

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GEOTAB INC. AND GEOTAB USA, INC.,
Petitioners,

v.

FRACTUS, S.A.,
Patent Owner.

Case No. IPR2025-00928
Patent No. 8,456,365

EXPERT DECLARATION OF HOSSEIN HASHEMI, Ph.D.

I, Hossein Hashemi, Ph.D., do hereby declare as follows:

I. Introduction

1. I am a Professor of Electrical Engineering at the University of Southern California. I am, however, currently on a leave of absence and temporarily working as a full-time employee at Astera Labs, Inc.

2. I have been retained by Edell, Shapiro and Finnan, LLC (hereinafter "the Edell Firm"), to provide various opinions regarding U.S. Patent No. 8,456,365 ("the '365 Patent"). I understand that my declaration is being submitted in connection with a Patent Owner Preliminary Response in an *inter partes* review of the '365 Patent. Unless otherwise noted, the statements made herein are based on my personal knowledge and, if called to testify with regards to this declaration, I could and would do so competently and truthfully.

3. I have been retained in this matter by the Edell Firm as a technical expert in the field of electrical engineering, particularly within the context of antenna design and operation in multifunction wireless devices. I am being compensated for my work in this matter at my usual and customary rate of \$760.00 per hour. I have no personal or financial stake or interest in the outcome of the *inter partes* review or any related action. My compensation in no way depends upon my testimony or the outcome of the *inter partes* review.

4. I have been advised that the Edell Firm represents Fractus, S.A. (hereinafter "Patent Owner") in this matter and that Geotab Inc. and Geotab USA, Inc. (hereinafter "Petitioners") have petitioned for *inter partes* review of the '365 Patent. I have no personal or financial stake or interest in Patent Owner, Petitioners, or the '365 Patent.

5. I reserve the right to supplement and/or amend my opinions in this declaration based on future positions taken by Petitioners or their experts, additional documents, testimony or other information provided by Petitioners or their witnesses, any actions from the Board, or as otherwise necessary.

II. Qualifications

6. My qualifications for forming the opinions set forth in this expert report are summarized here and explained in more detail in my *curriculum vitae* which is attached as Exhibit A to this Declaration. Exhibit A includes a full list of my publications and other professional contributions and achievements, and a list of the cases in which I have testified at deposition, hearing or trial.

7. I am currently the Ming Hsieh Electro-Physics Professor of Electrical and Computer Engineering, and a Co-Director of the Ming Hsieh Institute at the University of Southern California ("USC"). I received my Bachelor of Science degree in Electronics Engineering from Sharif University of Technology in 1997. I

received my Master's degree in Electronics Engineering from Sharif University of Technology in 1999. I received my Master's degree and Ph.D. in Electrical Engineering from the California Institute of Technology in 2001 and 2003, respectively.

8. From 1997 to 1999 I was a radiofrequency integrated circuit design engineer at Keresem Communications Research. I became an Assistant Professor of Electrical Engineering at the USC in October 2003 and remained in that position until May of 2009. From November 2007 to May 2009, I also occupied the Gordon S. Marshall Early Career Chair at USC. In May 2009 I became a tenured Associate Professor of Electrical Engineering at USC and remained in that position until my promotion to Professor in December 2014, a title I have held since then.

9. I have over 25 years of industry and academic experience. In particular, I have experience with antennas and electromagnetic technologies including designing, simulating, taping out, and measuring complex electromagnetic structures spanning frequency ranges of 100 MHz – 170 GHz, as well as infrared frequencies (1550nm wavelength), and demonstrating numerous phased arrays (multi-antenna systems) spanning radiofrequency to infrared frequencies.

10. I have been privileged to receive a number of awards and honors throughout my career. These include:

- Fellow, Optica 2023

- Fellow, Institute of Electrical and Electronics Engineers (IEEE) - 2019
- Winner, Nokia Bell Labs Prize - 2016
- Outstanding Young Engineer Award of the IEEE Microwave Theory and Techniques Society (MTT-S) - 2015
- Distinguished Lecturer, IEEE Solid State Circuits Society 2013 – 2014
- Distinguished Scholar for "Outstanding Achievement in Advancement of Engineering," Association of Professors and Scholars of Iranian Heritage - 2011
- Inaugural Winner, Maseeh Entrepreneurship Prize Competition, USC - 2011
- NSF CAREER Award - 2009
- USC Viterbi School of Engineering Junior Faculty Research Award - 2008
- DARPA Young Faculty Award - 2008
- Lewis Winner Award for Outstanding Paper, IEEE International Solid-State Circuits Symposium (ISSCC) - 2007
- Best Paper Award, IEEE Journal of Solid-State Circuits - 2004
- Charles Lee Powell Foundation Research Award - 2004
- Young Scholar Award, Association of Professors and Scholars of Iranian Heritage - 2003
- Graduate Fellowship Award, Intel Foundation - 2002
- Outstanding Student Designer Award, Analog Devices - 2001
- Outstanding Accomplishment Award, von Brimer foundation - 2000
- Engineering and Applied Science Division Fellowship, California Institute of Technology - 1999

- Ranked first in Ph.D. EE qualifying exam, California Institute of Technology - 2000
- Ninth place out of 300,000 in national qualifying exam for undergraduate studies – 1993

11. I have co-authored two books and over 125 peer-reviewed journal and conference papers. I have also spoken at numerous invited workshops, talks and short courses. Many of these relate directly or indirectly to antennas, antenna arrays and various modes of wireless communication and electronics design.

12. I am the named inventor on 15 United States Patents, including patents related to antenna technology, including U.S. Patent Nos. 10,615,949 (Hybrid-based cancellation in presence of antenna mismatch) and 8,203,484 (Path-sharing transceiver architecture for antenna arrays).

III. Legal Standards

13. While I am not an attorney, I have been informed by counsel of certain legal principles I should apply in reaching my opinions in this matter. Also, as an inventor, expert witness and otherwise in the course of my work, I have experience studying and analyzing patents and patent claims from the perspective of a person of ordinary skill in the art (POSITA or "skilled artisan").

A. Claim Construction

14. I understand that claim terms are to be interpreted from the point of view of a person of ordinary skill in the art (also referred to herein as the "skilled artisan") at the time the application leading to the patent was filed. I further understand that claim terms are generally to be given their ordinary meaning, considered in light of the claim language, patent specification, and prosecution history. I further understand that a patentee may act as its own lexicographer and depart from the ordinary and customary meaning by defining a term with reasonable clarity, deliberateness, and precision, but that there is a presumption that a claim term carries its ordinary and customary meaning.

B. Person of Ordinary Skill in the Art

15. I understand that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. He or she is a person of ordinary creativity who understands the scientific and engineering principles applicable to the pertinent art. I am familiar with the knowledge and capabilities of one of ordinary skill in the art in the field of the '365 Patent at the time of invention.

16. I understand that whether a patent claim would have been obvious is determined through the point of view of a person of ordinary skill in the art at the time of the invention. I have applied this standard in my analysis.

C. Validity

17. I understand that to invalidate a claim, Petitioners must show that there is a reasonable likelihood of success as to any of the claims challenged. I understand that Petitioners bear the burden of proving any instituted grounds of invalidity by a preponderance of the evidence. I understand that a "preponderance" means "more likely than not." I understand that general and conclusory assertions, without underlying factual evidence, may not support a conclusion that something is "more likely than not." Rather, the preponderance of the evidence standard requires that a reasonable finder of fact be convinced that the existence of a specific material fact is more probable than the non-existence of that fact. The preponderance of the evidence standard does not support speculation regarding specific facts and is instead focused on whether the evidence more likely than not demonstrates the existence or non-existence of specific material facts. Here, I understand that Petitioners have argued that the claims at issue are obvious over different grounds, each applying a combination of two or more references.

18. I also understand that, in performing a proper unpatentability analysis, an expert must do more than simply provide quotes from the evidentiary record along with conclusory allegations of unpatentability. To the contrary, an expert's conclusions regarding unpatentability must be supported by actual analysis and reasoning set forth in the expert declaration, such that the theoretical and factual foundation for the expert's conclusions can be properly evaluated.

19. I understand that a patent claim may be found unpatentable as obvious under 35 U.S.C. §103 only if the Office establishes by a preponderance of the evidence that, as of the priority date, the subject matter of the claim, considered as a whole, would have been obvious to a person having ordinary skill in the field of the technology (the "art") to which the claimed subject matter belongs.

20. I understand that the analysis of whether a claim is obvious depends on a number of necessary factual inquiries, for example, (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of non-obviousness.

21. I understand that the claimed invention must be considered as a whole in analyzing obviousness or non-obviousness. In determining the differences

between the prior art and the claims, the question under the obviousness inquiry is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Relatedly, I understand that it may be appropriate to consider whether there is evidence of a "teaching, suggestion, or motivation" to combine the prior art teachings in the prior art, the nature of the problem or the knowledge of a person having ordinary skill in the art. I further understand arguments in support of obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

22. I have also been informed that some examples of rationales that may support a conclusion of obviousness include:

- a) Combining prior art elements according to known methods to yield predictable results;
- b) Simply substituting one known element for another to obtain predictable results;
- c) Using known techniques to improve similar devices (or product) in the same way (*e.g.*, obvious design choices);

- d) Applying a known technique to a known device (or product) ready for improvement to yield predictable results;
- e) Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success—in other words, whether something is "obvious to try";
- f) Using work in one field of endeavor to prompt variations of that work for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- g) Arriving at a claimed invention as a result of some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings.

23. I have also been informed that other rationales to support a conclusion of obviousness may be relied upon, for instance, that common sense (where substantiated) may be a reason to combine or modify prior art to achieve the claimed invention.

24. I understand that one indicator of non-obviousness is when prior art "teaches away" from combining certain known elements. For example, a prior art reference teaches away from the patent's particular combination if it leads in a

different direction or discourages that combination, recommends steps that would not likely lead to the patent's result, or otherwise indicates that a seemingly inoperative device would be produced.

25. I understand that an obviousness determination also requires that a person of ordinary skill in the art would have had a reasonable expectation of success in making any modifications to the cited references.

26. I further understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious, including the existence of a long-felt but unsolved need, unexpected results, commercial success, copying, and industry acceptance or praise. Evidence of such objective indicia must be considered when present. It is generally an error to reach a conclusion on obviousness before considering the evidence of secondary considerations, and then evaluating the latter solely in terms of whether it may fill any gaps in the initial conclusion on obviousness. On the other hand, such evidence is not a requirement for patentability, and the absence of such evidence is a neutral factor in the analysis of obviousness or non-obviousness.

27. I also understand that a prior art reference must be enabled to anticipate a patent. That is, I understand that the prior art reference's description must be such

that a person of ordinary skill in the field of the invention can practice the subject matter based on the reference without undue experimentation.

28. Finally, I understand that the obviousness analysis cannot be based on “hindsight.” The skilled artisan must view prior art at the time the invention was made and without using the disclosure of the subject patent as a guide.

IV. Material Reviewed

29. In forming the opinions offered in this Declaration I reviewed and considered as appropriate the following materials, the '365 Patent and its prosecution history, the Petition, the Expert Declaration of David M. Pozar, Ph.D. (Ex. 1003), and the remaining exhibits to the Petition and any additional materials cited herein.

V. Background

A. Person of Ordinary Skill in the Art

29. I understand that Petitioners have relied upon the following definition of a POSITA utilized by Fractus in prior litigation involving the '365 Patent:

[A] person with at least a bachelor's degree in electrical engineering, computer science, or a similar degree and at least four years of experience in applied electromagnetics with an emphasis on antennas. Alternatively, the person of ordinary skill in the art would have a

master's degree in electrical engineering (or similar discipline) and at least two years of similar experience.

Petition, 6, *citing* Ex. 1009, 8-9 at ¶32, Ex. 1003 at ¶39. For the purpose of forming my opinions as set forth in this Declaration I have applied this definition of a POSITA.

B. Overview of the '365 Patent

30. The '365 Patent is entitled "Multi-Band Monopole Antennas for Mobile Communications Devices," and issued on June 4, 2013. EX1001, 1. I understand the '365 Patent issued from United States Patent Application No. 12/228,487, filed on August 13, 2008, which is a continuation of U.S. Patent Application No. 10/584,442, filed on July 18, 2006 (now U.S. Patent No. 7,423,592), which is a national stage application of international application No. PCT/EP2005/000880, filed January 28, 2005, which claims priority from U.S. Provisional Application No. 60/540,450, filed January 30, 2004. It is my understanding that Patent Owner has taken the position in litigation that at least claims 1-2, 4-8, 12-13, 31-32, 35-37, and 41 are entitled to a priority date of December 5, 2003, based on the conception of the invention and no later than January 30, 2004, based on the filing of U.S. Provisional Application No. 60/540,450, EX1007, 2, 4. I have not been asked to offer an opinion on this issue

and, accordingly, have assumed for purposes of my analysis that all the claims are entitled to a priority date of at least January 30, 2004, the filing date of the U.S. provisional patent application.

31. The '365 Patent explains that prior art antennas mounted inside a mobile communication device suffered from problematic amounts of electromagnetic interference and provided limited bandwidth, making implementation of an internally mounted multi-band antenna difficult. EX1001, 34 (1:26-39). The multi-band antennas for use in a mobile communication device disclosed in the '365 Patent, overcomes such problems by implementing internal antenna elements with multiple branches, called "radiating arms," having specific characteristics and arrangements. At least one radiating arm of the antenna elements described in the '365 Patent can include a shape that meets the requirements of a "space filling curve" and/or "grid dimension curve." EX1001, 35, 38-39 (3:1-23; 6:50-8:10). Such shapes enable a compact, internal radiating arm to have sufficient length to operate at lower-frequency bands. EX1001, 35 (3:43-51).

32. The disclosed mobile communication device includes a printed circuit board (PCB) with a ground plane layer, a feeding point, and communication circuitry. The radiating arms of the multi-band antenna element are connected via a

common conductor that includes a feeding port that is coupled to the PCB's feeding point such that the antenna element operates in cooperation with the ground plane layer. EX1001, 20-23, 35-36 (Figs. 10, 12, 13, 14; 4:49-5:26; 5:49-6:50). In some embodiments, at least portions of the radiating arms are arranged on different planes. EX1001, 29-32, 37-38 (Figs. 20a-23; 8:13-9:49).

C. Claim Construction

33. I have reviewed and understand Petitioners' claim construction (Petition, 7-13), and do not necessarily agree with it. Any differences I have with Petitioners' claim construction, however, are not directly pertinent to any of the opinions that I am offering in this Declaration and, accordingly, are not addressed. I reserve, however, the right to disagree with Petitioners' claim construction and to provide different and additional opinions on claim construction if an IPR is instituted.

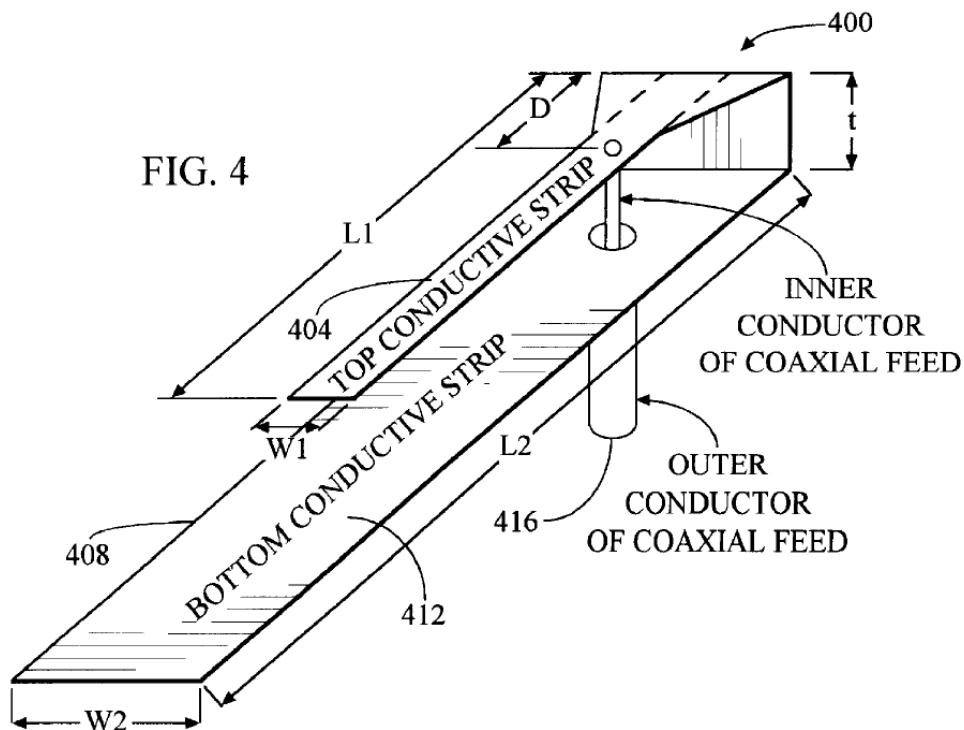
D. Overview of the Cited Art

1. Tran

34. U.S. Patent No. 6,184,833 to Tran, entitled "Dual Strip Antenna" ("Tran") issued on February 6, 2001. Tran is generally directed to a dual strip antenna that provides a broader bandwidth with a reduced antenna size. As depicted

in Figure 4, an example dual strip antenna 400 includes a top (first) conductive strip 404 arranged above and parallel to a larger bottom (second) conductive strip 408. The two strips are electrically connected to each other at one end and separated by a dielectric material 412. EX1005, 1, 3, 18-19, 21 (Abstract; Fig. 4; 2:65-3:7; 2:35-37; 7:63-8:9).

35. Tran's antenna utilizes a distinctive principle of operation, in that it functions as an "open-ended parallel plate waveguide" having "asymmetrical conductor terminations." EX1005, 20-23 (5:39-41; 8:59-65; 9:3-7; 11:54-59). Both the first and second conductive strips in Tran's antenna are active radiators. EX1005, 21-23 (8:66-9:9; 11:63-12:3). An inner, positive conductor of a coaxial feed is electrically connected to the top strip 404 at a distance from the connected end, and an outer, negative conductor of the coaxial feed is electrically connected to the bottom strip 408, also at a distance from the connected end. EX1005, 19, 21, 23, 24 (3:8-13; 7:67; 8:37-43; 12:39-42; 13:12-14). Accordingly, the two radiating strips of Tran's antenna are separately fed by two different conductors at two different points and with two different signals at different potentials, and neither radiating strip is fed at the commonly connected end as illustrated by Tran's Figure 4 below:



36. Tran explains the significance of its invention by noting that the overall sizes of then-existing antenna designs, such as whip antennas and microstrip antennas, were problematic for wireless communication devices.

It may also require a minimum device housing dimension when retracted that is larger than desired. While the antenna can be configured with additional telescoping sections to reduce size when retracted, it would generally be perceived as less aesthetic, more flimsy or unstable, or less operational by consumers.

EX1005, 18 (2:2-7)

Another area in which further improvement is desired is the size of a microstrip antenna. For example, a reduction in the size of a microstrip antenna would make a wireless communication device in which it is used more compact and aesthetic.

EX1005, 20 (5:17-21)

37. Tran's antenna, in contrast, was designed to achieve "antenna compactness" EX1005, 1 (Abstract).

One area in which a reduction in size is still desired is communication device antennas. This is due to the fact that the size of the antenna can play an important role in decreasing the size of the device. In addition, the antenna size and shape impacts device aesthetics and manufacturing costs.

EX1005, 18 (1:31-36)

One such area in which a further improvement is desired is a reduction in overall size.

EX1005, 18 (2:49-50).

38. Another design goal of Tran is to increase the bandwidth of the antenna without increasing its size. EX1005 1, 18-23 (Abstract; 1:9-13; 1:47-58; 2:56-59; 4:11-18; 5:9-16; 5:42-45; 8:56-65; 9:14-16; 11:46-57; 12:4-19; 12:57-62).

39. Tran's disclosure relates exclusively to the design of a single-band antenna. Tran's two radiator strips have center frequencies that are offset from each other, one to each side of a center frequency of a single operating band. The bandwidths of the two radiators are combined to achieve a single, wider bandwidth at one operating frequency band.

In order to enhance the radiator or antenna bandwidth, the dimensions of each strip, in a preferred embodiment, are chosen to establish different center frequencies which are related to each other in a preselected manner. For example, say that f_0 is the desired center frequency of the antenna. The length of the shorter strip can be chosen such that its center frequency resides at or around $f_0 + \Delta f$, and the length of the longer strip such that its center frequency is at or around $f_0 - \Delta f$. This provides the antenna with a wide bandwidth on the order of from $3\Delta f/f_0$ to $4\Delta f/f_0$.

EX 1005, 23 (12:4-15).

40. While Tran's two radiator strips have offset center frequencies, Tran's antenna is not a multi-band antenna with each strip acting as an independent antenna radiator. After describing the technique of achieving a broader single-band bandwidth from the two offset center frequencies of the two radiator strips, Tran clarifies that:

In other words, this is not intended for use as a dual-band antenna with each strip acting as an independent radiator.

EX1005, 23 (12:20-22).

41. Tran provides two detailed embodiments of single-band antennas. The first is a dual strip antenna that operates at the single cellular band from 824-894 MHz. EX1005, 23 (12:23-62). Tran's Table I lists the lengths and widths of the first strip 404 (3.0 in. x 0.2 in.) and the second strip 408 (4.9 in. x 0.4 in.) and the thickness of the dielectric 412 between the strips (0.3 in.). Considering the size of the antenna of Tran's first embodiment volumetrically, the minimum-sized rectangular box into which the antenna fits is:

$$4.9 \text{ in.} \times 0.4 \text{ in.} \times 0.3 \text{ in.} = 124.5 \text{ mm} \times 10.2 \text{ mm} \times 7.6 \text{ mm} = 9,651.2 \text{ mm}^3$$

42. As shown in Tran's Fig. 10, the frequency response of the dual strip antenna of the first embodiment covers only the single band from 824-894 MHz.

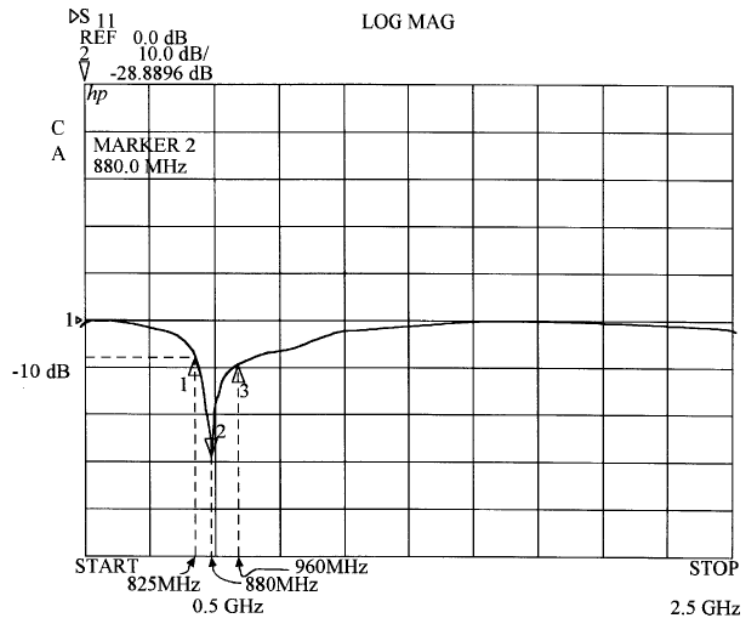


FIG. 10

43. The dual strip antenna of Tran's second embodiment operates at the single cellular PCS band from 1.85-1.99 GHz. EX1005, 23, 24 (12:63-13:14). Tran's Table II lists the dimensions of the first strip 404 (1.34 in. x 0.2 in.), the second strip 408 (2.21 in. x 0.2 in.), and the thickness of the dielectric 412 (0.08 in.) for the dual strip antenna of the second embodiment. Considering the size of the antenna of Tran's second embodiment volumetrically, the minimum-sized rectangular box into which the antenna fits is:

$$2.21 \text{ in.} \times 0.2 \text{ in.} \times 0.08 \text{ in.} = 56.1 \text{ mm} \times 5.1 \text{ mm} \times 2.0 \text{ mm} = 572.2 \text{ mm}^3$$

44. As shown Tran's Fig. 11, the frequency response of the dual strip antenna of the second embodiment covers only the single PCS band from 1.85-1.99 GHz. Thus, neither of Tran's embodiments suggests operation at two frequency bands, and the design of Tran's antenna is not capable of supporting transmission or reception of signals at two frequency bands.

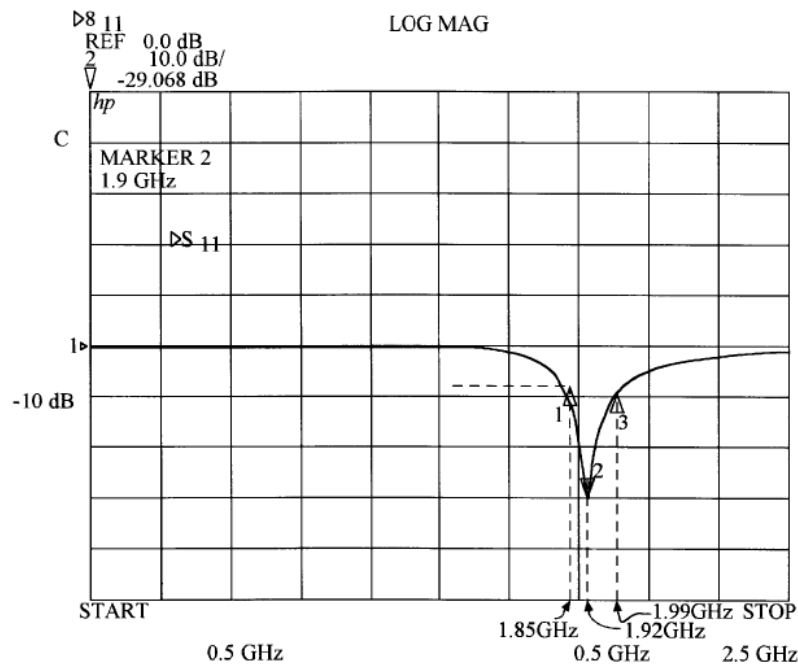


FIG. 11

45. As background and context for why the disclosed single-band dual strip antenna is smaller than comparable then-known antennas, Tran explains that certain types of antennas require both a radiating element and a ground plane. Because the

ground plane of such antennas is much larger than their radiating element, it contributes significantly to the overall size of the antenna.

FIG. 2 shows a conventional microstrip patch antenna 200. Antenna 200 includes a microstrip element 204, a dielectric substrate 208, a ground plane 212 and a feed point 216. Microstrip element 204 (also commonly referred to as a radiator patch) and ground plane 212 are each made from a layer of conductive material, Such as a plate of copper.

EX 1005, 20 (6:55-6:60).

A second microstrip antenna commonly used is the quarter wavelength microstrip antenna. The ground plane of the quarter wavelength microstrip antenna generally has a much larger area than the area of the microstrip element. The length of the microstrip element is approximately a quarter wavelength at the frequency of interest in the substrate material. The length of the ground plane is approximately one-half wavelength at the frequency of interest in the substrate material.

EX1005, 21 (7:38-46).

46. Tran contrasts the size requirements of its dual strip antenna with antennas requiring both a radiating element and a ground plane. Specifically, Tran

notes that the dual strip antenna design reduces the overall length and area required because its largest component, the second, lower radiator strip, is much shorter than the length of a ground plane required for a conventional antenna. Tran also states that the area of the second radiator strip is "much smaller" than the area of the ground plane required for a conventional microstrip antenna.

In dual strip antenna 400, the length of first strip 404 is approximately 20 percent less than the length of the radiator patch of a quarter wavelength microstrip antenna operating at the same frequency. The length of second strip 408 is approximately 40 percent less than the length of the ground plane of a quarter wavelength microstrip antenna operating at the same frequency. Thus, the present invention allows a significant reduction in the overall length of the antenna, thereby making it more desirable for use in personal communication devices.

Generally, the ground plane of a conventional microstrip antenna is required to be much larger than the radiator patch. Typically, it is at least one-half of the wavelength in dimension in order to work properly. In dual strip antenna 400, the area of second strip 408 is much smaller than the area of the ground plane of a conventional

microstrip antenna, thereby significantly reducing the overall size of the antenna.

EX1005, 21 (8:20-36).

47. Contrasting the size of its second radiating strip to the size of a ground plane is meaningful only if Tran's antenna does not include a ground plane. The second radiating element is the largest component of Tran's antenna, unlike antennas that include a ground plane. In fact, Tran explicitly highlights this distinction.

Unlike a conventional microstrip patch antenna having a radiator patch and a ground plane, in the dual strip antenna, both the first and second strips act as active radiators. During operation of the dual strip antenna, surface currents are induced in the first strip as well as in the second strip. ... In other words, the length and the width of the first and second strips are carefully sized so that both the first and second strips perform as active radiators.

EX1005, 21-23 (8:66-9:9).

48. These passages show that Tran's disclosure considers the appropriate size comparison between antennas as requiring inclusion of both an antenna's radiating element and its ground plane, where a ground plane is part of the antenna structure. Tran uses this methodology when comparing the size of its dual strip

antenna, which does not include or require a ground plane, with antennas that do include a ground plane.

49. Figs. 14A and 14B of Tran show the overall layout of the antenna system within a mobile phone, including a printed circuit board (PCB). The only mention of any ground plane within the cellular phone is a single sentence stating that "either layer 1414 or 1418 [of the PCB] could form a ground layer or ground plane for board 1402, as would be known in the art." EX1005, 24 (13:55-57). Despite Tran's use of reference numerals, layers 1414 and 1418 are not identified in any of Tran's figures, including Figs. 14A and 14B. Tran does not suggest that the ground plane mentioned in this passage is part of the dual strip antenna or that the antenna uses or relies on the ground plane. Rather, the PCB's ground layer or ground plane is described merely as being "for board 1402." EX1005, 24 (13:56).

2. Teng

50. Teng, P.L. & Wong, K.L., "Planar monopole folded into a compact structure for very-low-profile multiband mobile-phone antenna." *Microwave and Optical Technology Letters*, vol. 33, no. 1, 2002 ("Teng") discloses a planar monopole antenna having three meandering branch strips designed to operate as quarter-wavelength radiators at three respective, different frequencies: 900 MHz,

1800 MHz, and 1900 MHz. EX1006, 4 (p. 22). The antenna is formed on one side of a substrate and then folded into a three-dimensional box-like shape. EX1006, 5 (p. 23). Teng's antenna also includes a ground plane that is substantially larger than the three-branch radiating element. EX1006, 23. All three branches of Teng's radiating element are fed at a common point via a single microstrip line conductor. EX1006, 6 (p. 24).

51. Teng's antenna is designed to radiate at frequencies that overlap with only one of the single bands covered by Tran's single-band antennas, *i.e.*, at 1900 MHz. Teng's antenna does not have a radiating element or branch that corresponds to the frequency band covered by the first embodiment of Tran's single-band dual strip antenna (824-894 MHz). Because lower frequencies require longer radiator lengths, to provide operation at frequencies within the operating band of Tran's first embodiment, Teng's antenna would have required modification to include a longer branch radiator. No evidence or arguments presented with the Petition attempt to establish that such a modification to Teng's antenna would have been feasible within the space constraints of Teng's antenna or whether such a modified antenna would have suitable operating characteristics.

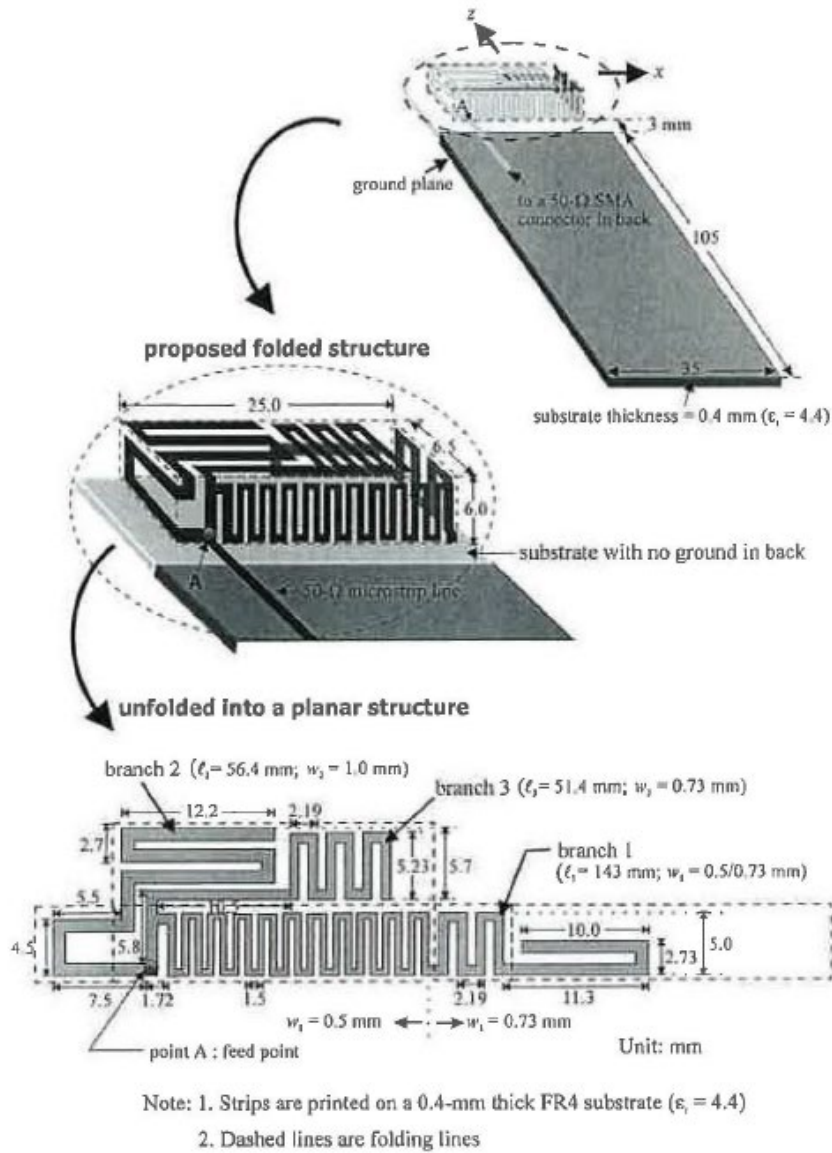


Figure 1 Proposed planar monopole folded into a compact structure for multiband mobile phone antennas

52. As a monopole antenna, Teng's antenna requires both a radiating element and a ground plane. In addition, the positioning of the radiating element

relative to the ground plane is critical to the operating characteristics of the antenna.

EX1006, 6 (p. 24).

Notice that the top portion has no ground plane in back, and the proposed antenna should be placed at a minimum distance of 3 mm away from the other portion with a ground plane in back (see the figure), which has dimensions of 35 x 105 mm².

EX1006, 6 (p. 24).

53. Teng's three-branch radiating element has a height of 6.5 mm, a width of 6 mm, and a length of 25 mm. EX1006, 4, (p. 22). As shown in Teng's Fig. 1 and like the prior art antennas Tran compares to its single-band dual strip antenna, the ground plane of Teng's antenna is considerably larger than its three-branch radiating element, making the ground plane the dominant component for the space requirements of Teng's antenna.

VI. A Person of Ordinary Skill in the Art Would Not Combine Tran and Teng in Order to Obtain the Claimed Inventions

54. It is my opinion that a POSITA would neither have been motivated to combine nor would have had a reasonable expectation of success in combining Tran and Teng due to fundamental differences between the disclosures in both references that were either inaccurately represented or overlooked in the Petition and by

Petitioners' expert. These include (1) Tran discloses only a single-band antenna and not a multi-band antenna as asserted in the Petition; (2) Tran's antenna intentionally avoids using a ground plane, so replacing Tran's antenna with one requiring a ground plane would not have been obvious; (3) contrary to the statements in the Petition, Teng's antenna is substantially larger than Tran's antenna; (4) Teng's antenna cannot operate at the frequency band covered by the single-band antenna of Tran's first embodiment (824-894 MHz) and would need to be modified to include a larger radiating branch to reach such low frequencies; (5) the feeding mechanisms of Tran and Ten are fundamentally different and incompatible.

55. The Petition states a POSITA would have been motivated to replace Tran's antenna with Teng's antenna because Tran's antenna is a multiband antenna. *See* Petition, 14 ("Tran's antennas are dual-band antennas"); *id.* at 17 ("Tran's desire for 'small' multiband antennas (Tran, 1:24-37)"); *id.* at 18 ("Tran's antenna operated on GSM850 and PCS1900 bands. Tran, FIG 10, 12:23-27, 12:56-57"); *id.* at 19 ("Tran discloses mounting its multi-band antenna"). As I note in paragraph 44, however, Tran's antenna is not a multi-band antenna, but rather a single-band antenna. Indeed, Tran explicitly states its antenna is "not intended for use as a dual-band antenna." EX1005, 23 (12:20-22).

56. Because Tran's dual-strip antenna is designed to operate at a single frequency band, all of the components and communication circuitry on Tran's printed circuit board that enable operation of Tran's wireless phone would necessarily be designed to handle communication signals transmitted and received in a single frequency band. This communication circuitry would not be capable of transmitting or receiving signals in more than one frequency band or of discriminating between or switching operation between different frequency bands, as would be necessary in a mobile device supporting two or more frequency bands. The Petition is proposing to change Tran's single-band communication device into a multi-band communication device merely by swapping a single-band antenna for a multi-band antenna without addressing how the single-band architecture of Tran's electronics could be adapted to support multiple bands. I note that the Petition relies exclusively on Tran for the "communication circuitry" recited in the claims (Petition, 27-28) but fails to address how the single-band architecture of Tran's electronics could be adapted to support multiple bands, because the Petition incorrectly characterizes Tran's antenna as being "multi-band."

57. The Petition also states that Tran's antenna uses a ground plane. *See* Petition, 17 (noting that Tran has a ground plane); *id.* at 23 ("Tran, 13:43-57 (PCB

comprises 'dielectric material layer 1412 disposed next to *metallic conductor layer* 1414 disposed next to dielectric material layer 1416 supporting or disposed next to *metallic conductor layer 1418*' wherein 'either layer 1414 or 1418 *could form a ground layer or ground plane* for board 1402, as would be known in the art.'" (emphasis original). As I note in paragraphs 46-48, however, Tran's antenna not only does not use a ground plane, but expressly relies on the benefits of not having a ground plane. EX1005, 21 (8:20-36). In fact, Tran specifically explains there is a size benefit of not using a ground plane in contrasting the ground-plane-less two-strip design with antennas that require a ground plane.

58. I do not think that it would have been a simple substitution to replace Tran's single band two-strip antenna, which does not require a ground plane, with a multi-band antenna such as Teng's three-branch radiating element, which does require a ground plane. Making the change would require introducing a ground plane into an antenna design in which a ground plane was not required or desired.

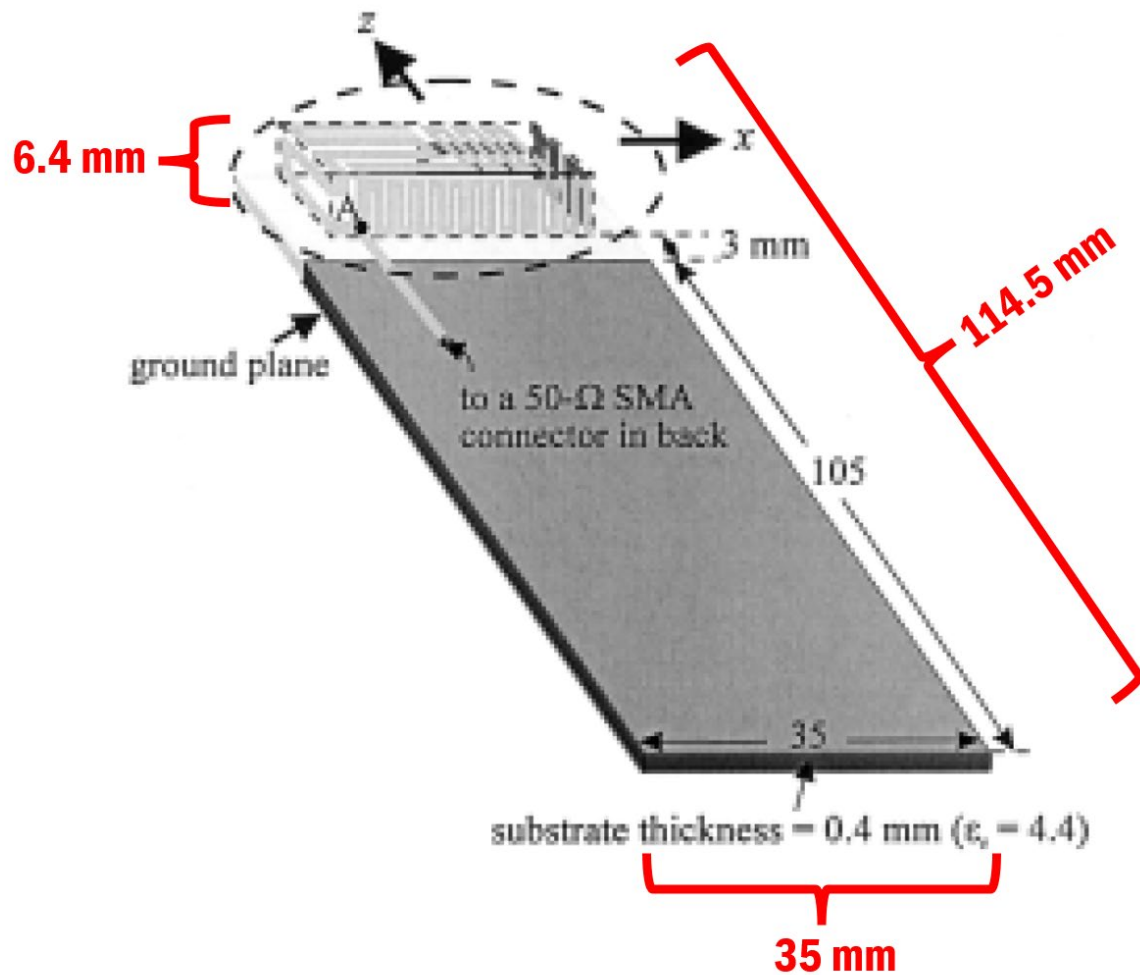
59. Tran's disclosure explains why introducing a ground plane in its antenna design is undesirable – it greatly increases the overall size of the antenna. EX 1005, 20 (6:55-6:60). Tran considers the appropriate size comparison between antennas as requiring inclusion of both an antenna's radiating element and its ground

plane, where a ground plane is part of the antenna structure. Tran uses this methodology when comparing the size of its dual strip antenna, which does not include or require a ground plane, with antennas that do include a ground plane. Tran compares the size of its dual strip antenna with antennas requiring both a radiating element and a ground plane, explaining that the dual strip antenna design reduces the overall length and area compared to the length and area required by the ground plane of a conventional antenna. EX1005, 21 (8:20-36). The "significantly reducing the overall size of the antenna" would not be so if Tran's antenna also required a ground plane. Tran's contrasting of the size of its second radiating strip to the size of a conventional ground plane is meaningful only if Tran's antenna does not include a ground plane. The second radiating element is the largest component of Tran's antenna, unlike antennas that include a ground plane.

60. The Petition further relies on the assertion that "Teng's compact antenna ($6.5 \times 6 \times 25 \text{ mm}^3$, Teng 25) is substantially smaller than Tran's internal antenna ($4.9 \times .04 \times 0.3 \text{ inches}^3 \cong 124 \times 10 \times 8 \text{ mm}^3$, Tran, 12;23-41)." Petition, 17; "Teng's antenna is 'compact,' smaller than Tran's, and intended for use in a 'practical mobile headset.'" *Id.* at 20, citing Teng 24. As seen in Teng's Figure 1, however, like the ground-plane-dependent antennas Tran compares to its single-band dual strip

antenna, the ground plane of Teng's antenna is considerably larger than its three-branch radiating element, making the ground plane the dominant component for the space requirements of Teng's antenna.

61. The comparable size of Teng's antenna with Tran's, therefore, requires determining the volume of the smallest rectangular box that encloses both components of Teng's antenna, *i.e.*, both the three-branch radiating element and the ground plane.



62. The overall length of Teng's antenna includes: 1) the length of the ground plane (105 mm); 2) the length of the side of Teng's radiating element in the length direction (6.5 mm); and 3) the space between the radiating element and the ground plane (3.0 mm). Thus, the length dimension of Teng's antenna is:

$$105 \text{ mm} + 6.5 \text{ mm} + 3 \text{ mm} = 114.5 \text{ mm}$$

63. The height of Teng's antenna is determined from the sum of the height of the radiating element, which is 6 mm, and the thickness of the ground plane, which is 0.4 mm (the bottom of the radiating element is substantially coplanar with the top of the ground plane layer), totaling 6.4 mm. The width of Teng's antenna is determined from the width of the ground plane (the widest component), which is 35 mm. The overall volume of Teng's antenna is then:

$$114.5 \text{ mm} \times 35 \text{ mm} \times 6.4 \text{ mm} = 25,648 \text{ mm}^3$$

64. Based on these measurements and the appropriate inclusion of Teng's ground plane, Teng's antenna is over two and half times larger than the single-band antenna of Tran's first embodiment and about 45 times larger than the single-band antenna of Tran's second embodiment. That is, as a result of its need for a ground plane, the overall size of Teng's antenna is substantially larger than every antenna disclosed in Tran. Even using the Petition's incorrect methodology, which ignores the required ground plane in Teng's antenna, Teng's radiating element alone is still larger than the single-band antenna of Tran's second embodiment. Specifically, the volume of Teng's radiating element alone is $25 \text{ mm} \times 6.5 \text{ mm} \times 6 \text{ mm} = 975 \text{ mm}^3$, which is larger than the volume of the antenna of Tran's second embodiment (572.2 mm^3).

65. In addition, Teng's antenna cannot operate at the frequency band covered by the single-band antenna of Tran's first embodiment (824-894 MHz) and would need to be modified to include a larger radiating branch to reach such low frequencies. I have seen no evidence to indicate that such a modification is feasible. In addition, the size of Teng's resulting radiating element is unknown, making it impossible to compare Teng's radiating element and the antenna of Tran's first embodiment.

66. As set forth in paragraphs 35 and 50 above, the feeding mechanisms of Tran and Teng are fundamentally different. Specifically, in Tran the two radiating strips of the antenna are separately fed by two different conductors at two different points and with two different signals at different potentials, and neither radiating strip is fed at the commonly connected end. In contrast, all three branches of Teng's radiating element are fed at a common point via a single microstrip line conductor. I disagree with the Petition and Petitioners' expert that it would have been a "design choice" to utilize either Tran or Teng's feeding point. These are not common, interchangeable options for at least the following reasons.

67. To replace Tran's coaxial cable – which includes two conductors that separately feed two radiating elements with two different signals at two different

feed points – with Teng's single microstrip line conductor – which feeds all three branches of Teng's radiating element at a common point – at a minimum, it would necessary to substantially modify Tran's communication circuitry to accommodate this completely different feeding mechanism to support Teng's antenna, which as previously explained, has a fundamentally different principle of operation. The need to make such substantial changes to Tran's communication circuitry and feeding mechanism do not amount to a simple design choice between two well-known alternatives. The Petition relies exclusively on Tran for the claimed communication circuitry (Petition, 27-28) but then relies on exclusively on Teng for the claimed feeding port on a common conductor (Petition, 39-40) without attempting to reconcile the fundamental incompatibility between these two systems or addressing the substantial changes that would be required within Tran's communication circuitry.

I declare that all statements made herein of my own knowledge are true, 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 are punishable by fine or imprisonment, or both of under Section 1001 of Title 18 of the United States Code.

I declare under penalty of perjury that the foregoing is true and correct.

Date: 08/27/2025

By: 
Hossein Hashemi, Ph.D.