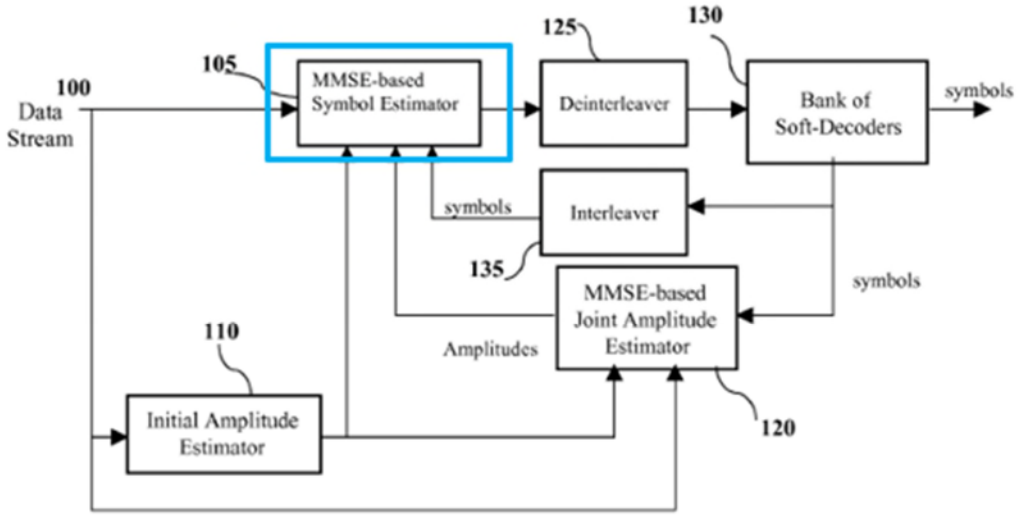


Figure 2

(EX1001 at Figure 2, 15:42-49). The symbol estimator then uses that data to estimate symbols for each user. (*Id.*).

46. The symbol estimator uses the initial amplitude estimates to compute symbol estimates only during the first cycle/iteration. (EX1001 at 15:42-49). During all other iterations, the symbol estimator uses updated amplitude estimates from the joint amplitude estimator (along with other information, such as prior information on the symbols) to re-estimate the symbols. (EX1001 at 15:42-49, 16:42-51).

47. ***Decoders:*** The symbol estimates from the symbol estimator are routed to the exemplary decoders 130.[1] (EX1001 at 16:2-4). The decoders calculate the likelihood for each estimated symbol and then routes those estimated symbols and their respective likelihoods to various units, including joint amplitude estimator 120:

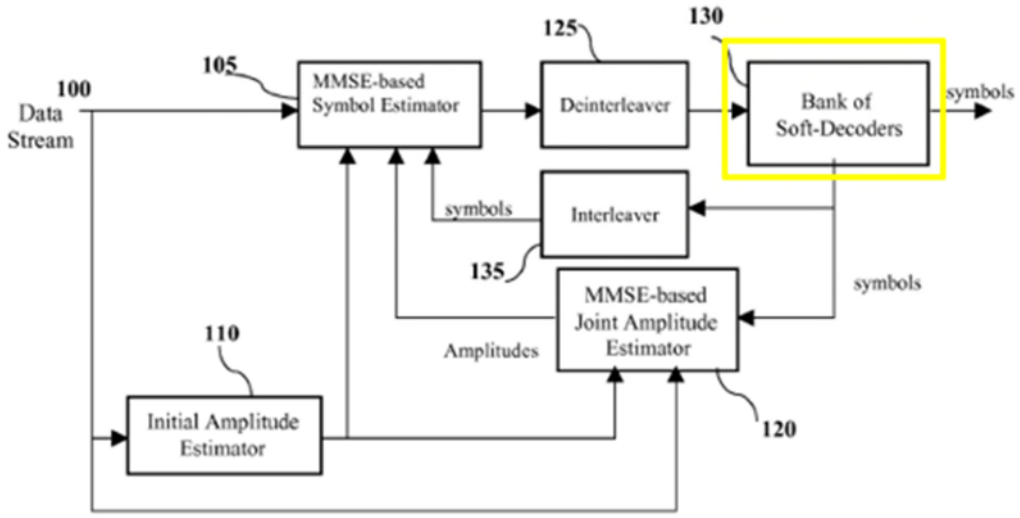


Figure 2

(EX1001 at Figure 2, 16:38-40, 18:63-20:51).

48. ***Joint Amplitude Estimator:*** Disclosed architecture embodiments include a joint amplitude estimator (discussed in more detail in the following section) apart from the initial amplitude estimator, symbol estimator, and decoders.

[1] For purposes of this general overview, details concerning other disclosed blocks, such as the deinterleaver 125 and interleaver 135 are omitted. (*See, e.g.*, EX1001 at 16:14-27).

After the initial amplitude estimator provides the initial amplitude estimate, all updated amplitude estimates are computed and provided to the symbol estimator by and from exemplary joint amplitude estimator 120:

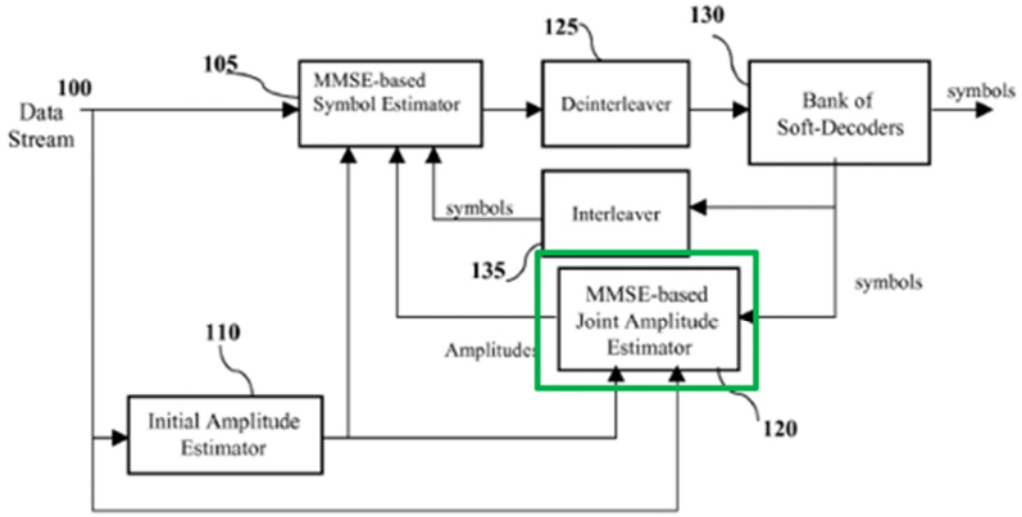


Figure 2

(EX1001 at Figure 2, 16:38-40, 18:63-20:51).

49. These updated amplitude estimates are based on the symbol likelihoods from the decoders and are provided to the symbol estimator to start a new cycle of computations, which continues and repeats until a predefined condition is met:

> The new symbol likelihoods from decoders 130 are used to update previous amplitude estimates in the joint amplitude estimator 120. … The new amplitude estimates from the join amplitude estimator 120 are passed to the MMSE-based Symbol Estimator 105 that re-estimates the symbols based on prior information on the symbols and updated parameter estimates. These updates symbol estimates from the symbol estimator 105 are then re-routed to the bank of decoders 130. This process is repeated for either some fixed number of iterations or until

> estimates of the bit error rate or frame error rate achieve some desired level.

(EX1001 at 16:38-51).

50. The blocks involved in this exemplary iterative cycle are outlined in dotted blue below:

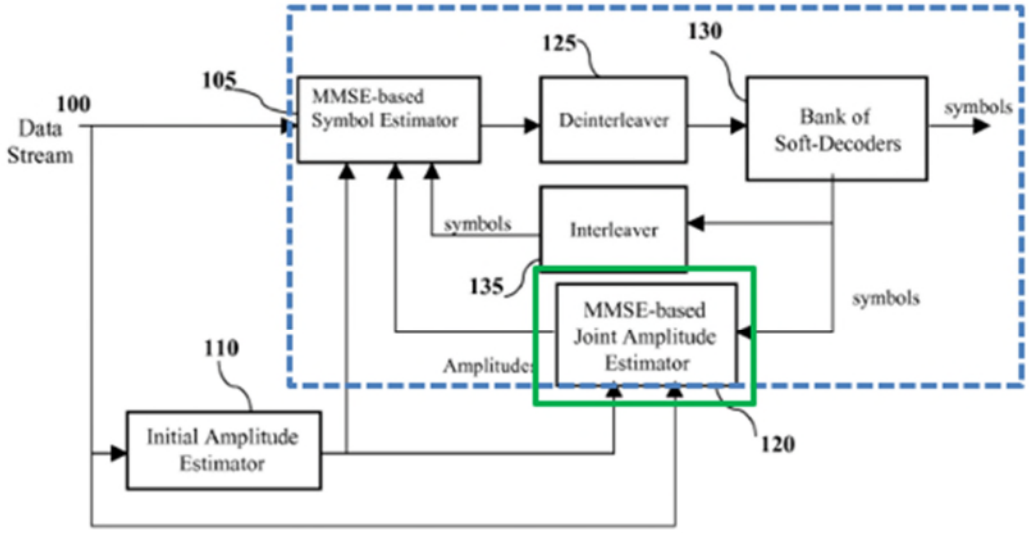


Figure 2

(EX1001 at Figure 2, 16:38-51).

B. Exemplary Updated Amplitude Estimations

51. The ’651 Patent provides detailed descriptions of exemplary joint amplitude estimators for computing updated amplitude estimates. (*E.g.*, EX1001 at Figure 4, 18:63-20:51). In one example, the multi-user information stream (data stream 100) received by the joint amplitude estimator is divided up into a plurality

of "observation intervals." (EX1001 at 18:63-67). "These intervals can be based on distinguishing attributes such as time, code, or frequency." (EX1001 at 18:63-19:1).

52. Figure 4 depicts an exemplary joint amplitude estimator receiving three time-based observation intervals labeled 400, 405, and 410:

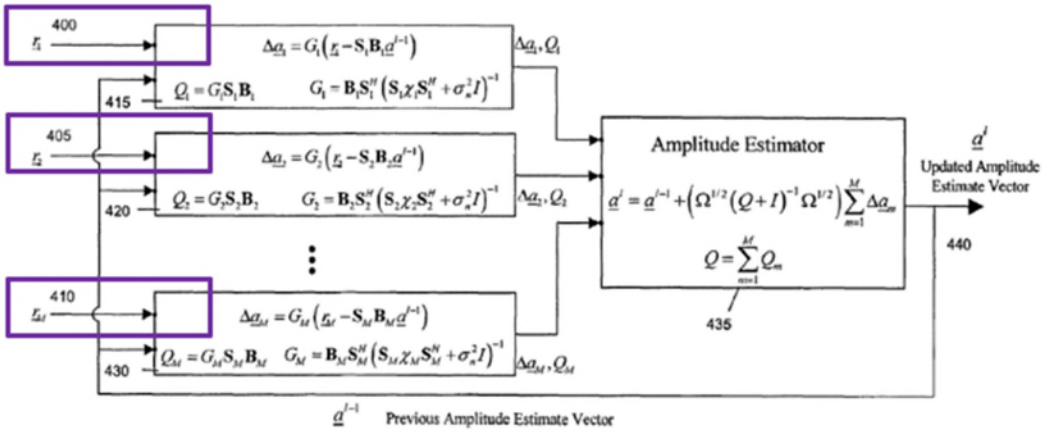


Figure 4

53.

(EX1001 at Figure 4, 11:24-25, 18:63-19:5).

54. Figure 4 illustrates that this exemplary joint amplitude estimator comprises three processing modules 415, 420, and 430 (annotated in orange) and an amplitude estimator (in pink):

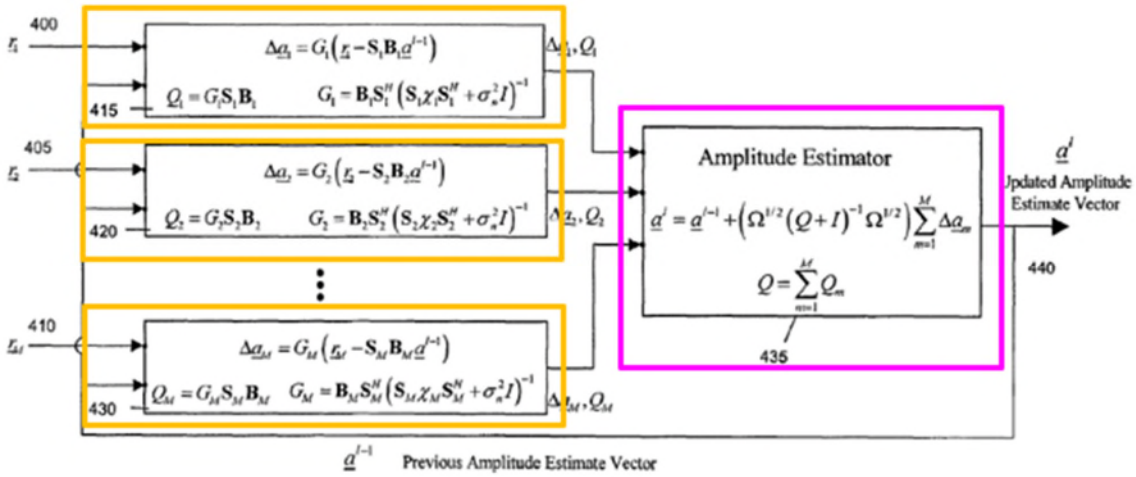


Figure 4

(EX1001 at Figure 4, 11:24-25, 18:63-19:5, 19:60-20:40).

55. Each processor (1) performs interference cancellation, each cancelling out different interference; and (2) includes a filter that is applied after the interference cancellation to compute an amplitude estimate for the observation interval. (*E.g.*, EX1001 at 19:5-59).

56. The individual amplitude estimates from the filter processors are passed to the amplitude estimator 435, which combines those estimates in a weighted manner. (*E.g.*, EX1001 at 19:60-20:24). The amplitude estimator uses this weighted combination and symbol estimates and likelihoods received from the bank of decoders (as discussed above) to compute new updated amplitude estimates. (*E.g.*, EX1001 at 19:60-20:24, 20:32-51).

57. These updated amplitude estimates are fed back both to the symbol estimator (as explained above) and to the joint amplitude estimator's individual

filter processors. (*E.g.*, EX1001 at 20:32-51). This iterative process is repeated (again, as discussed above) until a predefined condition is met, such as a maximum number of iterations or a desired error rate. (*E.g.*, EX1001 at 20:32-51).

C. The Challenged Claims

58. The Petition challenges claims 1-4 and 6-8. The foregoing innovative approaches are embodied in those challenged claims, each of which requires:

- a data stream from multiple users divided into observation intervals;
- a plurality of processors/filters that perform interference cancellations and compute individual amplitude estimates;
- processing those individual amplitude estimates to calculate new amplitude estimates;
- iteratively passing those new amplitude estimates back to the processors/filters until either a maximum number of iterations or a desired error rate is reached.

(*See, e.g.*, ’651 Patent at claims 1-4 and 6-8).

59. For example, challenged independent claim 1 and its challenged dependent claims 2-4 are directed to a joint amplitude estimator that includes the following limitations:

> 1. A joint amplitude estimator for a data stream from multiple users, comprising:

> a data stream from said multiple users divided into a **plurality of observation intervals**;
>
> **a plurality of processing modules** coupled to said observation intervals, wherein said processing module **calculates interference cancellation values** for each of said users and computes a filter for each of said observation intervals, said **filter being applied to said data within said observation interval to compute individual amplitude estimates**; and
>
> **an amplitude estimation unit which processes said individual amplitude estimates and calculates new amplitude estimates**, wherein said new amplitude estimates are **iteratively passed back to said processing modules** either a maximum number of iterations or a desired bit error rate have been reached.

(EX1001 at claim 1).

60. Similarly, challenged independent claim 6 and its challenged dependent claims 7 and 8 are directed to a method for processing amplitude estimates and include the following limitations:

> 6. A method for processing amplitude estimates for a multiuser data stream divided into a plurality of observation intervals, comprising:
>
> **computing a filter for each observation interval** of said data stream;
>
> **applying interference cancellation** to said data stream for each said observation interval;
>
> **applying said filter** to said data stream for each said observation interval from said interference cancellation **to produce individual amplitude estimates** for each said observation interval;
>
> **computing new amplitude estimates using said individual amplitude estimates**; and

> **passing said new amplitude estimates back to said filter for iterative processing** until either a maximum number of iterations or a desired bit error rate have been reached.

(EX1001 at claim 6).

VI. Samsung's Petition

61. I understand Samsung's Petition asserts the following obviousness Grounds 1 and 2:

Ground	References	Basis	Challenged Claims
1	*Fuller and Reznik*	§ 103	1-4, 6-8
2	*Frank and Zha*	§ 103	1-4, 6-8

62. I further understand the Petition relies on two primary references for all its grounds, *Fuller* and *Frank*, and two secondary references, *Reznik* and *Zha*, but in my opinion both of these combinations fail to disclose all the required claim limitations of independent claims 1 and 6.

A. Ground 1

63. Ground 1's primary reference is *Fuller*, which Samsung relies on as allegedly disclosing almost all of the limitations of the independent claims, replying on *Reznik* almost exclusively for the claimed filters, which the Petition concedes are not disclosed in *Fuller*. (Pet. at 32). For example, Ground 1 relies on *Fuller* as allegedly disclosed the amplitude limitations, including the claimed computing of individual amplitude estimates, processing those individual amplitude estimates to calculate new amplitude estimates, and iteratively passing those new amplitude

estimates back to the claimed processors or filters. (*E.g.*, Pet. at 31, 34-36, 37, 41-43).

64. In my opinion, the Petition's reliance on *Fuller* for these amplitude limitations is both curious and telling because *Fuller* not only fails to disclose these individual amplitude estimates, new amplitude estimates, and passing back of the new amplitude estimates, ***Fuller* fails to even mention amplitude at all**.

65. This is because *Fuller* does not concern the calculation or recalculation of amplitude estimates, iteratively or otherwise. Instead, at best, Fuller generally concerns other **unclaimed** aspects of the '651 Patent's disclosed architecture, namely the estimation of **symbols** and **signals**, not of amplitudes. (*See, e.g.*, EX1004 at Abstract).

66. According to *Fuller*, its disclosure concerns interference cancellation that relies on iterative symbol estimation, where symbol estimates are iteratively weighted based on the consistency of prior estimates for that symbol. (EX1004 at Abstract). But this is (again, at best) the (general) subject matter of the '651 Patent's symbol estimator and bank of decoders, not of the additional inventive joint amplitude estimator.

67. For example, the iterative cycle described in Fuller and depicted in its Figure 2 (outlined in a dotted blue line below) employs blocks such rake

demodulation 65, symbol decision 70, regeneration 74, and symbol directed processing 72:

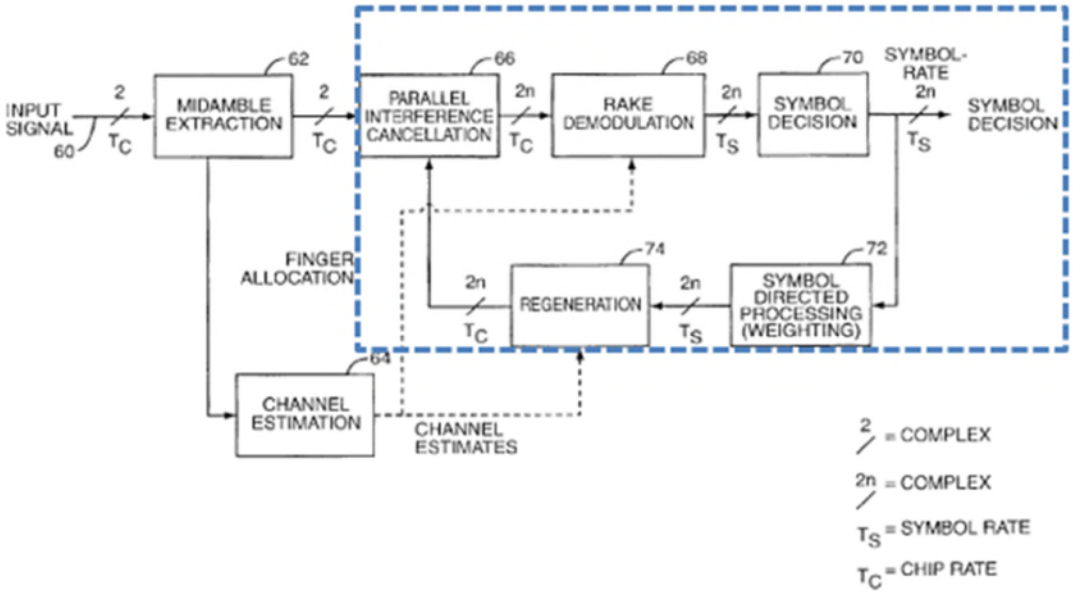


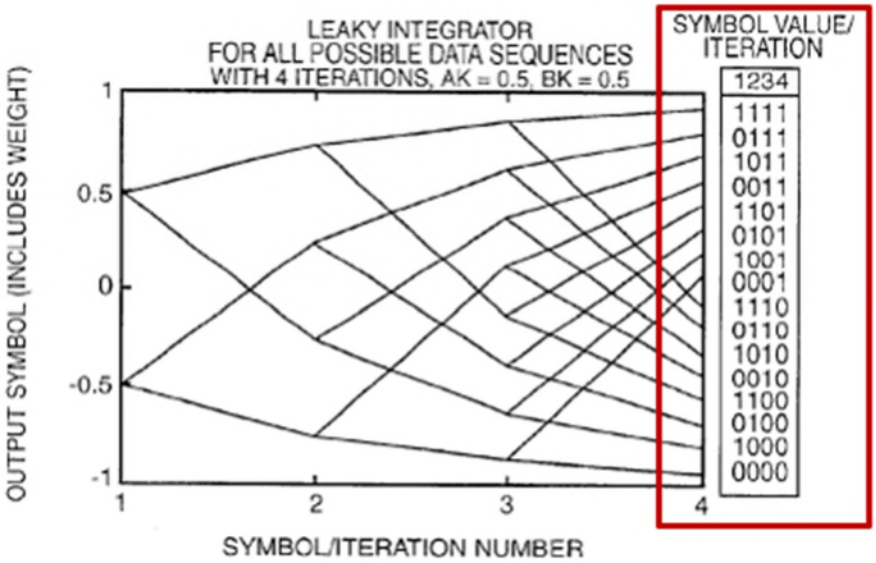
FIG. 2

(EX1004 at Fig. 2).

68. *Fuller* describes that rake modulation block 68 separates a stream comprising multiple user signals ("composite input signal 60") into "individual signals corresponding to the respective signals for each user." (EX1004 at 5:9-12, 5:19-21). These individual signals are then passed to symbol decision block 70, which determines "symbol estimates for each user" signal output by rake demodulation 68. (EX1004 at 5:25-34).

69. *Fuller* next describes that these symbol estimates are provided by symbol estimator 70 to symbol directed processing block 72, which provides

weighting "based on the consistency of previous estimates for the given symbol" and then calculates and outputs "weighted symbols based on [that] weighting and the [received] symbol estimate[s.]" (EX1004 at 5:32-39). Figure 8 illustrates these 4-bit symbols—1111, 0111, 1011, 0011, etc.—and a disclosed function for weighting them:



70. *FIG. 8*

(EX1004 at Figure 8, 3:17-19, 7:10-12).

71. Finally, these weighted symbols are provided to regeneration function 74, which "recreates estimates of the individual signals from the weighted symbols for each of the estimated users." (EX1004 at 5:40-56). *Fuller* does not describe the use or iterative calculation of amplitudes in this or any other of the foregoing

functions. (EX1004 at 5:9-56). It cannot because, again, *Fuller* does not mention amplitudes at all.

B. Ground 2

72. I understand Ground 2 relies on combining primary reference *Frank* with *Zha*. In my opinion, the supposed basis for combining these references—that they both use successive interference cancellation—is demonstrability incorrect: *Zha* uses **successive** interference cancellation, but every *Frank* embodiment relied on in the Petition explicitly uses the incompatible **parallel** interference cancellation approach. (*E.g.*, Pet. at 44-46; EX1006 at ¶¶ [0012]-[0015]). Indeed, the Petition does not even identify how the references could supposedly be combined, much less establish that this undisclosed combination was somehow obvious. Nor could it. Not only do the systems it attempts to combine (in some unidentified manner) use different incompatible interference cancellation approaches, they also use completely different observation intervals—where the *Zha* embodiments process signals using **time**-based intervals, *Frank* processes signal using **code**-base intervals. (*See, e.g.*, Pet. at 48). The Petition does not acknowledge these material differences, nor does it try to explain how these incompatible approaches could somehow be combined.

73. Moreover, in my opinion, even if these references were (baselessly) somehow combined, they are still missing limitations required by every challenged claims.

74. ***Frank:*** For example, primary reference *Frank* iteratively estimates symbols, not amplitudes, and the Petition does not assert otherwise. It could not because Frank teaches an interference cancellation approach that calculates amplitude estimates just a single time.

75. *Frank* discloses two iterations of its system in figures 2A and 2B. (EX1006 at Figs. 2A and 2B).

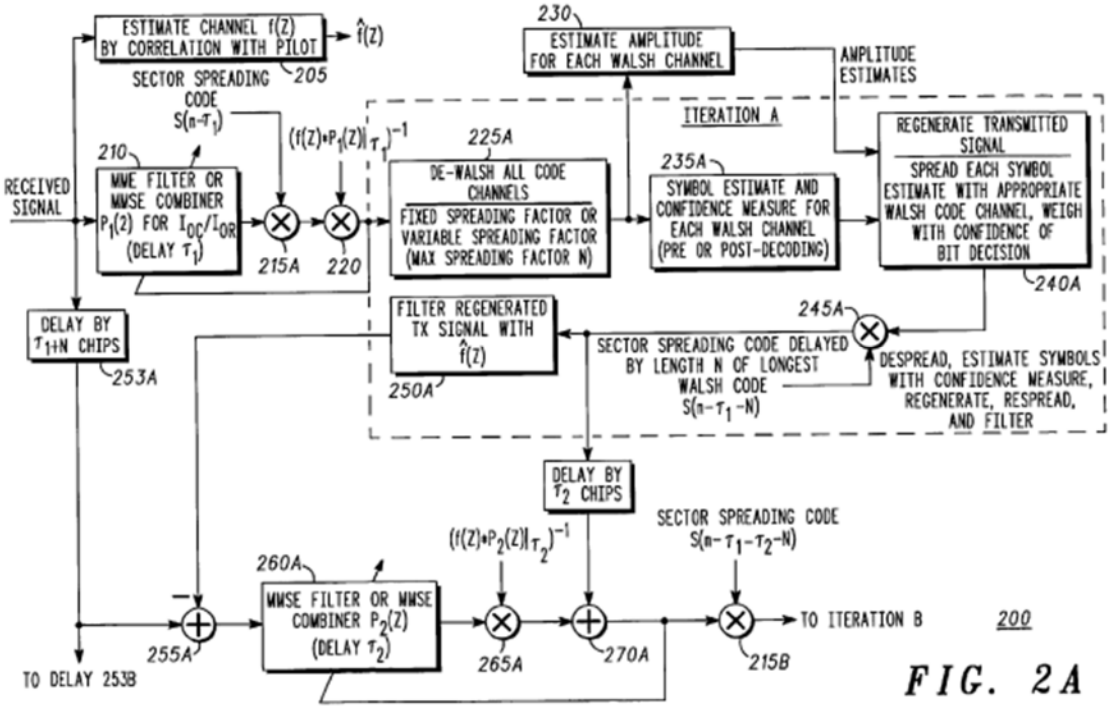
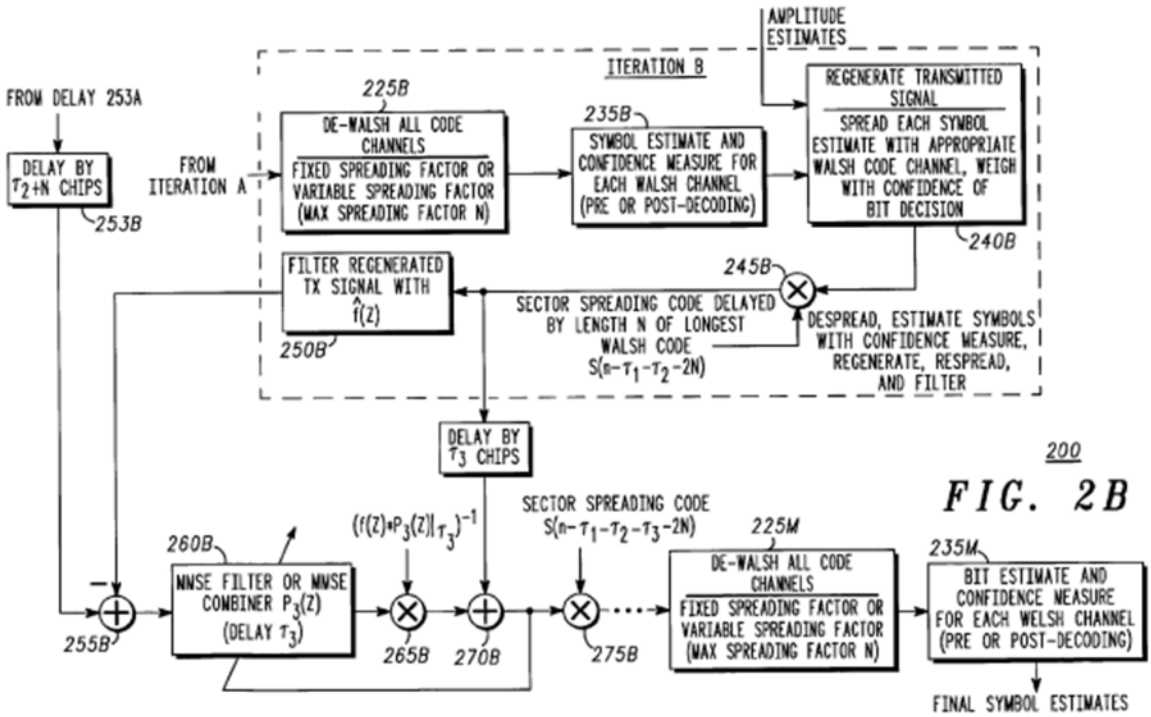


FIG. 2A



(EX1006 at Figs. 2A and 2B).

76. In each of these figures, amplitude estimates are calculated in block 230. *Frank* explains that "[t]o provide appropriate transmitted signal reconstruction, amplitude estimates are made for each of the code channels following dispreading, in block 230." (EX1006 at ¶[0029]). In Fig. 2A these amplitude estimates are sent to block 240A an in Fig. 2B, which is the next iteration of *Frank*'s system, amplitude estimates are sent to block 240B.

77. *Frank* does not disclose passing these amplitude estimates back after an iteration. To the contrary, Figs. 2A and 2B show that there is no path in *Frank* to pass back any values to iteratively recalculate amplitude estimates.

78. ***Zha:*** In my opinion, Ground 2's attempt to cure this deficiency through *Zha* fails because while *Zha* does iteratively calculate estimate amplitudes, it does not do so in the specific manners disclosed and claimed in the '651 Patent.

79. As established above and explicitly described in the challenged claims, the inventive method and joint amplitude estimator include:

- a plurality of processors/filters computing individual amplitude estimates;
- processing those individual amplitude estimates to calculate new amplitude estimates;
- iteratively passing those new amplitude estimates back to the processors/filters for iterative processing until either a maximum number of iterations or a desired error rate is reached.

80. But *Zha* does not disclose any such plurality of processors or filters, nor does it disclose passing new amplitude estimates back to such a plurality of processors or filters for the claimed iterative processing, and the Petition does not assert otherwise. (*E.g.*, Pet. at 19-20, 55). Instead, the Petition concedes that *Zha* merely discloses an algorithm that successively calculates "averaged amplitude estimates." (Pet. at 19-20; EX1010 at 744).

81. *Zha* describes a detector having multiple interference cancellation stages." According to the Petition, in each stage after the first, *Zha*'s algorithm

calculates an "averaged amplitude estimate" that corresponds to the claimed "new amplitude estimate." But *Zha* does not disclose—and the Petition does not assert that *Zha* discloses—passing this average (the alleged new amplitude estimates) back to the processors or filters that calculate the individual amplitude estimates for iterative processing.

82. Accordingly, this key claimed concept is entirely missing from both *Frank* and *Zha*, and combining them does not and cannot result in the claim estimator or method.

VII. Ground 1 Does Not Establish The Required Reasonable Likelihood Of Success

83. In my opinion, Ground 1 does not provide the required reasonable likelihood of success because, contrary to the Petition's unsupported, conclusory assertions, *Fuller* does not disclose the claimed iterative amplitude estimates.

A. The Challenged Claims Require Iterative Amplitude Estimates

84. Each challenged claims requires a number of iterative amplitude estimates, including:

- a plurality of processors/filters computing individual amplitude estimates (*e.g.*, claim 1 at 26:10-16 and claim 6 at 26:46-47, 26:50-54);
- processing those individual amplitude estimates to calculate new amplitude estimates (*e.g.*, claim 1 at 26:17-19 and claim 6 at 26:54-55);

- iteratively passing those new amplitude estimates back to the processors/filters for iterative processing until either a maximum number of iterations or a desired error rate is reached (*e.g.*, claim 1 at 26:19-22 and claim 6 at 26:56-58).

B. Fuller Discloses Successively Estimating Symbols, Not Amplitudes

85. But contrary to Ground 1, *Fuller* does not disclose any of these required iterative amplitude estimates. As established, *Fuller* not only fails to disclose these individual amplitude estimates, new amplitude estimates, and passing back of the new amplitude estimates, ***Fuller* fails to even mention amplitude at all**.

86. Ground 1 presents two *Fuller* arguments on these limitations, one under a time-based observation interval theory (Pet. at 35-36), and another under a code-based observation interval theory (Pet. at 36). In my opinion, both are baseless.

87. ***Ground 1's Time-Based Observation Interval Theory:*** Recall that weighted symbols are provided to regeneration function 74, which "recreates [and outputs] estimates of the individual signals from the weighted symbols for each of the estimated users":

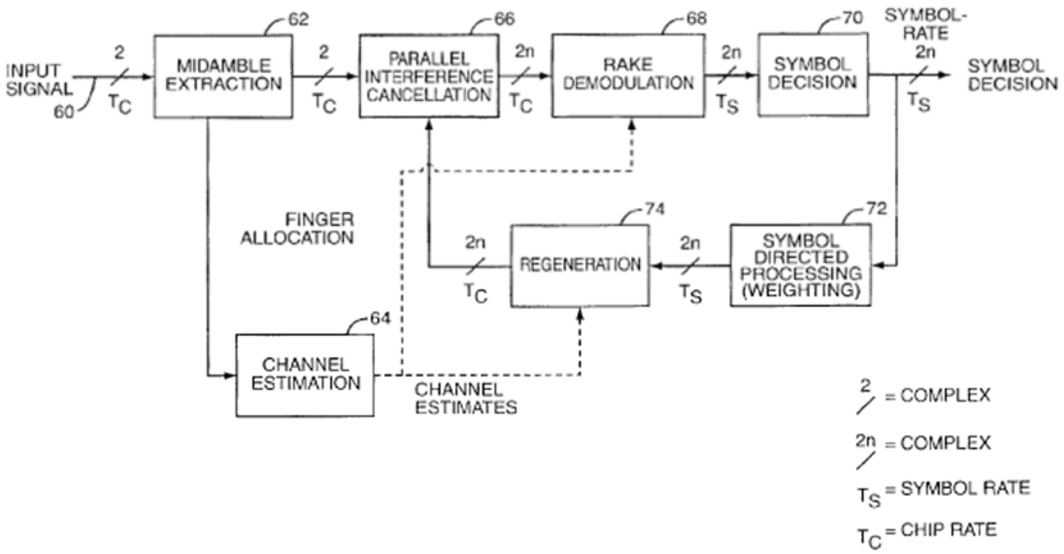


FIG. 2

(EX1004 at Fig. 2, 5:40-56).

88. For Ground 1's time-based interval theory, Samsung asserts that these estimates of the individual signals are the claimed "individual amplitude estimates." (Pet. at 35). But Samsung provides no basis whatsoever for this assertion, it just equates these two very different things (signals and amplitudes) in a parenthetical without any explanation, simply concluding that regeneration block 72 outputs "'estimates of the individual signals from the estimated symbols for each of the estimated users' (*i.e.*, **individual amplitude estimates**)." (Pet. at 35) (emphasis in original). But the Petition provides no basis for this incorrect assertion. There is no dispute that *Fuller* describes that the regeneration block 74 calculates and outputs **signal** estimates; *Fuller* does not describe regeneration block 74 as calculating individual **amplitude** estimates, nor does Fuller equate signal estimates with

amplitude estimates. In my opinion, it could not reasonably do so because, as established above and not addressed by the Petition, signals and amplitudes are fundamentally different.

89. Ground 1's time-based interval theory similarly asserts that Fuller's symbol directed processing block 72 outputs the claimed "new amplitude estimates." (Pet. at 35-36, 37). But this is again directly contrary to the express teaching of *Fuller*. Fuller explicitly describes that symbol directed processing block 72, which provides weighting "based on the consistency of previous estimates for the given symbol" and then calculates and outputs "weighted symbols based on [that] weighting and the [received] symbol estimate[s.]" (EX1004 at 5:32-39). Figure 8 illustrates these 4-bit symbols—1111, 0111, 1011, 0011, etc.—and a disclosed function for weighting them:

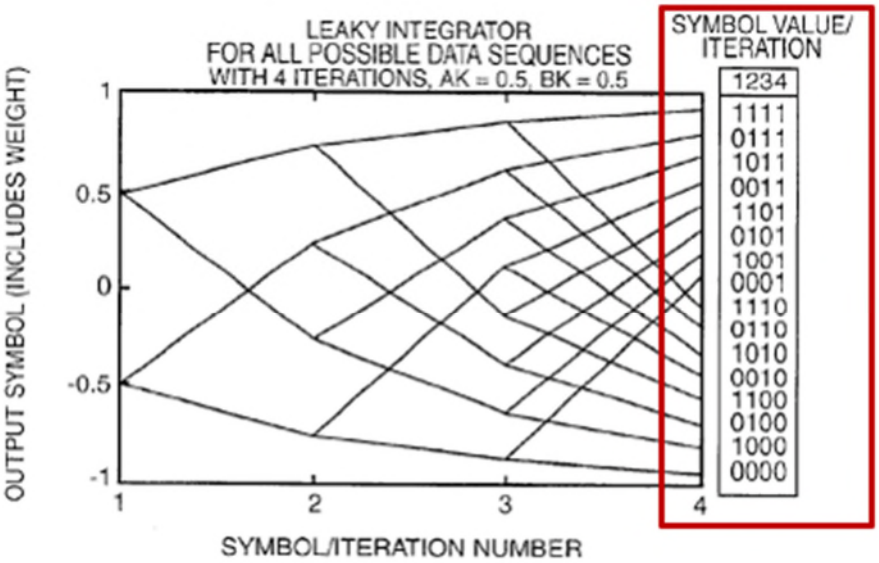


FIG. 8

90.

(EX1004 at Figure 8, 3:17-19, 7:10-12).

91. The Petition provides no explanation for its assertion that these weighted 4-bit symbol estimates would have included new amplitude estimates. There is no basis: *Fuller* does not describe symbols or signals as including amplitude estimates, and it would not because symbol and signal estimates are fundamentally different from amplitudes estimates, as established above.

92. ***Ground 1's Code-Based Observation Interval Theory:*** In my opinion, Ground 1's code-based interval theory suffers from the same fatal flaws as its time-based theory. (Pet. at 36). Once again, Ground 1 attempts to equate symbol and signal estimates for amplitude estimates, but provides no basis or explanation for doing so. There is none.

VIII. Ground 2 Does Not Establish the Required Reasonable Likelihood of Success

93. Each challenged claim requires iteratively passing new amplitude estimates back to the claimed processors or filters for iterative processing until either a maximum number of iterations or a desired error rate is reached. (*E.g.*, claim 1 at 26:19-22 and claim 6 at 26:56-58). Because Ground 2's primary reference *Frank* admittedly does not teach this limitation (or iteratively calculating amplitude estimates at all), Ground 2 attempts to cure this deficiency by combining *Zha* with *Frank*. But, in my opinion, *Zha* cannot save Ground 2 because (1) *Zha* also does not teach this limitation; and (2) the Petition does not establish it was obvious to combine *Frank* and *Zha* in the first place.

A. *Zha* Does Not Disclose Passing New Amplitude Estimates Back to Processors or Filters

94. Claim 1 and its dependent claims require:

> an amplitude estimation unit which processes said individual amplitude estimates and **calculates new amplitude estimates, wherein said new amplitude estimates are iteratively passed back to said processing modules** either a maximum number of iterations or a desired bit error rate have been reached.

(EX1001 at claim 1).

95. Claim 6 and its dependent claims similarly require:

> applying said filter to said data stream for each said observation interval from said interference cancellation to produce individual amplitude estimates for each said observation interval;

> computing new amplitude estimates using said individual amplitude estimates; and
>
> **passing said new amplitude estimates back to said filter for iterative processing** until either a maximum number of iterations or a desired bit error rate have been reached.

(EX1001 at claim 6).

96. *Zha* does not disclose either of these passing back requirements because (1) *Zha* does not disclose any such plurality of processors or filters, and (2) *Zha* does not disclose passing new amplitude estimates back to such a plurality of processors or filters for the claimed iterative processing.

97. The Petition does not even assert otherwise. (*E.g.*, Pet. at 19-20, 55). Rather, the Petition concedes that *Zha* merely discloses an algorithm that successively calculates "averaged amplitude estimates." (Pet. at 19-20; EX1010 at 744).

98. According to the Petition, *Zha* describes a detector having multiple interference cancellation stages." In each stage after the first, *Zha*'s algorithm calculates an "averaged amplitude estimate" that corresponds to the claimed "new amplitude estimate." (Pet. at 20, 54-55). But in my opinion *Zha* does not disclose—and the Petition does not assert that *Zha* discloses—passing this average (the alleged new amplitude estimates) back to processors or filters that calculate the individual amplitude estimates for iterative processing. Accordingly, *Zha* cannot remedy

Frank's deficiency on these limitations because *Zha* suffers from the same deficiency.

B. The Petition Does Not Establish That It Was Obvious To Combine *Zha* and *Frank*

99. In my opinion, the Petition fails to establish a reasonable likelihood of proving that it was obvious to combine *Frank* and *Zha*.

100. ***First***, the Petition's combination is entirely premised on combining *Zha*'s **successive** interference cancellation with *Frank*'s **successive** interference cancellation. (Pet. at 44-46). But all the *Frank* figures and embodiments relied by the Petition use **parallel** interference cancellation, not successive interference cancellation:

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1** is a block diagram illustrating a preferred receiver structure for MMSE equalization with parallel interference cancellation in accordance with the present invention.

[0013] **FIG. 2** (divided into **FIGS. 2A and 2B**) is a combined block and flow diagram illustrating, in greater detail, a preferred receiver structure and method for MMSE equalization with parallel interference cancellation in accordance with the present invention.

[0014] **FIG. 3** is a block diagram illustrating an apparatus embodiment of the preferred receiver structure for MMSE equalization with parallel interference cancellation in accordance with the present invention.

[0015] **FIG. 4** (divided into **FIGS. 4A and 4B**) is a flow diagram illustrating a method embodiment for MMSE equalization with parallel interference cancellation in accordance with the present invention.

(EX1006 at ¶¶ [0012]-[0015]).

101. And the Petition does not explain how a POSITA would combine the improved amplitude averaging algorithm designed for *Zha*'s successive interference cancellation with *Frank*'s parallel interference cancellation or how *Zha'*s successive interference cancellation teachings could be applied to *Frank*'s parallel interference cancellation. (*See* Pet. at 44-46). And for good reason—as established above but ignored by the Petition, a POSITA would understand that successive interference cancellation and parallel interference cancellation are fundamentally different cancellation techniques, and the two techniques cannot simply be mixed and matched as the Petition proposes.

102. ***Second***, the *Frank* and *Zha* embodiments that Samsung seeks to combine are incompatible for additional reasons. For example, as the Petition describes, they use completely different observation intervals—where the *Zha* embodiments process signals using **time**-based intervals, *Frank* processes signal using **code**-base intervals. (*See, e.g.*, Pet. at 48). The Petition does not acknowledge these material differences, nor does it try to explain how these incompatible approaches could somehow be combined.

103. Nor could the Petition reasonably do so. Not only are these different intervals incompatible, but *Zha*'s time-based amplitude averaging algorithm (which the Petition vaguely proposes somehow using with *Frank*) requires that associated

time delays are exactly known at the receiver. *Zha* states "[i]nitially, we assume that the time delays are exactly known at the receiver." (EX1010 at 743).

$$\mathbf{d}_k(i) = \delta_k \mathbf{c}_k(p_k + 1, i) + (1 - \delta_k)\mathbf{c}_k(p_k, i). \qquad (5)$$

(EX1010 at 744). This known time delay—$d_k(i)$—is used in the amplitude averaging algorithm relied on by the Petition:

$$\bar{A}_k^{v+1} = \frac{1}{M}\sum_{i=1}^{M} abs\left(Re\left(e^{-j\theta_k}(\mathbf{d}_k(i))^H\ \tilde{\mathbf{r}}_k^{v+1}\right)\right)$$

(Pet. at 52, 54; EX1010 at 744).

104. But *Zha* does not disclose how to achieve such required known time delays, nor does *Frank* disclose that time delays can be known in its disclosed wireless system as required by *Zha*'s amplitude averaging algorithm. (*See* EX1006). Moreover, a POSITA would understand that time delays are not known in wireless communication systems. The Petition does not explain how a POSITA would use an amplitude averaging algorithm that requires the time delays to be exactly known in a system where the time delays are not known. (*See* Pet. at 44-46).

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: 1/29/2025

Dr. Giuseppe Caire