

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Billhartz et al.
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Title: WIRELESS COMMUNICATIONS SYSTEM INCLUDING
A WIRELESS DEVICE LOCATOR AND RELATED
METHODS

DECLARATION OF DR. ZHI DING

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I, Zhi Ding, Ph.D., declare that:

I. Introduction

1. My name is Zhi Ding, and I have been retained by counsel for Petitioner Apple, Inc. (“Apple” or “Petitioner”) as an expert witness to provide assistance regarding U.S. Patent 7,110,779 (“the ’779 Patent”). Specifically, I have been asked to consider the validity of claims 1-34 of the ’779 Patent (the “Challenged Claims”) in view of prior art, anticipation and obviousness considerations, and understanding of a person of ordinary skill in the art (“POSITA”) at the time of the invention, i.e., as of the effective filing date of the patent application as it relates to the ’779 Patent. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto.

2. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study, the substance of my opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or on the pending litigation between Petitioner and Patent Owner.

3. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein.

4. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

5. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. Background and Qualifications

6. I presently hold the title of Distinguished Professor in the Department of Electrical and Computer Engineering at the University of California, Davis. Since my appointment on July 1, 2020, I have held the position of professor for the past 22 years and have served as a faculty member at several US universities for over 30 years. I am also a private technical consultant on various technologies related to information systems. I have more than three decades of research experience on a wide range of topics related to data communications and signal processing.

7. I earned my Bachelor of Science degree in 1982 in wireless engineering from the Nanjing Institute of Technology (later renamed as Southeast University) in Nanjing, China. I earned my Master of Science degree in 1987 in electrical

engineering from the University of Toronto in Toronto, Canada. I earned my Ph.D. in 1990 in electrical engineering from Cornell University in Ithaca, New York.

8. My responsibilities as a Professor at University of California, Davis, include classroom instruction on various topics of communication systems and signal analysis, as well as mentoring undergraduate students and supervising graduate students in their research and development efforts on various topics related to digital communications. I have directly supervised such research and development works ranging from signal detection to wireless networking. As the chief academic advisor, I have also directly supervised the completion of over 20 Masters theses and 30 Ph.D. dissertations on various topics related to digital communications. I have served full time as a faculty member at three major research universities in the United States over the past 30 years, including Auburn University from 1990 to 1998, University of Iowa from 1999 to 2000, and University of California, Davis, from 2000 to present.

9. Since 1990, I have been selected as the principal investigator of multiple highly competitive federal and local research grants, including more than twenty major research projects supported by the National Science Foundation and two research projects funded by the U.S. Army Research Office. These competitive research projects focused on developing more efficient and effective digital communication transceivers, networks, and signal processing tools. I have also

participated in several large-scale projects supported by the Defense Advanced Research Projects Agency (DARPA) with teams of researchers. I have applied for, and received support from, other federal, state, and industry sponsors.

10. I have published over 210 peer-reviewed research articles in premier international journals, in addition to over 240 refereed technical articles at top international conferences on communications and information technologies. According to Google Scholar, my published works have been cited by over 13,000 times by peers. I also authored two books on communications technologies. My most recent book, coauthored with B.P. Lathi, is entitled, “Modern Digital and Analog Communication Systems,” 5th edition, and was published by the Oxford University Press in 2018. The 4th edition of this book (published in 2009) had been widely adopted as an introductory textbook to communication systems.

11. In addition to the over 450 published technical papers that have been cited over 15,000 times according to Google Scholar, I am also co-inventor of 4 issued U.S. patents on communication technologies.

12. I am a member of the Institute of Electrical and Electronics Engineers (IEEE) and was elevated to the grade of Fellow in January 2003 for contributions made in signal processing for communication. The IEEE is the world’s largest professional society of engineers, with over 400,000 members in more than 160 countries. The IEEE has led the development of many standards for modern digital

communications and networking, most notably, the IEEE 802 series of network standards. The IEEE Grade of Fellow is conferred by the Boards of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership.

13. I have served the IEEE in the following capacities:

- Chief Information Officer of the IEEE Communications Society from Jan. 2018 to present.
- Chief Marketing Officer of the IEEE Communications Society from Jan. 2020 to present.
- General Chair of the 2016 IEEE International Conference on Acoustics, Speech, and Signal Processing, the flagship conference of the IEEE Signal Processing Society.
- Chair of the Steering Committee for the IEEE Transactions on Wireless Communications from 2008 to 2010.
- Distinguished Lecturer of the IEEE Communications Society from January 2008 to December 2009.
- Technical Program Chair of the 2006 IEEE Globecom, one of two flagship annual IEEE Communication Society conferences.

- Distinguished Lecturer of the IEEE Circuits and Systems Society from 2004 to 2005.
- Associate Editor of the IEEE Transactions on Signal Processing from 1994 to 1997 and from 2001 to 2004.
- Member of the IEEE Statistical Signal and Array Processing for Communications Technical Committee from 1993 to 1998.
- Member of the IEEE Signal Processing for Communications Technical Committee from 1998 to 2004.

14. In 2012, I received the Wireless Communications Technical Committee Recognition Award from the IEEE Communications Society, an award given to a person with a high degree of visibility and contribution in the field of “Wireless and Mobile Communications Theory, Systems, and Networks.” I received the 2020 Education Award from the IEEE Communications Society. According to the Society, this award “recognizes distinguished and significant contributions to education within the Society’s technical scope.”

15. I have also served as a technical consultant for the telecommunication industry. For example, in 1995 I consulted for Analog Devices, Inc., on the development of the first generation DOCSIS cable modem systems. I have also consulted for other companies, including Nortel Networks and NEC US Laboratories. I worked as a visiting faculty research fellow at NASA Glenn Research

Center in 1992 and at U.S. Air Force Wright Laboratory in 1993. I have served on multiple review panels of the National Science Foundation to evaluate competitive research proposals in the field of communication. I have also reviewed a large number of research proposals at the request of the National Science and Engineering Research Council (NSERC) of Canada as an expert panelist from 2010 to 2013, and also at the request of the Research Grant Council (RGC) of Hong Kong as an external reviewer.

16. I have served as an expert witness or consulting expert on a number of matters related to intellectual property, mostly in the arena of telecommunications, including cellular communications, Wi-Fi technologies, Bluetooth, and optical communications. For example, since 2007, I have been engaged to work on various litigations involving cellular, WiFi, Bluetooth, and optical communication networks.

17. Further experience and a complete list of my publications are presented in my curriculum vitae. I understand that a copy of my curriculum vitae is attached as APPLE-1004.

18. Based on my above-described near three decades of experience in communications technologies, and the acceptance of my publications and professional recognition by societies in my field, I believe that I am qualified to be an expert in wireless communication systems, communication networks, and signal processing.

19. Based on my experiences described above, and as indicated in my Curriculum Vitae, I am qualified to provide the following opinions with respect to the patents in this case. Additionally, I was at least a person having ordinary skill in the art as of January 29, 2004 (“Critical Date”).

III. Level of Ordinary Skill in the Art

20. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of one of ordinary skill at the time of the alleged invention, which I understand is asserted to be January 29, 2004 (the filing date of '779 Patent). I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time of the alleged invention. I understand that one of ordinary skill is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that one of ordinary skill would also have knowledge from the teachings of the prior art, including the art cited below.

21. Taking these factors into consideration, on or before January 29, 2004, one of ordinary skill relating to the technology of the '779 Patent would have had a Bachelor's degree in electrical engineering, computer engineering, computer science, or a related field, and 2-3 years of experience in design or development of wireless

communication systems/networks including ranging/positioning systems, or the equivalent. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education.

22. Before January 29, 2004, my level of skill in the art was at least that of one of ordinary skill. I am qualified to provide opinions concerning what one of ordinary skill would have known and understood at that time, and my analysis and conclusions herein are from the perspective of one of ordinary skill as of that date.

IV. Summary of Opinions and Materials Considered/Relied Upon

23. In reaching the conclusions described in this declaration, I have relied on the documents and materials cited herein as well as those identified in this declaration, including the '779 Patent, the prosecution history of the '779 Patent, and prior art references cited herein. These materials comprise patents, related documents, and printed publications. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions.

24. I have also relied on my education, training, research, knowledge, and personal and professional experience in the relevant technologies and systems that were already in use prior to, and within the timeframe of the earliest proclaimed priority date of the claimed subject matter in the '779 Patent, which is January 29,

2004 (“Critical Date”).

- APPLE-1001: U.S. Patent 7,110,779 to Thomas Jay Billhartz, *et al.* (“the ’779 Patent”)
- APPLE-1002: Excerpts from the Prosecution History of the ’779 Patent (“the Prosecution History”)
- APPLE-1005: U.S. Patent 6,453,168 to McCrady (“McCrady”)
- APPLE-1006: U.S. Patent 7,511,604 to Raphaeli, *et al.* (“Raphaeli”)
- APPLE-1007: U.S. Patent 6,070,079 to Kuwahara (“Kuwahara”)
- APPLE-1008: WO2003098528 to Raphaeli, *et al.* (“Raphaeli”)
- APPLE-1009: U.S. Patent 7,058,414 to Rofheart (“Rofheart”)
- APPLE-1010: Hargrave’s Communications Dictionary, 2001 (excerpts)
- APPLE-1011: The Authoritative Dictionary of IEEE Standards Terms, 2000 (excerpts)
- APPLE-1014: Complaint for Patent Infringement Against Apple Inc., *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1015: Amended Complaint for Patent Infringement Against Apple Inc., *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1016: Preliminary Disclosure of Asserted Claims and Infringement Contentions to Defendant Apple Inc., *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1017: Apple’s Opening Claim Construction Brief, *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1018: Speir’s Responsive Claim Construction Brief, *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1019: U.S. Patent 6,181,944 to Uebayashi *et al.* (“Uebayashi”)

- APPLE-1020: U.S. Patent 5,945,948 to Buford *et al.* (“Buford”)
- APPLE-1021: U.S. Patent 5,929,806 to Birchler *et al.* (“Birchler”)
- APPLE-1022: U.S. Patent 5,365,516 to Jandrell (“Jandrell”)
- APPLE-1023: U.S. Patent 6,760,882 to Gesbert *et al.* (“Gesbert”)
- APPLE-1024: U.S. Patent App. Pub. 2006/0234725 to Litwin (“Litwin”)
- APPLE-1025: U.S. Patent 6,760,882 to Christoffel *et al.* (“Christoffel”)
- APPLE-1026: C. Eisenhart, “Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems,” JOURNAL OF RESEARCH of the National Bureau of Standards-C. Engineering and Instrumentation, Vol. 67C, No.2, April-June 1963 (“Eisenhart”).
- APPLE-1027: U.S. Patent Publication 2003/0013146 to Werb (“Werb”)
- APPLE-1028: U.S. Patent Publication 2005/0130634 to Godfrey (“Godfrey”)
- APPLE-1029: U.S. Provisional No. 60/515,701 (“Godfrey-Provisional”)
- APPLE-1030: ANSI/IEEE Std 802.11, *Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications* (Aug. 20, 1999) (“IEEE 802.11”)
- APPLE-1031: Order Resetting Markman Hearing, *Speir Technologies Ltd. v. Apple Inc.*, Case 6:22-cv-00077-ADA (WDTX)
- APPLE-1032: L. van der Perre, S. Thoen, P. Vandenameele, B. Gyselinckx and M. Engels, “Adaptive loading strategy for a high speed OFDM-based WLAN,” IEEE GLOBECOM 1998 (Cat. NO. 98CH36250), 1998, pp. 1936-1940.

25. In my opinion, the Challenged Claims of the '779 Patent are unpatentable because they are rendered obvious by the combinations of prior art references cited in this report and explained herein. The following table summarizes my opinions.

'779 Patent Claims	Prior Art Invalidity
1, 2, 8-10, 12-13, 18-19, 22-24, 26-28, 32, 34	Obvious over McCrady and Raphaeli (Ground 1)
1, 3-6, 10-11, 13-17, 20-21, 24-25, 29-33	Obvious over McCrady, Raphaeli, and Rofheart (Ground 2)
6-7, 17, 21, 31	Obvious over McCrady, Raphaeli, and Kuwahara (Ground 3)
1-6, 8-34	Obvious over Rofheart, Raphaeli, Godfrey (Ground 4)

V. Legal Standards

26. I am not a lawyer and do not provide any legal opinions, but I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding meaning and validity of patent claims. I have applied the legal standards described below, which were provided to me by counsel for the Petitioner.

27. It is my understanding that assessing the validity of a U.S. patent based on a prior art analysis requires two steps. First, one must construe the terms of the patent claims to understand what meaning one of ordinary skill in the art would have

given the terms. Second, after the claim terms have been construed, one may then assess validity by comparing a patent claim to the “prior art.” I understand that the teaching of the prior art is viewed through the eyes of one of ordinary skill at the time of the invention, i.e., as of the effective filing date of the patent application. My analysis as to what constitutes a relevant POSITA is set forth above.

A. Legal Standards for Claim Construction

28. I understand that, for purposes of my analysis in this IPR, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and custom meaning, I understand that the words of a claim are first given the plain meaning that those words would have had to a person of ordinary skill in the art (“POSITA”) at the time of the invention, i.e., as of the effective filing date of the patent application. I also understand that the structure of the claims, the specification, and file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a POSITA to a claim term at the time of the invention.

29. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention (not today).

30. I have followed these guidelines in my analysis, and, unless otherwise indicated, I have applied the plain and ordinary meaning of the claim terms.

B. Legal Standard for Obviousness

31. My understanding is that a patent claim is invalid as obvious only if the subject matter of the claimed invention “as a whole” would have been obvious to one of ordinary skill at the time of the invention, i.e., as of the effective filing date of the patent application. To determine the differences between a prior art reference (or a proposed combination of prior art references) and the claims, the question of obviousness is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Also, obviousness grounds cannot be sustained by mere conclusory statements. Rather, it is necessary to provide some articulated reasoning with rational underpinning to support the legal conclusion of obviousness.

32. I understand that a patent claim that comprises several elements is not proved obvious by simply showing that each of its elements was independently known in the prior art. In my evaluation of whether any claim of the '779 Patent would have been obvious, I considered whether the Petition, or any evidence submitted in this proceeding, presented an articulated reason with a rational basis that would have motivated one of ordinary skill to combine the elements or concepts from the prior art in the same way as in the claimed invention.

33. It is my understanding that there is no single way to define the line between true inventiveness on one hand—which is patentable—and the application of common sense and ordinary skill to solve a problem on the other hand—which is not patentable. For instance, factors such as market forces or other design incentives may be the source of what produced a change, rather than true inventiveness.

34. I understand that the decision-maker may consider whether the change was merely the predictable result of using prior art elements according to their known functions, or whether it was the result of true inventiveness. And, the decision-maker may also consider whether there is some teaching or suggestion in the prior art to make the modification or combination of elements recited in the claim at issue. Also, the decision-maker may consider whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way. The decision-maker may also consider whether the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art.

35. I have been instructed by counsel that if any of these considerations are relied upon to reach a conclusion of obviousness, the law requires that the analysis of such a consideration must be made explicit. I understand that the decision-maker must be careful not to determine obviousness using the benefit of hindsight and that

many true inventions might seem obvious after the fact. I understand that the decision-maker should consider obviousness from the position of one of ordinary skill at the time of the invention and that the decision-maker should not consider what is known today or what is learned from the teaching of the patent.

36. I understand that in order to determine whether a patent claim is obvious, one must make certain factual findings regarding the claimed invention and the prior art. Specifically, I understand that the following factors must be evaluated to determine whether a claim is obvious: the scope and content of the prior art; the difference or differences, if any, between the claim of the patent and the prior art; the level of ordinary skill in the art at the time of the invention; and, if available, the objective indicia of non-obviousness, also known as “secondary considerations.”

37. I understand that the secondary considerations include: commercial success of a product due to the merits of the claimed invention; a long felt need for the solution provided by the claimed invention; unsuccessful attempts by others to find the solution provided by the claimed invention; copying of the claimed invention by others; unexpected and superior results from the claimed invention; acceptance by others of the claimed invention as shown by praise from others in the field or from the licensing of the claimed invention; teaching away from the conventional wisdom in the art at the time of the invention; independent invention of the claimed invention by others before or at about the same time as the named

inventor thought of it; and other evidence tending to show obviousness.

38. I understand that, to establish a secondary consideration, the evidence must demonstrate a nexus between that secondary consideration and the claimed invention.

VI. Overview of the '779 Patent

A. Subject Matter Overview

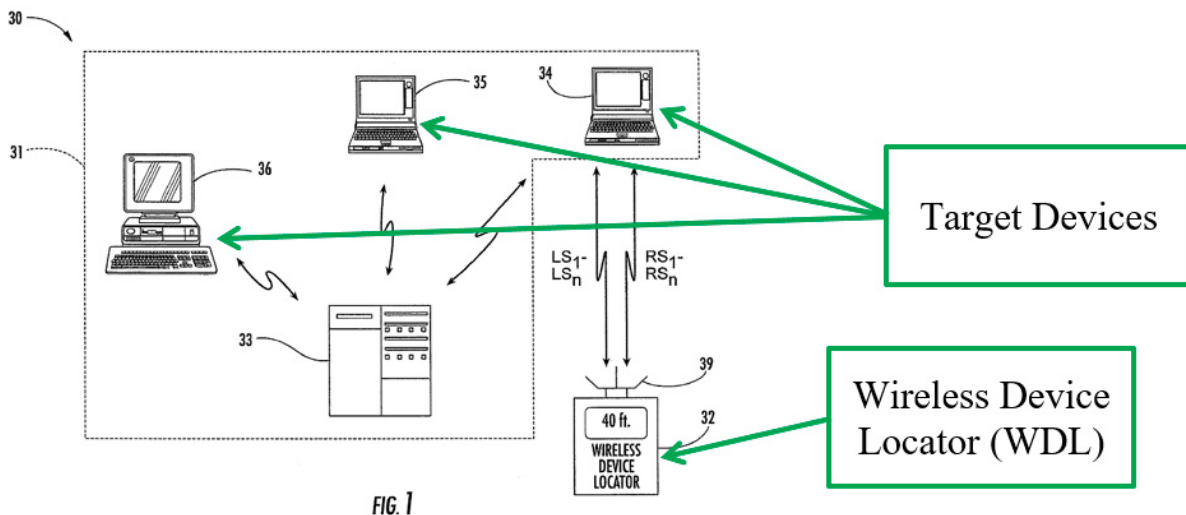
39. The '779 Patent describes “a wireless device locator” that locates other devices in a wireless communications system via “active range finding”:

A wireless communications system may include a plurality of wireless communications devices and a wireless device locator. More particularly, the wireless device locator may include at least one antenna and a transceiver connected thereto, and a controller for cooperating with the transceiver for transmitting a plurality of location finding signals to a target wireless communications device from among the plurality thereof. The target device may transmit a respective reply signal for each of the location finding signals. Additionally, the controller may also cooperate with the transceiver for receiving the reply signals, and it may determine a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon a known device latency of the target device. As such, the controller may estimate a range to the target device based upon a plurality of determined propagation delays.

APPLE-1001, Abstract. *See also* APPLE-1001, 2:35-3:4 (describing that “the wireless device locator advantageously provides *active range finding*. In other words, the wireless device locator prompts the target wireless communications

device to send reply signals using the location finding signals, rather than passively waiting until the target wireless communications device begins transmitting. This allows for quicker and more efficient device location.”). In sum, the ’779 Patent describes that the device locator exchanges signals with a target device for ranging, determines a propagation delay of those signals using a known device latency of the target device, and estimates a range to the target device based upon determined propagation delays.

40. The described system in Fig. 1, for example, includes wireless devices 34-36, “a wireless local area network (WLAN) 31,” and a “wireless location device 32.” APPLE-1001, 4:55-62.

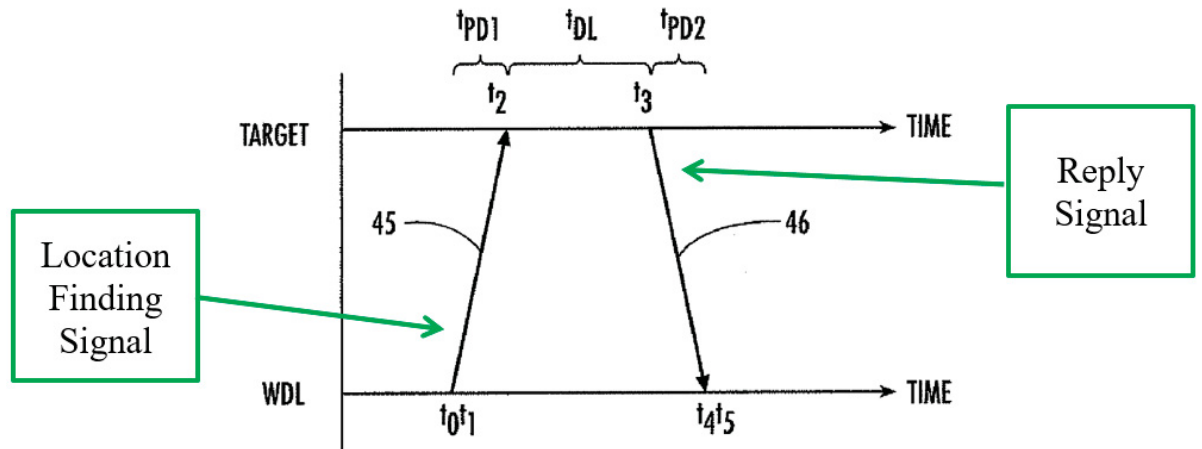


APPLE-1001, Fig. 1. Described wireless devices include WLAN devices, mobile ad-hoc network (MANET) devices, and cellular communications devices. APPLE-1001, 3:59-63 (“The wireless device locator may be used with numerous type [sic]

of wireless communications device. For example, the wireless communications devices may be wireless local area network (WLAN) devices, mobile ad-hoc network (MANET) devices, and cellular communications devices.”), Figs. 9-10. Additionally, the patent describes that each device may have a unique identifier (UID), which can be the device’s media access control (MAC) address. APPLE-1001, 3:17-45. Yet, the patent describes, in its background section, that Crabtree (a prior art reference) discloses “[a] handheld locator transmits a locator signal to the wireless transceiver *which includes a unique address code of the transceiver. If the received code matches that stored by the wireless transceiver, it sends a return signal back to the locator device.*” APPLE-1001, 1:12-26.

41. The described range finding includes a message/signal exchange where the locator transmits “a location finding signal 45” and the target device responds with a “reply signal 46.” APPLE-1001, 6:41-7:35 (“...The total round trip time will include several components. Referring more particularly to FIG. 3, the first component is the time associated with transmitting a *location finding signal 45*, which is illustrated with an arrow. That is, this is the time from the beginning of the location finding signal transmission (time t_0) to end thereof (time t_1). ... The second component of the round trip time is the propagation delay or time t_{PD1} , it takes for the location finding signal 45 to travel from the wireless device locator 32 to the target device 34 (i.e., from time t_1 to t_2). The third component of the round trip time

is the device latency t_{DL} of the target device 34 (i.e., from [sic] time t_2 to t_3). This is the time it takes the target device 34 to receive, process, and transmit a *reply signal 46 responsive to the location finding signal 45*.”).



APPLE-1001, Fig. 3.

42. A controller of the locator measures a “round trip time” (RTT) which includes propagation delays of the respective signals 45-46 and a device latency. APPLE-1001, 6:41-7:35 (“...The controller 42 will know the times associated with the transmission of the location finding signal 45 (i.e., from time t_0 to time t_1), as well as the time associated with the reception of the reply signal 46 (i.e., from time t_3 to t_4) for each round trip, since these can be readily measured by the controller. ...”).

43. The controller uses a “known device latency (i.e., a mean latency) for the device type of the target device” (which approximates the actual device latency) to determine a propagation delay, and subsequently a range (i.e., delay time

multiplied by the speed of light yields a distance to target). APPLE-1001, 6:41-7:35 (“... Yet, as noted above, the controller 42 will have access to the *known device latency (i.e., a mean latency) for the given device type of the target device* 34, which provides a close approximation of the actual device latency t_{DL} . The known device latency could be a measured value based upon collected data, it could be provided by manufacturers, or it could be based upon a value set in a communications standard, as discussed above, for example.”). A POSITA would have understood that “mean latency” represents a mean (i.e., average) of latency measurements for the given device type, where these latency measurements correspond to actual device latencies measured for one or more devices belonging to a given device type.

B. File History of the '779 Patent

44. As part of my preparation of this declaration, I reviewed the file history of the '779 Patent (APPLE-1001). I understand that the '779 Patent was filed on January 29, 2004 as U.S. Patent Application No. 10/767,794 (“the '794 application”). APPLE-1001, cover.

45. Several of the '487 application's pending claims were rejected under 35 U.S.C. 103(a) as being unpatentable over Deshpande (2004/0266348) and Kuwahara App '604 (2003/0191604). APPLE-1002, 2006-02-24 Non-Final Rejection. The remaining claims (which included unique identifier (UID)-based limitations) were allowable if rewritten in independent format. *Id.* In lieu of a claim

amendment, the Applicant traversed the Examiner's Deshpande-Kuwahara App '604 combination by arguing a lack of motivation and failure to provide the feature of "determining a propagation delay...based upon a known device latency" (Element [1.d.ii]). *Id.*, Applicant's 2006-05-24 Response.

46. Based on Applicant's telephonic authorization to incorporate allowable subject matter (the UID-based limitations) into the independent claims, the Examiner's next action was a Notice of Allowance, dated June 27, 2006. *Id.*

VII. Interpretation of the '779 Patent Claims at Issue

47. For purposes of my analysis in this IPR proceeding, I understand that the terms that appear in the claims of the '779 Patent should be interpreted according to their plain and ordinary meaning under the *Phillips* standard. In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to one of ordinary skill at the time of the invention, i.e., as of the effective filing date of the patent application. I also understand that the structure of the claims, the specification and file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by one of ordinary skill to a claim term at the time of the invention. I have followed this approach in my analysis, and for all of

the claim terms considered in this declaration, I have applied the plain and ordinary meaning of those terms.

48. I also understand that the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention. For purposes of my analysis here, I have used January 29, 2004 as the date of invention.

49. Further, I understand that the Parties have submitted claim construction briefs in the co-pending district court matter. I understand that Petitioner, for example, construed the term “known device latency” as “predetermined latency for the given device type of the target wireless communication device.” APPLE-1017, 3. I understand that Patent Owner opposed this construction and argued that “known device latency” should be given its plain meaning, which is presumably broader. *Id.*; APPLE-1018, 1-4. While pertinent to infringement, the parties’ dispute regarding this term does not change my analysis herein because the prior art renders obvious the Challenged Claims under either party’s interpretation.

VIII. Overview of the Cited References

A. McCrady (APPLE-1005)

50. McCrady is entitled “Method and apparatus for determining the position of a mobile communication device using low accuracy clocks.” APPLE-1005, cover. McCrady issued on September 17, 2002, which more than a year before

the Critical Date of the '779 Patent. I understand that McCrady qualifies as prior art under at least 102(b).

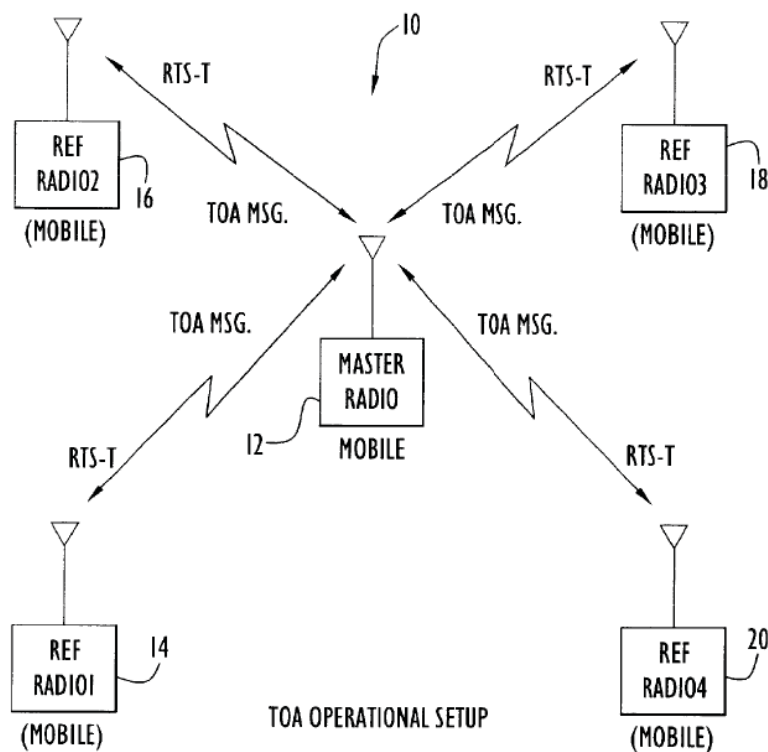
51. McCrady describes that “a position location system 10 includes a target or ‘master’ mobile communication device or ‘radio’ 12 communicating with ***four reference communication devices 14, 16, 18 and 20***” and that these devices can be “any portable electronic device equipped with wireless transmission and reception capabilities.”

Referring to FIG. 1, a position location system 10 includes a target or “master” mobile communication device or “radio” 12 communicating with ***four reference communication devices 14, 16, 18 and 20***. As used herein and in the claims, ***a mobile communication device or mobile radio is any portable device capable of transmitting and/or receiving communication signals***, including but not limited to: a handheld or body-mounted radio; any type of mobile telephone (e.g., analog cellular, digital cellular or satellite-based); a pager or beeper device; a radio carried on, built into or embedded in a ground-based or airborne vehicle; ***or any portable electronic device equipped with wireless transmission and reception capabilities***.

APPLE-1005, 6:44-56. The reference (“REF”) devices can also be their own master radios.

Finally, as explain in greater detail hereinbelow, one or more of the reference radios relied upon by a particular target radio can be another mobile communication device similar or identical to the master radio, wherein the reference radio determines its own position in accordance with the technique of the present invention (in this case, ***the “reference” radio functions as both a reference radio for other radios and as its own “master” radio***). The fact that each reference radio could potentially be a mobile radio is indicated in FIG. 1 by the designation

“(MOBILE)” next to each of reference radios 14, 16, 18 and 20.”
 APPLE-1005, 7:2-13.



APPLE-1005, Fig. 1.

52. Like the '779 Patent, McCrady describes techniques and systems relating to estimating ranges between wireless devices.

A spread spectrum position location communication system determines the position of a mobile master radio using a round-trip messaging scheme in which the time of arrive (TOA) of ranging messages is accurately determined to yield the range estimates required to calculate the position of the mobile radio via trilateration. *The master radio transmits outbound ranging messages to plural reference radios which respond by transmitting reply ranging messages.* Upon reception of the reply ranging message, *the master radio determines the range to the reference radio* from the signal propagation time calculated by *subtracting the far-end turn around time from the*

round-trip elapsed time.

APPLE-1005, Abstract. McCrady determines propagation delays (and subsequently ranges) based on ranging message exchanges between devices.

53. McCrady further describes:

More particularly, the system of the present invention employs a two-way, round-trip ranging message scheme in which the time of arrival of the ranging messages is accurately determined to yield accurate range estimates used to calculate the position of a mobile radio via trilateration. A master or target mobile radio transmits outbound ranging messages to plural reference radios which respond by transmitting reply ranging messages that indicate the location of the reference radio and the message turn around time (i.e., the time between reception of the outbound ranging message and transmission of the reply ranging message). Upon reception of the reply ranging message, the master radio determines the signal propagation time, and hence range, by subtracting the turn around time and internal processing delays from the elapsed time between transmission of the outbound ranging message and the time of arrival of the reply message. In this manner, the individual radios do not need to be synchronized to a common time reference, thereby eliminating the need for highly accurate system clocks required in conventional time-synchronized systems. The brief ranging messages can be interleaved with voice and data messages in a non-intrusive manner to provide position detection capabilities without disruption of voice and data communications.

APPLE-1005, 4:52-5:8.

54. McCrady determines a propagation delay (round-trip propagation time (T_{RT})) associated with the transmission of each ranging message, transmitted at time of transmission (T_T), and the respective reply signal therefor received at time of

arrival (TOA), using the known device latency (e.g., ΔT_{TA}):

By precisely knowing the time of transmission of the outbound ranging message, the far-end turn around time at the reference radio (supplied to the master radio in the reply ranging message), the time of arrival of the reply ranging message, and internal transmission/reception processing delays, the master radio can precisely determine the two-way signal propagation time between itself and each reference radio. More specifically, ***the two-way or round-trip propagation time (T_{RT})*** is the time of arrival (TOA) of the reply message minus the time of transmission (TT) of the outbound message minus ***the duration of the turn around time (ΔT_{TA})*** and internal processing delays within the master radio ΔT_{ID} (***the internal processing delays of the reference radio are incorporated into the turn around time ΔT_{TA} .***

$$T_{RT} = TOA - TT - \Delta T_{TA} - \Delta T_{ID} \quad (1)$$

Although separately represented in equation (1), the accounting for the ***internal processing delays*** can be considered part of accurately determining the time of arrival TOA and the time of transmission TT; thus, the round-trip signal propagation time T_{RT} can more generally be described as the difference between a) the elapsed time between the time of transmission of the outbound ranging message and the time of arrival of the reply ranging message and b) the turn around time ΔT_{TA} .

APPLE-1005, 8:65-9:23.

55. In determining propagation delay, McCrady accounts for the device latency (e.g., processing delay, antenna delay, etc.) of the reference radio as part of the subtracted “turn around time.” *Id.* McCrady describes that ***“the internal processing delays of the reference radio are incorporated into the turn around time ΔT_{TA} .”*** *Id.*

Referring to FIGS. 4 and 5, the master radio initiates the TOA ranging

process by performing an internal delay calibration using a loop back through pad 40 to determine internal delays ($T_{mt}+T_{mr}$) in the master radio for correction purposes. Multiple trials, for example ten, are performed and averaged to reduce the variance of the delay estimate. The delay T_{mt} is the master radio transmitter delay. It is the sum of the delays through the transmit modem (Tx mdm) 42 where the transmit signal is implemented, the transmit baseband to intermediate frequency (BB-IF) conversion 44, and the transmit radio frequency (Tx RF) analog circuitry 46 of the master radio. The delay T_{mr} is the master radio receiver delay. It is the sum of the delays through the receive radio frequency (Rx RF) analog circuitry 48 of the master radio, the IF-BB conversion 50, and the receive modem (Rx mdm) 52 where demodulation processing occurs.

APPLE-1005, 10:44-59, Figs. 4-5. McCrady provides details about the antenna delay:

The value for the master and reference radio *antenna delay T_a* (see FIG. 4) is a constant preloaded into the radios and combined with the results of delay calibration to reference the TOA to the antenna/air interface. The delay T_a is determined by measuring the delay through a large sample of antennas and cabling, over a range of operating temperatures, and calculating the mean and standard deviation of the measured values. Note that cabling delays for cabling between antenna and electronics are included in T_a .

APPLE-1005, 11:15-23. McCrady further discloses:

Thus, the internal processing delay of the master radio ΔT_{ID} seen in equation (1) is determined from the master radio transmitter and receiver delays T_{mt} and T_{mr} determined from the calibration process and the *estimated antenna delay T_a* . Similarly, the estimate of the duration of the turn around time TT includes *the reference radio transmitter and receiver delays T_{rt} and T_{rr} determined from the calibration process and the estimated antenna delay T_a* . The total elapsed time measured by the master radio between transmission of the

outbound ranging message and reception the reply ranging message includes time attributable to propagation of the message signals and time attributable to processing delays within the radios. By accurately estimating and subtracting out the time attributable to processing delays, the signal propagation time (and hence the range) can be more accurately determined.

APPLE-1005, 11:24-39. Additionally, McCrady's messages can include addresses.

The data portion of the RTS-T message includes a ***Destination Address*** 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The ***Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message.*** The other data field can include information such as the identification of the master radio, a flag or data indicating a ranging mode, or information relating to the state of multipath interference."

APPLE-1005, 8:38-46. *See also id.*, 8:50-53 ("In the data portion of the TOA message, the reference radio identifies the destination master radio and may also identify itself as the message source."). These addresses include a destination address that corresponds to the message's intended destination/recipient, a source address that corresponds to the message's source, or both. Each of the source and destination addresses is an example of a UID because it uniquely identifies an endpoint in McCrady's network.

B. Raphaeli (APPLE-1006)

56. Raphaeli is entitled "Method and system for distance determination of RF tags." APPLE-1006, cover. I understand that Raphaeli is a national stage application of a PCT application (PCT/IL2003/000358) filed on May 4, 2003, more

than eight months before the Critical Date. *Id.* I understand that the PCT application designated the United States, and was published under PCT Article 21(2) in English as WO2003098528. APPLE-1008, cover. I further understand that Raphaeli qualifies as prior art under at least 102(e) based on the PCT filing date.

57. Like the '779 Patent, Raphaeli describes techniques and systems relating to determining distances between wireless devices based on measuring the round trip propagation delay. Raphaeli describes, for example:

- APPLE-1006, Abstract (“The present invention relates to a method and system (10) for distance determination of RF tags (4) and its applications based on measuring the round trip delay...”),
- 1:10-15 (“distance determination....based on measuring the round trip delay”),
- 4:20-26 (“The present invention relates to distance determination of RF tags, used in RF identification systems, and more particularly, to a method and system for distance determination of RF tags and its applications, based on measuring the round trip delay by using a single channel.”), 6:50-54 (describing the same),
- 8:1-18 (“In the following description of the method of the present invention, included are only main or principal steps needed for sufficiently understanding proper enabling utilization and

implementation of the disclosed method and system for distance determination of RF tags and its applications, based on measuring the round trip delay by using one or more channels. Accordingly, descriptions of the various required or optional minor, intermediate, and/or, sub steps, which are readily known by one of ordinary skill in the art, and/or, which are available in the prior art and technical literature relating to the field of sampling analog signals, are not included herein.”),

- 22:16-36 (“In optional step (f) there is reader 2 comparing a predefined threshold to the round trip delay of at least one of the at least one wide band response signal received by reader 2, and performing a task with tags having round trip delay that is passing the threshold test. ...”).

58. Raphaeli describes transmitting interrogation signals to a target device, e.g., wireless RF tags, and receiving reply/response signals. Raphaeli for example discloses “*wide band broadcast interrogation signal 20 features a sequence of pulses 22* separated by a fixed interval” which can be organized into preamble, data, and response period portions.

FIG. 2 is a schematic time chart illustrating an exemplary preferred embodiment of *a wide band broadcast interrogation signal 20*, in accordance with an exemplary embodiment of the present invention. Optionally, *wide band broadcast interrogation signal 20 features a sequence of pulses 22* separated by a fixed interval, for example 10

microseconds (it is noted that for clarity of FIG. 2, the lengths of pulses 22 and the periods there-between are out of proportion). The pulses can be either unmodulated to generated base-band transmission, or modulated onto a carrier wave to generate pass-band transmission. Each pulse 22 optionally has a short duration of, for example, 10 ns (nanoseconds). In the preferred embodiment of the present invention, pulses 22 of wide band broadcast interrogation signal 20 are optionally organized in three intervals: ***a preamble portion 24, a data portion 26, and a response period portion 28***. Each interval may not be fixed, but be used, either periodic or not periodic, according to some pseudo-random sequence in order to reduce the collision probability between two readers 2.

APPLE-1006, 9:3-21. Upon “receiving the wide band broadcast interrogation signal 20, a tag 4 “respond[s]...with a response signal.” *Id.*, 10:58-60.

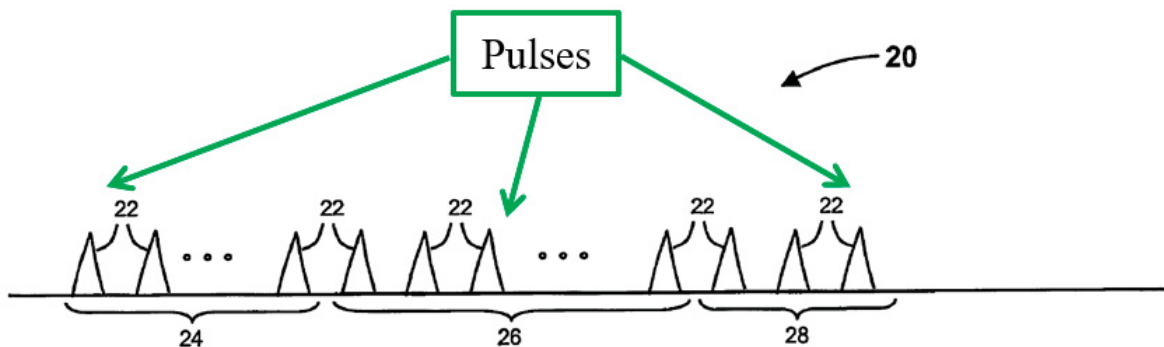


FIG. 2

APPLE-1006, Fig. 2 (annotated).

59. Raphaeli further describes multiple exchanges, *e.g.*, transmitting multiple interrogation signals to a device and receiving multiple responses from that device.

The transmission of the wide band broadcast interrogation signal

may be performed at a high repetition rate, for example: every tenth of a second, so as to substantially continuously monitor the vicinity of reader 2. Alternatively, the transmission of the wide band broadcast interrogation signal may be performed at a low repetition rate, for example: according to a predetermined scheme and/or under human control. The wide band broadcast interrogation signal may be transmitted in a specific direction, by using for example a directional antenna, or may be transmitted in all directions. Hereinafter, *the term signal refers to one signal or to a plurality of signals transmitted in one logical transmission period.*

APPLE-1006, 8:50-62. *See also* the following disclosures in Raphaëli:

- APPLE-1006, 9:3-21 (cited above),
- 16:61-67 (“Reader 2 is detecting at least one response sequence included in that at least one wide band response signal received by reader 2, counting the approximate number of distinguishable responses to that wide band broadcast interrogation signal, and *analyzing the wide band response signals transmitted by the authorized tags in order to determine the round trip delay (RTD).*”),
- 19:1-10 (“In an exemplary embodiment of the present invention, each collection of pulses belonging to a single tag 4 is examined to determine that it includes at least *a predetermined number of received pulses.* Optionally, the predetermined number of required pulses is a number that allows reconstructing the data content of the wide band response signal using error correction methods. In an exemplary embodiment of the invention, *the predetermined number of required pulses is at least about 7% of the total number of pulses in wide band response signal.*”),
- 20:43-51 (“Since the chances of a collision occurring increase with the number of responses received, in an exemplary embodiment of the

present invention, when more than a predetermined number (T) of responses are received in response to a first wide band broadcast interrogation signal 20, reader 2 may transmits a second wide band broadcast interrogation signal 20 or a plurality of wide band broadcast interrogation signal 20 immediately after the first wide band broadcast interrogation signal 20.”)

- 21:38-51 (“In an exemplary embodiment of the present invention, the number of additional wide band broadcast interrogation signal 20 transmitted in each additional wide band broadcast transmission round is $2(L \cdot m)$, where m is the number of the additional transmission round (the number of times additional wide band broadcast interrogation signal 20 were transmitted) and L is a predetermined number, for example 1. Alternatively, the number of additional wide band broadcast interrogation signal 20 transmitted in each additional wide band broadcast transmission round is $L \cdot m$, or any other function increasing with m . In an alternative exemplary embodiment of the present invention, L is adjusted according to the experience of previous collision resolution sessions in which the procedure was performed.”)
- 12:15-30 (“***The wide band response signal of tag 4 to the wide band broadcast interrogation signal 20*** may be carried out by using one of many available methods, all of them featuring adding some time delay, or other means, to the wide band response signal in order to avoid deterministic collisions between a plurality of tags. In other words, assuring that the collisions are not persistent and therefore can be resolved by using iterations. For example: each tag 4 waits a pseudo-random period before beginning to transmit the wide band response signal, in order to prevent occurrence of a collision, in case a plurality

of tags 4 respond together. Optionally, in these embodiments, each tag 4 transmits to reader 2 the length of the delay period it waited before transmitting the wide band response signals. The length of the delay period is optionally transmitted to reader 2 encoded in the wide band response signal, as described below.”).

60. Raphaeli further describes determining roundtrip delays based on the received responses from a device and calculating an average time delay:

For each wide band response signal received by reader 2, reader 2 determines the round trip delay (RTD) between the transmission of the wide band broadcast interrogation signal 20 and the reception of the wide band response signal.

APPLE-1006, 17:1-4.

DSP 40 is optionally calculating an *average time delay* for collected pulse groups including at least the predetermined number of pulses. Using the average time delay, DSP 40 is extracting the modulated data from the collected pulse groups. The timing of the pulses are optionally corrected according to their modulation (in those embodiments in which delay modulation is used), for example by adding or subtracting 5 ns according to the bit carried by the pulse group. Thereafter, a second, more accurate, average is optionally calculated. Alternatively or additionally, before calculating the second average, pulses determined to be erroneous in the error detection are removed from consideration, as their timing may be incorrect, for example, due to multi-path reflections. Pulses determined to be erroneous in the error detection may be due to a false detection and/or may otherwise contribute erroneous timing values to the timing average. In an exemplary embodiment of the present invention, a validity check, for example a CRC check, is applied to the data of the wide band response signals, and only signals which pass the validity check are considered. The validity check and the error correction may be performed in separate

steps or may be performed together in a single step.

APPLE-1006, 19:11-32.

By DSP 40 calculating an average time delay for collected pulse groups including at least the predetermined number of pulses, the precision of the round trip delay determination is increased relative to a single delay measurement. In an exemplary embodiment of the present invention, the pulse form of each received pulse is interpolated from the samples received from A/D converter 60, further enhancing the precision of the round trip delay determination.

APPLE-1006, 19:33-40.

C. Kuwahara (APPLE-1007)

61. Kuwahara is entitled “Positioning apparatus used in a cellular communication system and capable of carrying out a positioning with a high accuracy in urban area.” APPLE-1009, cover. I understand that Kuwahara issued on May 30, 2000, years before the Critical Date. I understand that Kuwahara qualifies as prior art under at least 102(b).

62. Like the '779 Patent, Kuwahara describes techniques and systems relating to position determination of a wireless device.

A positioning apparatus is provided in a cellular base station for *positioning a portable terminal* in a cell covered by the cellular base station. The positioning apparatus has a base position indicative of a position of the cellular base station on a map. The positioning apparatus comprises an array antenna for receiving a transmission signal transmitted by the portable terminal to output a plurality of reception signals. A receiver section translates the reception signals into a plurality of baseband signals to demodulate the baseband signals into a

plurality of demodulated signals. *An estimation section estimates incident direction and delay time of the transmission signal* on the basis of the demodulated signals to output an estimation result indicative of the incident direction and the delay time. A position calculating means calculates a *terminal position of the portable terminal* on the map in accordance with the estimation result and the base position to *output a terminal position signal indicative of the terminal position*.

APPLE-1005, Abstract.

63. Kuwahara further describes

Referring to FIG. 1, the illustrated cellular base station SB comprises an *array antenna 101 having first through M-th antenna elements 101-1 through 101-M for receiving signals transmitted by the portable terminal PT*, where M represents a positive integer which is not less than one. First through M-th receivers 102-1 through 102-M are for translating signals from the respective antenna elements of the array antenna 101 into baseband signals. First through M-th CDMA demodulators 103-1 through 103-M are for demodulating a transmission signal multiplexed using the CMDA (code division multiple access) method to output demodulated signals in a plurality of systems. *A PDA (power delay angle) estimation circuit 104* is for estimating an incident direction, delay time, and relative power from the demodulated signals in a plurality of systems and is for outputting the result of estimation indicating the incident direction, delay time, and relative power. *A positioning circuit 105* is for establishing the position of the portable terminal PT on the basis of the incident direction and delay time indicated by the result of estimation output by the PDA estimation circuit 104 and is for outputting the result of position of the portable terminal PT. A transmitter 106 is for transmitting the result of positioning to the portable terminal PT through a transmission antenna 107. The combination of the receivers and CDMA demodulators is referred to as receiving device. Among the above-described

components, the transmitter 106 and transmission antenna 107 may be a transmitter and a transmission antenna shared by cellular base stations SB.

APPLE-1007, 2:66-3:27.

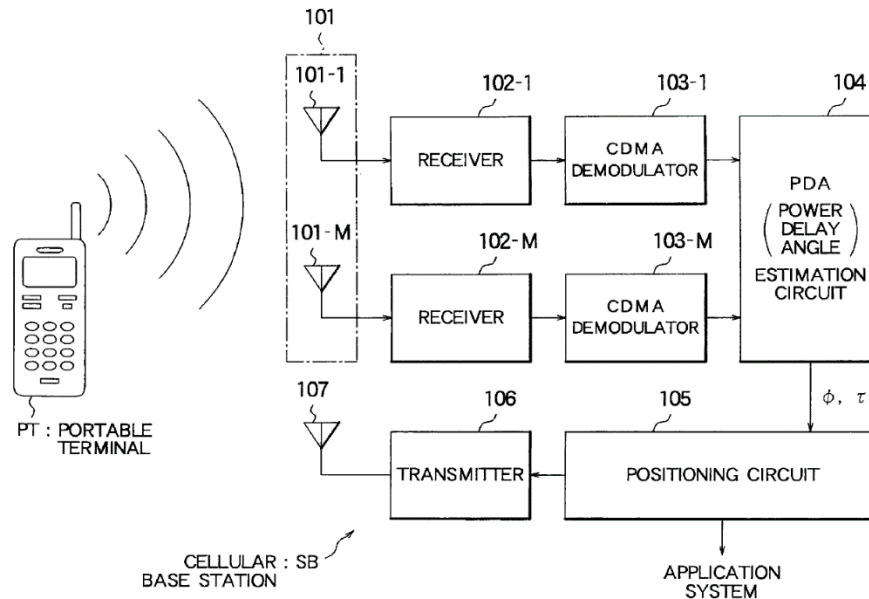


FIG. 1

APPLE-1007, Fig. 1.

D. Rofheart (APPLE-1009)

64. Rofheart is entitled “Method and system for enabling device functions based on distance information.” APPLE-1009, cover. Rofheart’s corresponding patent application was filed on October 10, 2000, which is years before the Critical Date of the ’779 Patent. *Id.* I understand that Rofheart qualifies as prior art under at least 102(e).

65. Like the ’779 Patent, Rofheart describes techniques and systems

relating to estimation of ranges (distances) between wireless devices:

The present invention relates generally to a method and system for enabling device functions, and more specifically to a method and system for enabling communications functions in a local wireless device based on a distance between the local wireless device and a remote wireless device.

APPLE-1009, 2:3-8. Rofheart describes:

FIG. 3 discloses a wireless network 300 in which a plurality of wireless devices may exchange information. The wireless network 300 may be WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a ***first remote device 302, a second remote device 303 and N number of additional remote devices 300N*** via UWB links 312, 313, and 315N respectively.

APPLE-1009, 17:13-22.

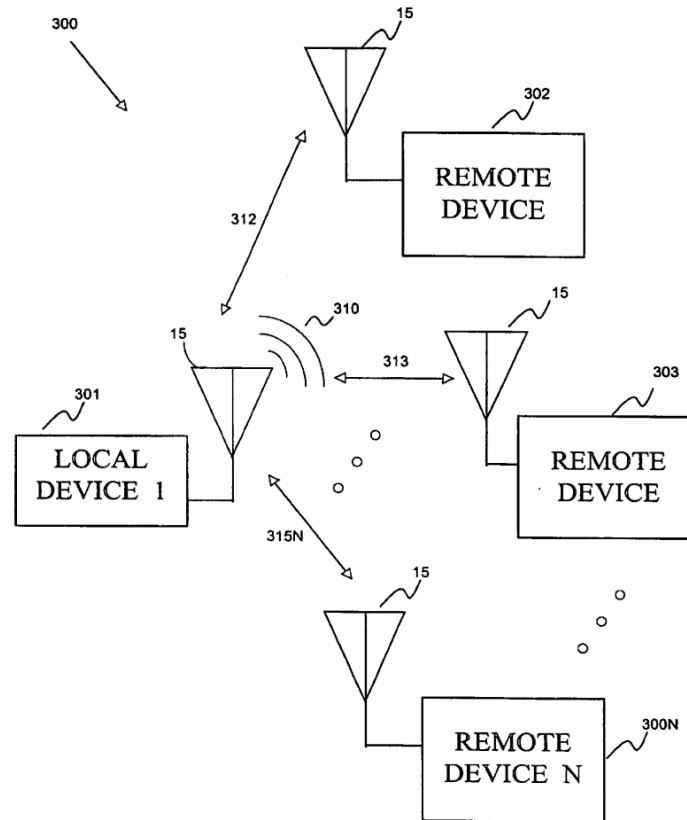


FIGURE 3

APPLE-1009, Fig. 3.

66. Rofheart discloses various types of wireless devices such as WLAN devices, mobile ad-hoc network (MANET) devices, and mobile/cellular telephones:

The wireless network 300 may be *WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet*. The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. *Each of the wireless devices 301 through 300N may be a mobile device such as a mobile telephone, a laptop computer or personal digital assistant*

(PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices. It is to be understood that device 301 is referred to as a “local device” and devices 302-400N are referred to as “remote devices” for purposes of description only, and that the present invention is not limited to an infrastructure system having an access point and may be implemented in an ad hoc system wherein any device in the network can act as a master and/or a slave device and no access point is needed.

APPLE-1009, 17:13-37. *See also id.*, 15:24-30 (“The communications interface 219 provides a two-way UWB data communication coupling to a network link 221 that is connected to a communications network 223 such as a local network (LAN) or personal area network (PAN) 223.”), and 15:50-53 (“Moreover, the network link 221 may provide a connection through a PAN 223 to a mobile device 229 such as a personal digital assistant (PDA) laptop computer, or cellular telephone. The LAN/PAN communications network 223 and IP network 227 both use electrical, electromagnetic or optical signals that carry digital data streams.”).

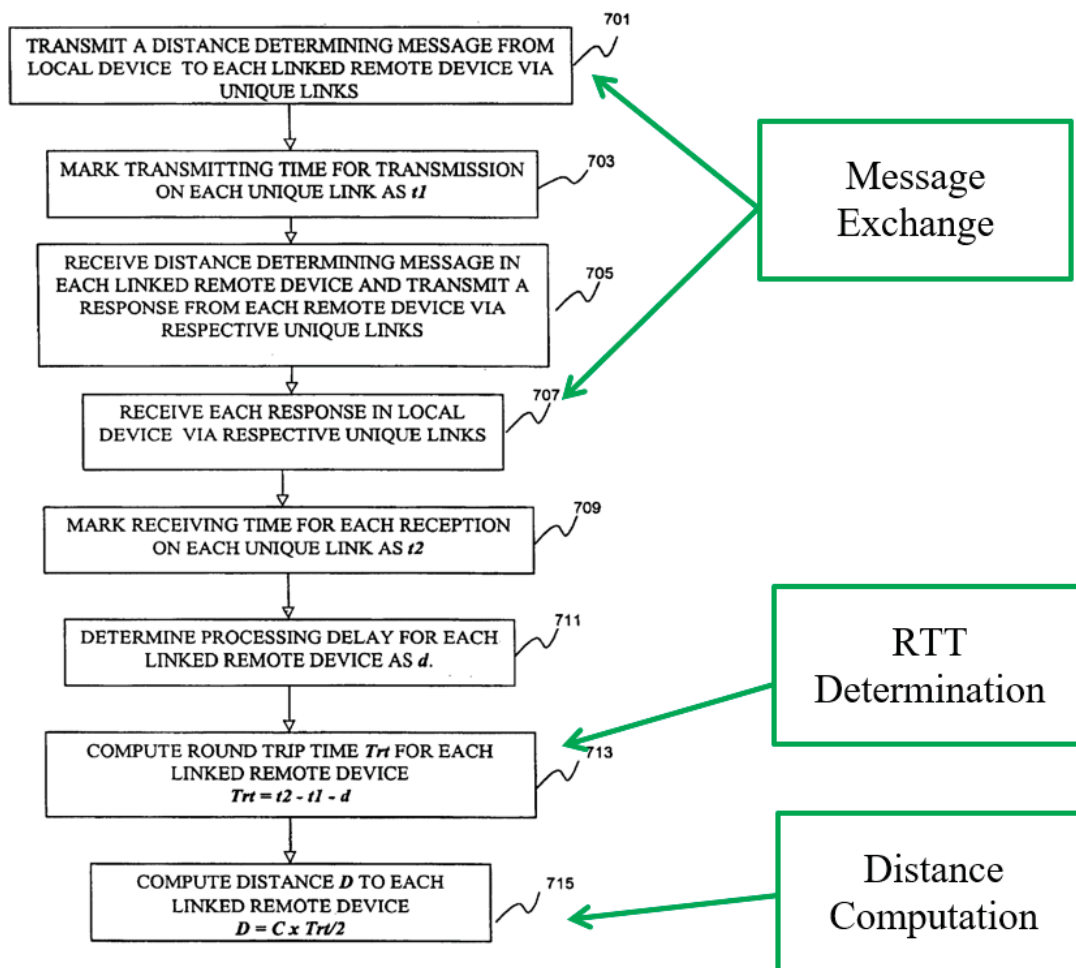
67. Rofheart describes that a message exchange is performed and a time is determined:

According to one aspect of the invention, the method, on which the device and computer program product are based includes *transmitting a message from a local device to a remote device via an ultra wide band (UWB) wireless medium and receiving a response from the remote device* via the UWB wireless medium. The transmitting and receiving steps are preferably performed in accordance with a Media Access Control (MAC) protocol. *A time between the transmitting of*

the message and the receiving of the response is then determined and a function is performed in the local device based on the round trip time determined.

APPLE-1009, 3:61-4:4. See also *id.*, 4:5-21.

68. Rofheart's Fig. 7 (annotated below) depicts one example of a process in Rofheart that includes a message exchange, determination of a round trip time (RTT), and distance computation.



APPLE-1009, Fig. 7 (annotated). See generally *id.*, 23:59-25:31. The round trip time (“ Trt ”) takes into account a processing delay (“ d ”) of the remote device (*e.g.*, delay

between receiving a message and transmitting a response). The processing delay is based on a device/radio type information provided by Rofheart's remote device in a reply/response exchange or via an independent (unsolicited) signal. APPLE-1009, 4:5-21, 20:62-66, and 24:36-55 ("...the processing delay d is determined by retrieving the delay from the memory of the local device 201. In this embodiment, *the local device 201 receives information from each remote device about the radio type of the remote device*, as part of the reply and/or response received from the remote devices as discussed with respect to steps 507 and 707 respectively. Alternatively, *the type information may be received as part of an independent signal sent by the remote devices....*").

E. Godfrey (APPLE-1028)

69. Godfrey is entitled "Location Awareness in Wireless Networks" APPLE-1028, cover. Godfrey was published on June 16, 2005, and claims priority to Godfrey-Provisional, which was filed before the Critical Date on October 31, 2003. *Id.* I understand that Rofheart qualifies as prior art under at least 102(e).

70. In my opinion, claim 1 of Godfrey, for example, is supported by the Godfrey-Provisional as shown in the below provided table. I understand Godfrey is entitled to the Godfrey-Provisional's filing date because Godfrey (APPLE-1028, [0001]) incorporates by reference the Godfrey-Provisional (APPLE-1029), which, in my opinion, supports at least one of Godfrey's claims.

1. A method for determining a proximity of one or more wireless devices to a first wireless device, the method comprising: providing network information associated with the first wireless device to a server, the network information including at least a media access control (MAC) address and service set identifier (SSID) of an access point to which the first wireless device is connected;	“The access point 608, knowing the address of the proximity server 630, then may forward the proximity request 640 to the proximity server 630. The proximity request 640 may include various information useful to the proximity server 630 in identifying proximate stations and providing their relevant information. The information in the proximity request 640 may include, for example, information associated with the wireless station 620 such as its MAC address, one or more user IDs, a BSSID, position coordinates provided by the GPS receiver 218 (Figure 2), etc. The information in the proximity request 640, in one embodiment, may also include a desired proximity definition, such as a maximum proximity radius, a limitation to a same room, BSS, set of BSSs, etc.”APPLE-1029, 15. “To obtain proximity information, the wireless station 620 can transmit a proximity request 740 (analogous to proximity request 640, Figure 6) to the proximity server 720. The proximity request 740 may include a proximity definition that provides, for example, a definition of proximity that spans multiple ESSs. In response to the proximity request 740, the proximity server 722 may identify proximate wireless stations using proximity database 722 and provide information relevant to identified proximate wireless stations as proximity listing 742 (analogous to proximity listing 642, Figure 6) for use by the wireless device 620.” APPLE-1029, 16-17.
comparing, at the server, the network information associated with the first wireless device	“Figure 8 illustrates an exemplary table 800 whereby information related to wireless stations (e.g., stations 614-624, Figure 6) of an ESS may be stored by, for example, MAC address of the wireless stations (column 802), MAC address of

wit[h] network information associated with each of a predetermined set of wireless devices to identify one or more wireless devices connected to a same access point as the first device; and	the access point associated with the corresponding wireless station (column 804), the device type (column 806), and one or more user IDs associated with the corresponding work station (column 808). As noted above, proximity may be limited to a BSS or a group of adjacent BSSs. Under this proximity definition, the proximity server 630/720 may identify a wireless stations proximate to a certain wireless station by identifying entries in the table 800 having an AP MAC address (or BSSID) common to the certain wireless station. To illustrate, to identify stations proximate to the wireless station having MAC address MAC 4, the proximity server 630/720 can analyze the table 800 to identify other wireless stations associated with the same access point identified by MAC address AP MAC 3. In the illustrated example, the proximate wireless station would include the station having MAC address MAC 5. The proximity server 630/72 then may select information associated with the identified proximate stations, such as the device type (column 806) and the user ID(s) (column 808).” APPLE-1029, 17.
and notifying a user of the first wireless device of a proximity of the one or more wireless devices.	“Using the information of the proximity request 640 and the proximity database 632, the proximity server 630 may identify proximate stations using a default proximity definition or a proximity definition provided by the wireless device 620. After identifying proximate stations, the proximity server 630 may identify information in the proximity database 632 corresponding to the identified proximate stations and provide some or all of this information to the wireless station 620 as a proximity listing 642. The proximity identification module 208 (Figure 2) of the wireless station 620 may process the information of the proximity listing 642 as appropriate and provide relevant portions to the notification module 210 (Figure 2) for use in

	notifying the user of the wireless station 620 of nearby wireless station users.” APPLE-1029, 15-16.
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71. Godfrey relates to “location awareness in wireless networks and more particularly to identifying and communicating with proximate wireless stations,” such as “notebook (or ‘laptop’) computers, handheld computers,...portable digital assistants (PDAs), cellular phones, etc.” APPLE-1028, [0003], [0033]; APPLE-1029, 1, 5. In short, Godfrey provides “a method...for determining a proximity of one or more wireless devices to a first wireless device.” APPLE-1028, [0009]; APPLE-1029, 6.

72. Godfrey’s location-awareness techniques employ communications based on the well-known IEEE 802.11 standard, e.g., transmitting/sending a frame (or “message”) that includes MAC addresses (UIDs) to convey information about the frame’s source and destination. APPLE-1028, [0033], [0081]; APPLE-1029, 5, 20-21. Godfrey further describes storing device type information received from a device in a table based on the device’s MAC address. APPLE-1028, [0071], [0056]-[0060]; APPLE-1029, 17, 13.

IX. McCrady in view of Raphaeli renders obvious claims 1, 2, 8-10, 12-13, 18-19, 22-24, 26-28, 32, 34 (GROUND 1)

A. McCrady-Raphaeli Combination

73. As I discuss below, the McCrady-Raphaeli combination incorporates Raphaeli's teachings about averaging propagation delays into McCrady's system. As a result, McCrady's calculation of the range between the master radio and a reference radio would have used the average propagation delay. APPLE-1005, 9:23-30 (range equation).

74. A POSITA motivated to incorporate an averaging technique, such as the one described by Raphaeli (see motivation discussion below), would have appreciated the need for McCrady's system to calculate multiple propagation delays based on multiple ranging message exchanges. It would have been readily apparent to a POSITA of ordinary creativity and/or training exercising basic common design sense that there were multiple predictable ways to achieve this result. These predictable ways include the "First Combination Theory" and the "Second Combination Theory."

75. **First Combination Theory:** A POSITA would have appreciated that McCrady's disclosure already contemplates multiple message exchanges during the "frequency diversity" process, where the master radio "transmit[s] a sequence of M outbound ranging messages" on different frequencies and receives "M corresponding reply ranging messages":

- 14:35-65 (describing that "the TOA processor implements a process employing *frequency diversity* to identify an optimal transmission

frequency that minimizes multipath interference” and that “the set of M carrier frequencies that will be used to *transmit a sequence of M outbound ranging messages and M corresponding reply ranging messages*”),

- 7:14-26 (“**Master radio 12** communicates with the four reference radios 14, 16, 18 and 20 to *determine its location in three dimensions*” and that “master radio 12 ... includes an antenna coupled to a transmitter and a receiver for *transmitting* and receiving *ranging messages*. ... The time of arrival (TOA) of ranging messages transmitted between the master and reference radios is used to determine the range to each reference radio, and trilateration is then used to determine from the range measurements the location of the master radio with respect to the reference radios.”)
- 8:4-7 (“Referring again to FIG. 2, the ranging message sequence begins with the master radio transmitting an *initial outbound ranging message RTS-T to a particular reference radio*”),
- 11:54-58 (“For example, if Subsequent ranging messages are exchanged between the master and reference radio immediately after the initial exchange, calibration does not need to be repeated for these Subsequent messages (see FIG. 4).”),

- 15:14-23 (describing that “Once the number M of ranging message exchanges and ping frequencies are determined or selected, *the next M-1 [RTS-T]/TOA message exchanges are transmitted*, using different carrier frequencies for each exchange.”),
- Figs. 2, 4, 5, 7

76. The POSITA would have calculated the individual propagation delays (or delay estimates) from the “M” ranging message exchanges on various frequencies, and then averaged those delays as taught by Raphaeli:

...DSP 40 is optionally *calculating an average time delay* for collected pulse groups including at least the predetermined number of pulses...

By DSP 40 calculating an average time delay for collected pulse groups including at least the predetermined number of pulses, the precision of the round trip delay determination is increased relative to a single delay measurement. In an exemplary embodiment of the present invention, *the pulse form of each received pulse is interpolated from the samples received from A/D converter 60*, further enhancing the precision of the round trip delay determination.

APPLE-1006, 19:1-40.

77. McCrady’s message exchange technique employs “frequency diversity” to handle “severe multipath” interference. McCrady describes, for example:

The system uses state-of-the art spread spectrum chipping rates and bandwidths to reduce multipath interference, taking advantage of existing hardware and software to carrying out a portion of the TOA estimation processing. Leading edge curve fitting is used to accurately

locate the leading-edge of an acquisition sequence in the ranging message in order to further reduce effect of multipath interference on TOA estimates. The severity of multipath interference is determined by evaluating the pulse width of the acquisition sequence. If necessitated by severe multipath, frequency diversity is used to orthogonalize multipath interference with respect to the direct path signal, wherein an optimal carrier frequency is identified and used to estimate the TOA to minimize the impact of multipath interference.

APPLE-1005, 5:12-27. McCrady further describes:

... In this manner, the pulse width evaluator 96 can determine the separation, in terms of chips, between the direct path signal and the closest substantial multipath interference signal.

The TOA processor can be configured to provide one or more levels of TOA accuracy. In the embodiment shown in FIG. 7, the TOA processor is capable of providing two selectable levels of accuracy; a one meter accuracy and a three meter accuracy (the accuracy refers to the resultant range estimate). The desired accuracy mode can be set by the master radio or by a system controller and can be conveyed to the reference radio in the initial RTS-T message or another preceding message.

If the pulse width evaluator determines that the multipath interference is separated from the direct path signal by more than a predetermined number of chip widths, the multipath interference is classified as insubstantial in terms of impacting the TOA estimate. In the exemplary embodiment shown in FIG. 7, if the multipath interference is separated from the direct path signal by more than three chip widths, the multipath interference is considered to be insubstantial. Optionally, more than one chip width threshold can be used to provide a more refined estimate of the severity of multipath interference.”).

APPLE-1005, 13:45-67. The POSITA would have seen the benefit of leveraging McCrady’s technique to facilitate Raphaeli’s teaching on averaging propagation

delays. For example, setting aside multipath interference, the POSITA would have understood that diversifying the sample of to-be-averaged propagation delays from a frequency perspective would reduce the impact of other types of interference such as co-channel interference and general channel noise. Moreover, even with multipath interference, the POSITA would have averaged propagation delays produced from two or more of McCrady's "M" message exchanges that have favorable pulse-width evaluations. McCrady describes for example:

Referring again to FIG. 7, the TOA processor processes the communication acquisition Sequence and the TOA synchronization sequence of each of the M ranging messages in the same manner as the initial ranging message. Specifically, upon detection of the communication acquisition Sequence, the TOA synchronization sequence is match filtered (taking into consideration the carrier frequency), the magnitude is determined, and the resulting signal is evaluated by a pulse width evaluator to determine the proximity of the multipath interference to the direct path signal (see blocks 104, 106 and 108). The results of the *pulse width evaluation* from each of the M ranging messages and the output of the matched filter are stored in a buffer 110. Upon completion of the M trials, the frequency having the best multipath discrimination is identified (block 112) and a leading edge curve fit 114 is performed on the output of the corresponding matched filter to estimate the TOA. Specifically, *the data is searched to find the frequency where the optimal pulse width occurs at the carrier phase with the shortest path delay*. The resulting TOA measurement is processed in the aforementioned manner to accurately determine the range between the master radio and the reference radio, and the range estimate and TOA accuracy estimate are supplied to the navigation Kalman filter to update the master radio's position.

APPLE-1005, 15:24-47.

78. **Second Combination Theory:** The POSITA also would have contemplated the alternative approach to conducting multiple of McCrady's ranging message exchanges on a single frequency, determining corresponding delays, and averaging those delays as taught by Raphaeli. APPLE-1005, Abstract ("The master radio transmits outbound ranging messages..."), 7:14-26, 8:4-7, 14:35-65, 11:54-58, 15:14-23, Figs. 2, 4, 5; APPLE-1006, 19:1-40. A POSITA would have recognized that McCrady's ranging message exchanges (e.g., RTS-T/TOA message exchanges as discussed above) can occur on a single frequency because the message exchange is frequency agnostic. This single frequency could be, for example, a default frequency or selected based on McCrady's M ranging message exchanges on different frequencies.

79. As I discussed in VIII.B, Raphaeli describes transmitting multiple interrogation signals via a sequence of pulses to a target device and receiving multiple reply/response signals. APPLE-1006, 8:50-62, 9:3-21, 10:58-60, 16:61-67, Fig. 2. Raphaeli further discloses: "DSP 40 is optionally *calculating an average time delay* for collected pulse groups including at least the predetermined number of pulses" and "By DSP 40 calculating an *average time delay for collected pulse groups* including at least the predetermined number of pulses, the precision of the round trip delay determination is increased relative to a single delay measurement."

APPLE-1006, 19:1-40. A POSITA would have recognized that Raphaeli’s average time delay is based on multiple determined propagation delay measurements, which correspond to respective responses from a device.

80. **Motivations:** A POSITA contemplating McCrady’s system would have been familiar with references like Raphaeli that also describe techniques for determining the distance to a target wireless device. *See* Sections VIII.A, VIII.B; APPLE-1005, 8:65-9:56 (“Once the two-way signal propagation time is determined, the range is then readily calculated...”), 10:44-11:39; APPLE-1006, 1:10-15 (“distance determination....based on measuring the round trip delay”), 4:20-26, 6:50-54, 8:1-18, 22:16-36. In my opinion, a reference like Raphaeli would have been one of the top choices for the POSITA given its similarity to McCrady. As I discuss above, like McCrady, Raphaeli describes measuring the round trip delay during a message exchange between devices, and then using the delay to estimate a range between the devices. It is therefore no surprise that a POSITA, in my opinion, would have been motivated to pursue the McCrady-Raphaeli combination for several reasons.

81. In my opinion, a POSITA would have sought out teachings from references like Raphaeli on the notion of averaging multiple propagation delays based on suggestions within McCrady. McCrady, for example, uses “*averag[ing]*” to reduce the variance” when “performing an internal delay calibration to reduce the

variance of the delay estimate.” APPLE-1005, 10:44-59. McCrady also discloses “calculating the *mean* and standard deviation of [multiple] measured values [of antenna delay].” *Id.*, 11:15-23. A POSITA would have taken these various discussions on averaging, mean, and standard deviation as a suggestion to apply the same concept to other aspects of McCrady’s disclosure. I know from personal experience that ordinarily skilled persons routinely apply concepts disclosed in one portion of a document, including its background section, to other portions of the same document. Engineers and scientists are well trained at critical thinking and problem solving. Such a person would not have read and interpreted McCrady’s disclosure in a rigid, narrow manner. Instead, they would have bolstered their understanding of any given disclosure in McCrady by applying both their pre-existing knowledge and the knowledge gleaned from other portions of McCrady. Accordingly, the POSITA would have viewed Raphaeli’s teaching to conduct multiple message exchanges and to average multiple propagation delays as consistent with McCrady’s suggestion.

82. Moreover, the use of averaging in other aspects of McCrady’s disclosure, such as in estimating a range, would have been one of the obvious “variations” that McCrady envisioned.

While a particular implementation of the TOA processing has been described in conjunction with FIG. 7, ***it will be understood that other implementation and variations in the TOA processing scheme fall***

within the scope of the invention. ...

APPLE-1005, 16:1-16.

83. In my opinion, a POSITA would have expected Raphaeli's teaching on averaging multiple propagation delays (either determined from message exchanges on the same or different frequencies) to predictably improve a similar system like McCrady's by enhancing the precision of the estimated range. Raphaeli's disclosure on this precision advantage would have reinforced the POSITA's understanding:

By DSP 40 calculating an average time delay ..., *the precision of the round trip delay determination is increased* relative to a single delay measurement. ..., the pulse form of each received pulse is interpolated ..., further *enhancing the precision* of the round trip delay determination.

APPLE-1006, 19:33-40.

84. My opinion that Raphaeli's "precision advantage" would also apply to McCrady is further supported by similarities among McCrady and Raphaeli. First, Raphaeli's time delay is analogous to McCrady's time delay (see discussions above in Sections VIII.A, VIII.B, and IX.A). Second, both McCrady and Raphaeli describe conducting multiple signal exchanges (see discussions above in Sections VIII.A, VIII.B, and IX.A). Third, enhanced precision by averaging is a technique that would improve McCrady's determination of the two-way or round-trip propagation time and accordingly the range estimate. APPLE-1005, 8:65-9:23 (describing a round-trip propagation time T_{RT} calculation), 9:24-30 (describing a range calculation).

85. Even without Raphaeli's observation of improved precision, a POSITA in my opinion would have recognized that unknown/random error(s) exists in the individual propagation delay estimates described by McCrady/Raphaeli due to channel noises, interferences, measurement errors, etc. It would have been well known to a POSITA that such error can be a result of channel noises and/or interferences (including multi-path interference) which can distort the received signals exchanged for the ranging estimate, thereby causing errors in estimating the time of arrival (TOA) and consequently the round-trip propagation time (T_{RT}) in McGrady. Similarly, channel noises and/or interferences can distort the received pulses and can cause errors to the round trip delay (RTD). It would have been also well known to a POSITA that any measurement method for TOA or RTD measurement is limited in accuracy, leading to measurement errors. *See, e.g.,* APPLE-1021 (Birchler), 1:33-39 ("propagation delays are measured in practice using transmitted signals, which signals are subject to the effects of various error sources, e.g., noise, multipath interference, distortion, etc. The resultant errors in the delay measurements are translated into errors in the pseudo-ranges and, consequently, into error in the location estimate"). Thus, in my opinion, the POSITA would have sought to employ known methods for the purpose of obtaining a more precise representation of the delay estimate. In this context, Raphaeli's averaging technique would have been an obvious choice.

86. Indeed, averaging multiple measurements/estimates was a centuries-old and commonly used technique to produce an estimation value that summarizes or represents a set of values with reduced standard deviation (*i.e.*, reduced variance). As stated by C. Eisenhart, “it is seen that the precision of the arithmetic mean of n independent measurement is proportional to $\sqrt{n}$ ”. APPLE-1026 (Eisenhart), 177. *See also* APPLE-1005, 10:44-59 (“averag[ing] to reduce the variance” when “performing an internal delay calibration to reduce the variance of the delay estimate”). I know from personal experience that averaging was a mathematical operation commonly employed by those of skill in the art of wireless communications systems on or around January 2004. Moreover, various patents predating the ’779 patent show that “averaging” was a known element in the context of range finding systems. *See, e.g.*, APPLE-1019 (Uebayashi), 11:3-42 (“...the mobile station obtains the estimated distance D by averaging...”; APPLE-1020 (Buford), 7:39-43 (“By taking plural sets of information in a relatively short time frame (e.g., 10 times, every 64 chips, across about 500 microseconds), and averaging or otherwise best-fit calculating using the determined positions, position errors can be minimized.”), 9:34-41 (“to allow for averaging to improve accuracy, each base 301, 356 may forward 8 chip/time pairs,...”); APPLE-1021 (Birchler), 5:9-31 (“For each signal, the delay time delimited by the time of transmission indication and the time of reception indication (or an average delay time between multiple sets of time

of transmission and reception indications for known symbols within a given signal) is determined. Assuming speed of light propagation (and possibly accounting for atmospheric delays or any other known delays), the pseudo-ranges are readily calculated from the delay times thus determined.”); APPLE-1022 (Jandrell), 17:47-58 (“symbol is capable of serving as a high-resolution ranging pulse. Again, according to the procedure for resolution improvement by multi-measurement averaging described later, the resolution arrival time of the message is increased. ...”), 56:2-57:20 (“The jitter reduces the resolution of the time-of-arrival estimate of the pulses. However, due to the fact that most of the contributions to the jitter are randomly related variables, it is possible to markedly improve the estimate by making more than one measurement and then averaging the result as shown below. ...”). Applying this well-known concept in the context of McCrady yields the predictable outcome suggested by Raphaeli, which is taking multiple measurements and averaging the corresponding delay estimates.

87. **Reasonable Expectation of Success:** As discussed, McCrady and Raphaeli both describe techniques for position/range determination in the context of wireless devices. Moreover, given McCrady’s disclosure of multiple message exchanges (as I discussed, including for example, APPLE-1005, 14:35-65), the notion of ascertaining and averaging multiple delays based on those exchanges would have been straightforward from a POSITA’s perspective. Likewise, the

POSITA would have expected Raphaeli's averaging technique to work in the context of McCrady because McCrady employed averaging in other aspects of its disclosure. APPLE-1005, 10:44-59 ("averag[ing] to reduce the variance" when "performing an internal delay calibration to reduce the variance of the delay estimate"), 11:15-23 (describing that "[t]he delay T_a is determined by measuring the delay through a large sample of antennas and cabling, over a range of operating temperatures, and calculating the mean and standard deviation of the measured values.").

88. Additionally, averaging sampled values would have been within the skill level of a POSITA because averaging is taught/used in a variety of engineering, science, and/or math courses that a POSITA would have had taken as part of the degree requirement for a relevant degree as discussed in Section III. I have taught many such courses. My lectures for courses such as EEC 161 ("Probabilistic Analysis Of Electrical & Computer Systems") in UC Davis required for BS degree students in Electrical and Computer Engineering often include topics where averaging is taught.

89. Further, the McCrady-Raphaeli combination represents a combination of known elements each performing the functions it had been known to perform to produce the predictable result of combining/averaging multiple propagation delay values. The above-cited patents (APPLE-1019, APPLE-1020, APPLE-1021, APPLE-1022, among others) show that "averaging" was a known element in the

context of range finding systems. As such, a POSITA would have reasonably expected a successful outcome from combining Raphaeli's teachings on averaging propagation delays with McCrady's description of a position location system.

90. As I explain in more detail below through my feature-by-feature analysis, McCrady in combination with Raphaeli renders obvious each of claims 1, 2, 8-10, 12-13, 18-19, 22-24, 26-28, 32, and 34.

B. Claims 1, 13, 18, 27

1. Claim 1

91. The McCrady-Raphaeli combination provides claim 1 for the following reasons.

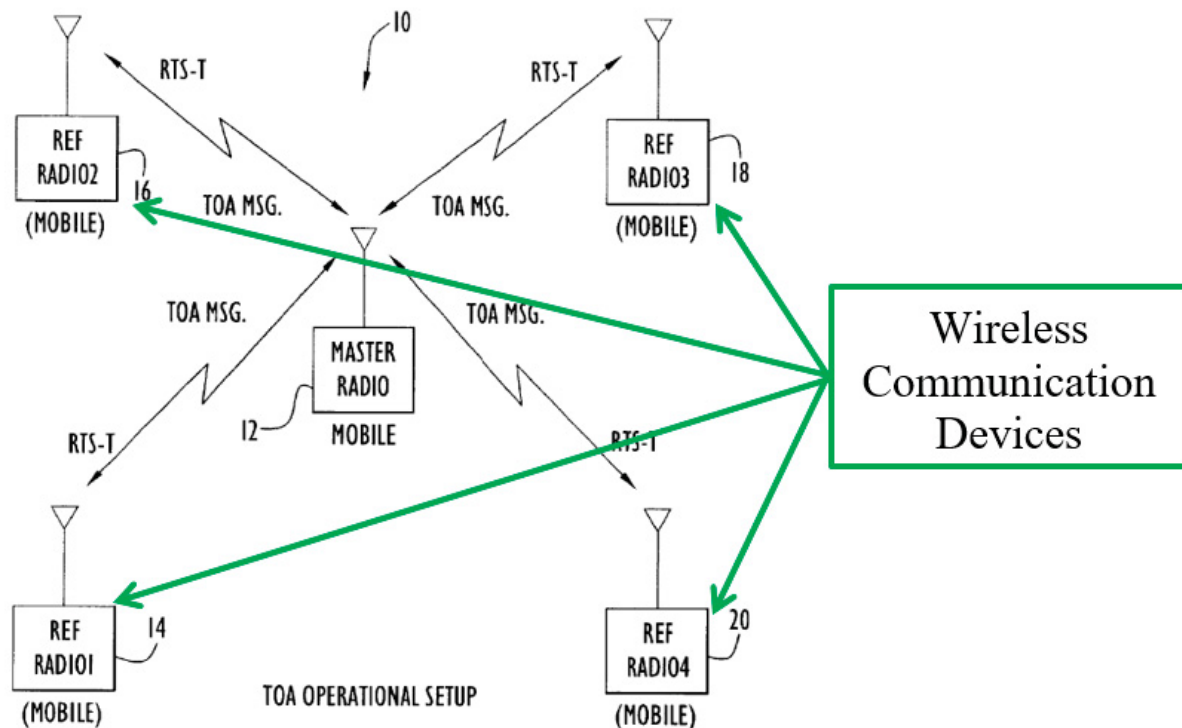
[1.pre] A wireless communications system comprising:

92. To the extent the preamble is limiting, it is my opinion that the McCrady-Raphaeli combination provides [1.pre]. As discussed below, McCrady describes a system, *e.g.*, "position location system 10," that includes wireless communications devices (*e.g.*, reference radios) and a wireless device locator (*e.g.*, a master radio). APPLE-1005, 6:44-56, Fig. 1.

[1.a.i] a plurality of wireless communications devices each having a device type associated therewith from among a plurality of different device types,

93. It is my opinion that the McCrady-Raphaeli combination provides [1.a.i]. For example, as I discussed in section VIII.A, McCrady describes that "a position location system 10 includes a target or 'master' mobile communication

device or ‘radio’ 12 communicating with *four reference communication devices 14, 16, 18 and 20.* APPLE-1005, 6:44-56. These devices can be “any portable electronic device equipped with wireless transmission and reception capabilities.” *Id.* As I note above, the reference (“REF”) devices can also be their own master radios. APPLE-1005, 7:2-13.



APPLE-1005, Fig. 1 (annotated).

94. Each of McCrady’s devices has an associated device type which can be one of a plurality of different device types:

Referring to FIG. 1, a position location system 10 includes a target or “master” mobile communication device or “radio” 12 communicating with four reference communication devices 14, 16, 18 and 20. As used herein and in the claims, a mobile communication device or mobile

radio is any portable device capable of transmitting and/or receiving communication signals, including but not limited to: ***a handheld or body-mounted radio; any type of mobile telephone (e.g., analog cellular, digital cellular or satellite-based); a pager or beeper device; a radio carried on, built into or embedded in a ground-based or airborne vehicle; or any portable electronic device equipped with wireless transmission and reception capabilities.***

APPLE-1005, 6:44-56. A POSITA would have recognized that these devices (see bolded devices in the preceding citation) comprise different device types. For example, a mobile telephone is a different type of device compared to a pager. Moreover, even within the category of mobile telephone, the POSITA would have understood “analog cellular,” “digital cellular,” and “satellite-based” versions as comprising different devices types. Moreover, a POSITA reading McCrady would have distinguished between different types of devices based on their antenna hardware. For example, first generation analog cellular phones were as bulky as a brick and often had a much bigger and visible antenna than the compact digital cellular phones of later generations. Wireless devices such as Bluetooth radios can use an antenna that is small in size in comparison with cellular. Similarly, satellite phones relied on larger and more powerful antennas. A POSITA would have recognized that “digital cellular” devices and “satellite-based” devices would have used different types of antennas because cellular-based and satellite-based communications occurred in different frequency bands. Indeed, a POSITA would have recognized that even in cellular-based communications there are different

frequency bands which have different antenna designs. For example, for cellular service, the 850 MHz band has a wavelength nearly three times longer than the wavelength of the 2.5GHz band.

[1.a.ii] each WLAN device having a unique identifier (UID) associated therewith, and

95. It is my opinion that the McCrady-Raphaeli combination provides [1.a.ii]. As an initial matter, my analysis here treats “each WLAN device” in [1.a.ii] as referencing the “wireless communications devices” of [1.a.i] because [1.a.ii] immediately follows [1.a.i] and there are no other previously introduced devices.

96. McCrady discloses that the devices are WLAN devices. McCrady’s devices (including master and reference radios) can be “any portable electronic device equipped with *wireless* transmission and reception capabilities.” APPLE-1005, 6:44-56, 7:2-13, Fig. 1. As such, McCrady teaches that the reference radios include WLAN devices. Moreover, in a WLAN, devices can communicate via radio waves with nearby radios. This is consistent with a dictionary definition: WLAN is a “local area network (LAN) architecture radiated transmissions (such as radio or light).” APPLE-1010 (see definition of WLAN). A POSITA would have recognized that McCrady’s radios communicate wirelessly using radio waves and that for a device to communicate within a WLAN, the device itself would have to be a WLAN device which would fall within the above-identified description of devices in McCrady.

97. Regardless, even if Patent Owner were to argue that McCrady somehow lacks an express disclosure, the fact that McCrady's reference radios can be "any" device with the ability to transmit/receive wireless signals would have at least suggested or otherwise rendered obvious WLAN devices to a POSITA. At the time of the '779 Patent in 2004, mobile computing devices (such as laptops, handhelds, tablets, PDAs, smartphones, etc.) with WLAN capabilities were known in the art, desirable, and commercialized especially given that they allowed interconnectivity without with wires among two or many devices. *See, e.g.*, APPLE-1024 (Litwin), [0018] ("the mobile device 110 can comprise a personal digital assistant (PDA) or a laptop computer with a WLAN and plug-in card."), [0004-0005], [0013]; APPLE-1025 (Christoffel), [0011] ("Some mobile devices also have the capability of moving among different types of wireless communication networks, such as between a WLAN network (Bluetooth or IEEE 802.11, as described above) and a mobile telecommunications network..."), [0002-0003].

98. Thus, when McCrady mentioned "any" wireless device, the POSITA would have contemplated WLAN devices, which were well known. In fact, even at the filing date of McGrady (Aug. 2, 1999), WLAN was well known to a person of ordinary skill in the art. *See, e.g.*, APPLE-1032 (a 1998 article by van der Perre, *et al.* titled "Adaptive loading strategy for a high speed OFDM-based WLAN," IEEE GLOBECOM 1998). Further, WLAN devices would have come to mind given that

McCrady's background section discloses a WLAN and its use for transferring ranging information (TOAs). APPLE-1005, 2:58-60 ("TOAs are transferred via wireless local area network to the RAM-drive of a third computer acting as the base computer.").

99. This is also consistent with Raphaeli, which discloses that various/other "transmission methods" can be used for the disclosed signal/message exchanges:

In another example, instead of transmitting pulses carried on RF signals, the pulses are transmitted without an RF carrier, for example in accordance with UWB (ultra high bandwidth) methods.

Moreover, although the above description relates to using pulse signals for communicating between reader 2 and tags 4, other types of signals may be used, in accordance with some embodiments of the invention. For example, in an exemplary embodiment of the present invention, various spread spectrum transmission methods may be used, including direct sequence (DS), frequency-hopping (FH) and multi-carrier CDMA (MC-CDMA). Moreover, other transmission methods are used, such as chirp signals and/or short pulses or long pulses with arbitrary shapes with or without time hopping (TH).

APPLE-1006, 25:19-33.

100. McCrady further discloses each WLAN device having a unique identifier (UID) associated therewith. McCrady's master radio transmits, for example, an outbound ranging message (e.g., RTS-T) that includes a Destination Address:

The data portion of the RTS-T message includes a ***Destination Address*** 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The ***Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message.*** The other data field can include information such as the identification of the master radio, a flag or data indicating a ranging mode, or information relating to the state of multipath interference.”

APPLE-1005, 8:38-46. *See also* Sections VIII.A, IX.B.1 ([1.b.iii]-[i.b.iv]). In my opinion, McCrady’s destination address is consistent with a POSITA’s understanding of a UID. For example, McCrady’s description of the destination address shows that it is used to uniquely identify different message destinations, *i.e.*, reference radios, within the network in a manner that ensures the message is directed to and received by the intended radio.

101. In my opinion, McCrady’s description is also consistent with the specification and claims of the ’779 Patent which describe that the UID includes an address of a device.

Additionally, the controller may also determine the device type of the target wireless communications device based upon the UID. By way of example, ***the UIDs may include media access control (MAC) addresses of respective wireless communications devices.*** Accordingly, the controller may determine the device type of the target wireless communications device based upon the MAC address in some applications.

APPLE-1001, 3:38-45.

Additionally, the controller 42 may also determine the device type of the target wireless communications device 34 based upon the UID

thereof. By way of example, *the UIDs may include media access control (MAC) addresses of respective wireless communications devices*. The MAC addresses may be specific to a particular type of device manufacturer, or indicate a particular operational protocol with which the device is operating, as will be appreciated by those skilled in the art. Accordingly, the controller may determine the device type of the target wireless communications device 34 based upon the MAC address thereof in some applications.

APPLE-1001, 6:14-25. *See also id.*, claim 5 (“The wireless communications system of claim 4 wherein *the UIDs comprise media access control (MAC) addresses of respective wireless communications devices, ...*”).

[1.a.iii] each device type having a known device latency associated therewith; and

102. It is my opinion that the McCrady-Raphaeli combination provides [1.a.iii]. McCrady explains that the reference radios (mapped to the claimed “wireless communication devices”) have an associated latency during the ranging message exchange (*e.g.*, a processing delay, antenna delay, etc.). McCrady describes that “*the internal processing delays of the reference radio are incorporated into the turn around time ΔT_{TA}* .” APPLE-1005, 8:65-9:23. McCrady provides details about the antenna delay:

The value for the master and *reference radio antenna delay T_a* (see *FIG. 4*) *is a constant preloaded* into the radios and combined with the results of delay calibration to reference the TOA to the antenna/air interface. *The delay T_a is determined by measuring the delay through a large sample of antennas and cabling, over a range of operating*

temperatures, and calculating the mean and standard deviation of the measured values. Note that cabling delays for cabling between antenna and electronics are included in T_a .

APPLE-1005, 11:15-23. McCrady provides additional details about the internal processing delay:

Thus, the internal processing delay of the master radio ΔT_{ID} seen in equation (1) is determined from the master radio transmitter and receiver delays T_{mt} and T_{mr} determined from the calibration process and the estimated antenna delay T_a . Similarly, the estimate of the duration of the turn around time TT includes *the reference radio transmitter and receiver delays T_{rt} and T_{rr} determined from the calibration process and the estimated antenna delay T_a .* The total elapsed time measured by the master radio between transmission of the outbound ranging message and reception the reply ranging message includes time attributable to propagation of the message signals and time attributable to processing delays within the radios. By accurately estimating and subtracting out the time attributable to processing delays, the signal propagation time (and hence the range) can be more accurately determined.

APPLE-1005, 11:24-39, Fig. 5.

103. As to the antenna delay latency, McCrady teaches that it is a predetermined value associated with a device type. *Id.*, 11:15-23 (The value for the master and reference radio antenna delay T_a (see FIG. 4) is a *constant preloaded* into the radios; T_a is “determined by measuring the delay through a large sample of antennas”). Moreover, a POSITA would have understood that McCrady contemplates different known device latencies under either its plain meaning or “predetermined latency” discussed in Section VII because there are different antenna

delay values for devices equipped with different types of antennas (“device type,” as I discussed above). In other words, a POSITA would have recognized that the antenna delay T_a for a given antenna type applies to any device with that antenna type (“device type”).

104. McCrady reinforces this understanding through its teaching that the antenna delay value is previously determined “by measuring the delay through a large sample of antennas...and calculating the mean and standard deviation of the measured values.” APPLE-1005, 11:15-23. As the POSITA would have known, sampling antenna delay across a population of antennas of the same type reduces variance and increases accuracy in the delay estimate. For example, McCrady discloses:

Referring to FIGS. 4 and 5, the master radio initiates the TOA ranging process by performing an internal delay calibration using a loop back through pad 40 to determine internal delays ($T_{mt}+T_{mr}$) in the master radio for correction purposes. *Multiple trials, for example ten, are performed and averaged to reduce the variance of the delay estimate.*

APPLE-1005, 10:44-59.

105. A POSITA would have recognized that McCrady’s disclosure regarding reduced variance at 10:44-59 is a general property about averaging. As such, McCrady’s averaged antenna delay value for a given antenna type would have reduced variance. As I discuss above, McCrady discloses a wide variety of different

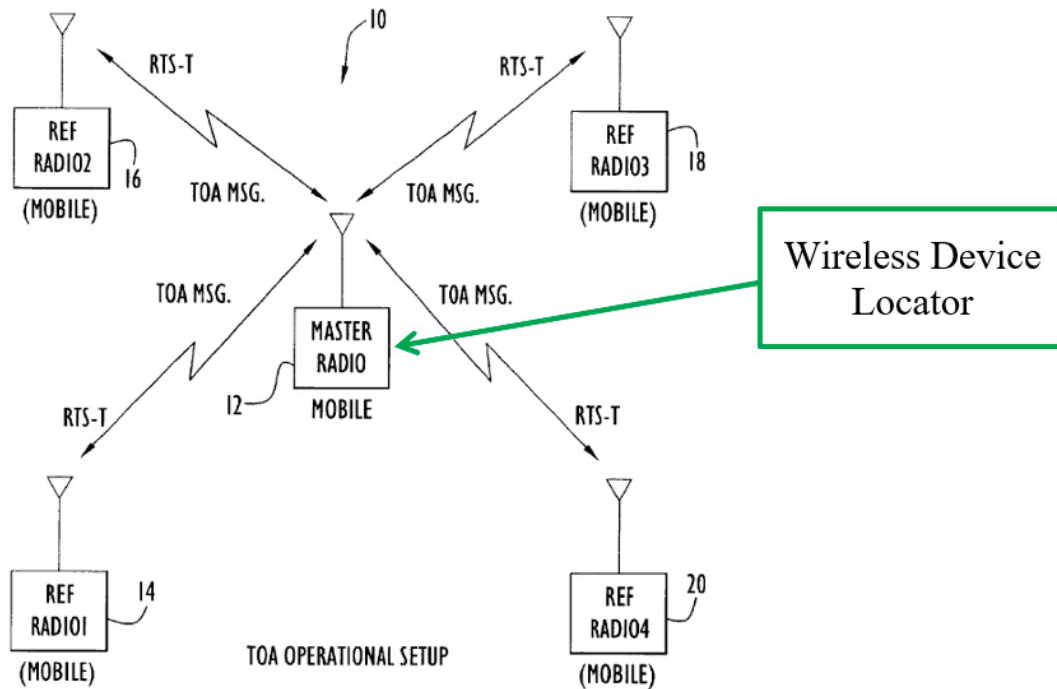
devices which use different types of antennas. Combining values from disparate antenna types would produce a value that is physically meaningless as a representative delay of any specific antenna type, which would skew the propagation delay estimate. As such, the POSITA would not read McCrady as suggesting a single value for all device/antenna types.

106. To the extent Patent Owner argues that McCrady teaches a single antenna delay value for every single type (which it does not), a POSITA would have been motivated to pursue a predictable variation with different delay values for devices with different types of antennas. This approach would have predictably increased the precision and accuracy of the estimated delay (as noted above) with no material impact on other aspects of the McCrady-Raphaeli combination.

[1.b.i] a wireless device locator comprising at least one antenna and a transceiver connected thereto, and

107. It is my opinion that the McCrady-Raphaeli combination provides [1.b.i].

108. McCrady describes, for example, “*Master radio 12* communicates with the four reference radios 14, 16, 18 and 20 to *determine its location in three dimensions*” by “determin[ing] the range to each reference radio.” APPLE-1005, 7:14-21. The master radio’s functionality of locating reference radios to ascertain its own relative location is consistent with a POSITA’s understanding of a wireless device locator.



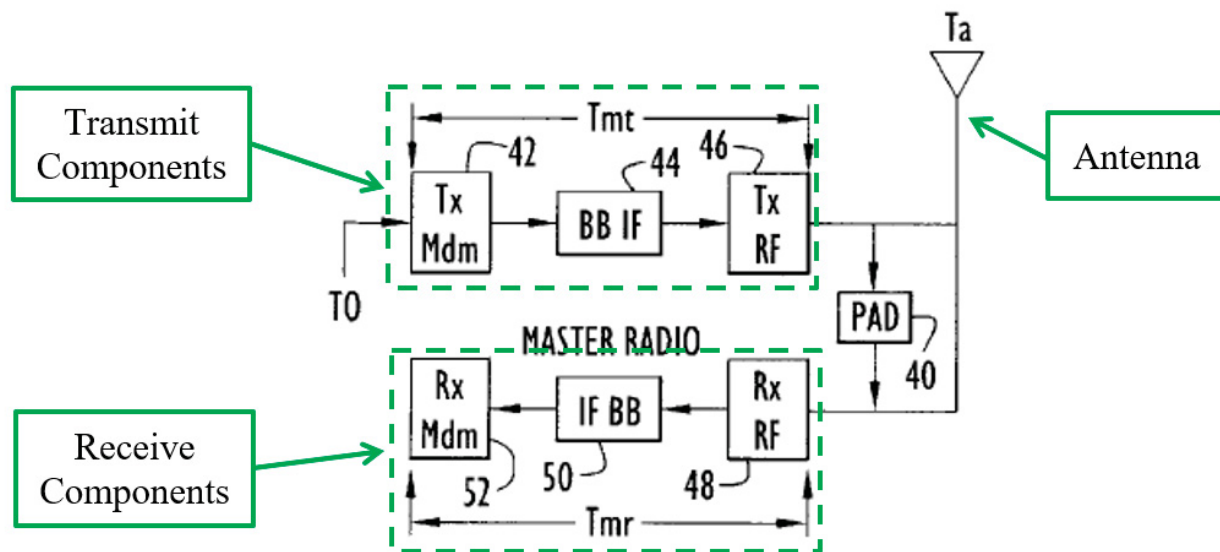
APPLE-1005, Fig. 1 (annotated).

109. McCrady further explains that “master radio 12...includes an *antenna* coupled to a *transmitter and a receiver* for transmitting and receiving ranging messages.” APPLE-1005, 7:14-21. McCrady describes that the master radio includes multiple components including transmit and receive components that are coupled with the antenna:

Referring to FIGS. 4 and 5, the master radio initiates the TOA ranging process by performing an internal delay calibration using a loop back through pad 40 to determine internal delays ($T_{mt} + T_{mr}$) in the master radio for correction purposes. Multiple trials, for example ten, are performed and averaged to reduce the variance of the delay estimate. The delay T_{mt} is the master radio transmitter delay. It is the sum of the delays through the *transmit modem (Tx mdm) 42 where the transmit signal is implemented, the transmit baseband to intermediate frequency (BB-IF) conversion 44, and the transmit radio frequency*

(Tx RF) analog circuitry 46 of the master radio. The delay T_{mr} is the master radio receiver delay. It is the sum of the delays through the receive radio frequency (Rx RF) analog circuitry 48 of the master radio, the IF-BB conversion 50, and the receive modem (Rx mdm) 52 where demodulation processing occurs.

APPLE-1005, 10:44-59.



APPLE-1005, Fig. 5 (annotated).

110. A receiver and a transmitter in the same device and coupled to the same antenna, such as what is described in the above-identified disclosures of McCrady, is consistent with a POSITA's understanding of a *transceiver*. This is consistent with dictionary definitions. A transceiver "can both transmit and receive signals. APPLE-1010 (see definition of transceiver). A transceiver is "[t]he combination of radio transmitting and receiving equipment in a common housing, usually for portable or mobile use, and employing common circuit components for both transmitting and

receiving.” APPLE-1011 (see definition of transceiver).

[1.b.ii] a controller for cooperating with said transceiver for

111. It is my opinion that the McCrady-Raphaeli combination provides [1.b.ii].

112. McCrady’s master radio includes processor/processing circuitry as disclosed in various places throughout McCrady’s specification:

- 8:65-9:23 (describing “internal processing delays within the master radio”),
- 10:36-43 (describing “signal processors of the radios”),
- 10:44-59 (describing that “the master radio initiates the TOA ranging process by performing an internal delay calibration using a loop back through pad 40 to determine internal delays”),
- 12:8-23 (describing “communication acquisition processor 70”),
- 13:15-47 (describing “TOA processor 92”),
- Figs. 6, 7 (see “TOA processing in DSP software”) (DSP stands for a digital signal processor).

113. A POSITA would have understood that McCrady’s processor/processing circuitry (see above cites) controls the components of the master radio, including the transceiver discussed in [1.b.i]. McCrady’s disclosure that “master radio initiates the TOA ranging process” indicates McCrady’s

processor/processing circuitry controls the radio's components to perform the ranging process which includes, among other things, causing McCrady's transceiver (discussed above) to transmit and receive ranging signals. As such, it is my opinion that McCrady teaches the claimed controller for cooperating with said transceiver.

114. Regardless, even if Patent Owner argues that McCrady's disclosure of processor/processing circuitry is deficient (which it is not), the '779 Patent's claims are no less obvious. As discussed at [1.a.i], McCrady contemplates known wireless communications devices such as mobile telephones. APPLE-1005, 6:44-56. McCrady further sought to maintain the "existing hardware and software" of these devices. APPLE-1005, 4:26-30 ("A further object of the present invention is to minimize design and manufacturing costs of a position-locating mobile communication device by using much of the existing hardware and Software capability of a conventional mobile communication device."), 7:42-43 ("By way of non-limiting example, to take advantage of existing hardware and software found in certain radios, ..."). This at least suggests a controller. For example, wireless communications devices (e.g., mobile phones) were known to include a conventional "hardware" component called a "controller" that performs central processing and controls onboard peripherals, including a transceiver. *See, e.g.*, APPLE-1024 (Litwin), Fig. 2 (see "controller 210" coupled with "wireless transceiver 206"), [0018] ("The mobile device 110 comprises a wireless transceiver

206 coupled to an antenna 202, a controller 210 configured with inventive WLAN location processing 208, wireless baseband circuitry 212, and WLAN baseband circuitry 214. Wireless baseband circuitry 212 processes signals associated with a wireless communication system, such as cellular telephone signals.”); [0019] (“The controller 210 can comprise a processor coupled between the wireless baseband circuitry 212, the WLAN baseband circuitry 214, and the wireless transceiver 206. In this embodiment, the controller 210 is programmed to perform various control functions in accordance with the present invention.”). *See also* APPLE-1023 (Gesbert), 1:9-13 (“present invention relates generally to wireless communication systems”), 5:55-61 (discussing the transmit unit of Fig. 3), 6:46-50 (“controller 66 [of transmit unit], which is also connected to transmit processing block 56 and spatial map ping unit 58. Controller 66 controls which mode from database 78 is applied to each of the k streams and spatial mapping to be performed by spatial mapping unit 58.”).

115. Again, as I discussed above McCrady’s goal was to preserve this “existing hardware” in its master radio. Raphaeli’s disclosure corroborates McCrady’s suggestion on this point by describing in a similar context that “a single processor” can “perform the tasks of both [a digital signal processor] and [a] controller.” APPLE-1006, 19:60-63; *see also id.*, 18:22-42, 19:11-53, Fig. 3.

[1.b.iii] transmitting a plurality of location finding signals to a target wireless communications device from among said plurality of wireless communications devices and

116. It is my opinion that the McCrady-Raphaeli combination provides [1.b.iii].

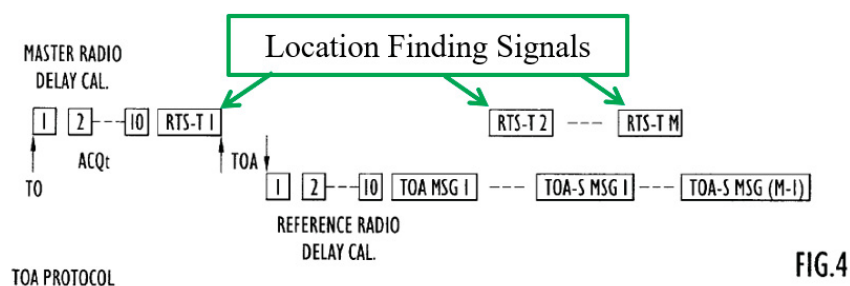
117. The transmitter (“transceiver” per analysis at [1.b.i]) in the McCrady-Raphaeli combination, as controlled by the controller which I discussed for [1.b.ii], provides the claimed functionality under each of the First/Second Combination Theories that I set forth in Section IX.A.

118. First Combination Theory: The transmitter of the master radio in the McCrady-Raphaeli combination transmits a plurality of location finding signals to a target wireless communications device (McCrady’s reference radio) during the “frequency diversity” process, where the master radio “transmit[s] a sequence of *M* outbound ranging messages” on different frequencies and receives “*M* corresponding reply ranging messages”:

- 14:35-65 (describing that “the TOA processor implements a process employing *frequency diversity* to identify an optimal transmission frequency that minimizes multipath interference” and that “the set of *M* carrier frequencies that will be used to *transmit a sequence of M outbound ranging messages and M corresponding reply ranging messages*”),

- 7:14-26 (“**Master radio 12** communicates with the four reference radios 14, 16, 18 and 20 to **determine its location in three dimensions**” and that “master radio 12 ... includes an antenna coupled to a transmitter and a receiver for **transmitting** and receiving **ranging messages**. ... The time of arrival (TOA) of ranging messages transmitted between the master and reference radios is used to determine the range to each reference radio, and trilateration is then used to determine from the range measurements the location of the master radio with respect to the reference radios.”)
- 8:4-7 (“Referring again to FIG. 2, the ranging message sequence begins with the master radio transmitting an **initial outbound ranging message RTS-T to a particular reference radio**”),
- 15:14-23 (describing that “Once the number M of ranging message exchanges and ping frequencies are determined or selected, **the next M-1 [RTS-T]/TOA message exchanges are transmitted**, using different carrier frequencies for each exchange.”),
- 11:54-58 (“For example, if subsequent ranging messages are exchanged between the master and reference radio immediately after the initial exchange, calibration does not need to be repeated for these subsequent messages (see FIG. 4).”),

- Abstract (describing that “The master radio transmits outbound ranging messages to plural reference radios which respond by transmitting reply ranging messages.”).



APPLE-1005, Fig. 4.

119. Second Combination Theory: The transmitter of the master radio in the McCrady-Raphaeli combination transmits a plurality of location finding signals to a target wireless communications device on a single frequency. APPLE-1005, Abstract (“The master radio transmits outbound ranging messages...”), 7:14-26, 8:4-7, Figs. 2, 5. Moreover, as I discussed above, Raphaeli describes transmitting multiple interrogation signals via a sequence of pulses to a target device and receiving multiple reply/response signals. APPLE-1006, 8:50-62, 9:3-21 (“interrogation” via “a sequence of pulses”), 10:58-60, 16:61-67, 19:1-40.

[1.b.iv] inserting the UID for said target wireless communications device in each of the location finding signals;

120. It is my opinion that the McCrady-Raphaeli combination provides

[1.b.iv]. McCrady describes, for example, that “[t]he data portion of the RTS-T message includes a *Destination Address* 28 ...[which] *is used to indicate the reference radio to which the master radio is directing the RTS-T message.*” APPLE-1005, 8:38-46. As a matter of basic common knowledge and common sense, a POSITA would have understood and expected that a device would insert (include) a destination address (UID) into a message before transmitting the message containing that address.

121. Further, it is my opinion that McCrady’s description is consistent with the specification of the ’779 Patent which describes inserting/including a UID in a signal (e.g., header packet).

As such, to locate the target device 34, the controller inserts the UID therefor in each of the location finding signals. By way of example, the location finding signal may include the UID of the target device 34 in a header packet and a valid but empty data packet. This will force the target device 34 to generate a reply signal acknowledging receipt of the location finding signal (i.e., an ACK signal). Of course, various other location finding signals could be used to cause the target terminal 34 to generate an ACK signal, as will be appreciated by those skilled in the art. The controller 42 cooperates with the transceiver 41 for receiving the reply signals from the target device 34 via the antenna 39. The location finding signals and reply signals may be radio frequency (RF), microwave, optical, or other suitable types of signals, as will be appreciated by those skilled in the art.

APPLE-1001, 6:26-30.

122. It is also my opinion that it would have been obvious to a POSITA that McCrady’s master radio (via controller, discussed for [1.b.ii]) inserts the destination

address in the RTS-T message in order for the message to include the address. For example, doing so would have been consistent with RTS-based protocols which require the inclusion of destination addresses in RTS messages. APPLE-1005, 7:42-8:46; APPLE-1030, Section 7.2.1.1 (“Request To Send (RTS) frame format”).

123. Thus, McCrady teaches as well as renders obvious inserting the UID (*i.e.*, destination address) for said target wireless communications device in each of the location finding signals (*i.e.*, RTS-T messages).

[1.c] said target wireless communications device transmitting a respective reply signal for each of said location finding signals based upon the UID in the location finding signals;

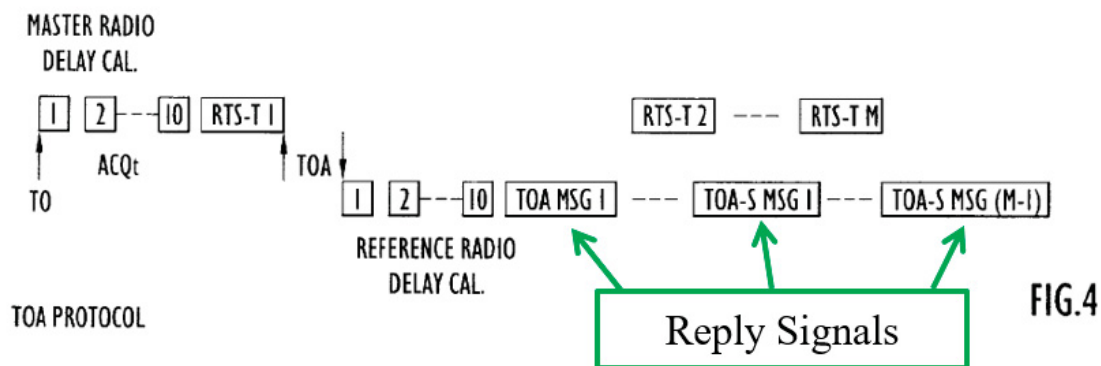
124. It is my opinion that the McCrady-Raphaeli combination provides [1.c]. As I discussed for [1.a.i] and [1.b.ii], McCrady-Raphaeli involves transmitting a plurality of location finding signals (McCrady’s ranging message, *e.g.*, outbound ranging message RTS-T, transmitted multiple times to facilitate the averaging technique taught by Raphaeli) to a target wireless communications device (McCrady’s reference radio).

125. McCrady also teaches that the target device transmits reply signals (McCrady’s reply ranging messages) for each location finding signal:

- APPLE-1005, 7:14-26 (discussing “transmitting and receiving ranging messages”),
- 8:39-50 (discussing the “*reply ranging message (TOA Msg.)*”)

transmitted from each reference radio to the master radio”),

- 14:45-49 (discussing “the set of M carrier frequencies that will be used to transmit a sequence of M outbound ranging messages and M *corresponding reply ranging messages*”),
- 15:14-23 (describing that “Once the number M of ranging message exchanges and ping frequencies are determined or selected, *the next $M-1$ [RTS-T]/TOA message exchanges are transmitted*, using different carrier frequencies for each exchange.”),
- 11:54-58 (“For example, if subsequent ranging messages are exchanged between the master and reference radio immediately after the initial exchange, calibration does not need to be repeated for these subsequent messages (see FIG. 4).”),
- Abstract (“The master radio transmits outbound ranging messages to plural reference radios which respond by transmitting reply ranging messages.”).



APPLE-1005, Fig. 4.

126. As I discuss above, there is a UID (*e.g.*, destination address) in the location finding signals (*e.g.*, RTS-T messages) that corresponds to the target device. McCrady's "Destination Address field is used to *indicate* the reference radio to which the master radio is directing the RTS-T message." APPLE-1005, 8:38-46. McCrady's reference radio transmits the reply if its address has been "indicated" in the RTS-T message. As such, a POSITA would have recognized that McCrady's reference radio transmits the reply *based upon the UID* (*e.g.*, destination address) in the location finding signals (*e.g.*, RTS-T messages). *Id.*

[1.d] said controller of said wireless device locator also for

127. It is my opinion that the McCrady-Raphaeli combination provides [1.d]. As I discussed for [1.b.ii], McCrady provides a controller.

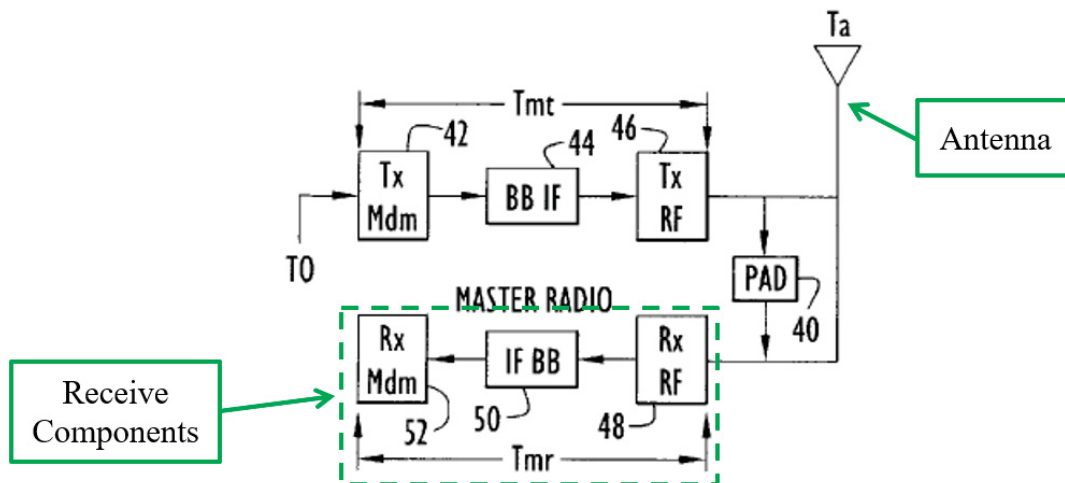
[1.d.i] cooperating with said transceiver for receiving the reply signals,

128. It is my opinion that the McCrady-Raphaeli combination provides [1.d.i]. Reply signals are transmitted, as previously discussed for [1.c], and are subsequently received. For example, McCrady describes:

- "*Master radio 12* communicates with the four reference radios 14, 16, 18 and 20 to *determine its location in three dimensions*" and that "master radio 12 ... includes an *antenna coupled to a transmitter and a receiver for transmitting and receiving ranging messages*." APPLE-

1005, 7:14-26.

- “Upon *reception of the reply ranging message*, the master radio determines the range to the reference radio from the signal propagation time calculated by subtracting the far-end turn around time from the round-trip elapsed time.” APPLE-1005, Abstract.
- Receive components of the master radio receive the reply ranging messages: “It is the sum of the delays through the receive radio frequency (Rx RF) analog circuitry 48 of the master radio, the IF-BB conversion 50, and the receive modem (Rx mdm) 52.” APPLE-1005, 10:44-59.



APPLE-1005, Fig. 5.

[1.d.ii] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of said target wireless communications device, and

129. It is my opinion that the McCrady-Raphaeli combination provides [1.d.ii]. For example, McCrady determines a propagation delay (round-trip propagation time (T_{RT})) using the time of transmission (TT) of each location finding signal and the time of arrival (TOA) of each respective reply signal:

“By precisely knowing the time of transmission of the outbound ranging message, the far-end turn around time at the reference radio (supplied to the master radio in the reply ranging message), the time of arrival of the reply ranging message, and internal transmission/reception processing delays, the master radio can precisely determine the two-way signal propagation time between itself and each reference radio. More specifically, ***the two-way or round-trip propagation time (T_{RT})*** is the time of arrival (TOA) of the reply message minus the time of transmission (TT) of the outbound message minus ***the duration of the turn around time (ΔT_{TA})*** and internal processing delays within the master radio ΔT_{ID} (***the internal processing delays of the reference radio are incorporated into the turn around time ΔT_{TA}***).

$$T_{RT} = TOA - TT - \Delta T_{TA} - \Delta T_{ID} \quad (1)$$

Although separately represented in equation (1), the accounting for the ***internal processing delays*** can be considered part of accurately determining the time of arrival TOA and the time of transmission TT; thus, the round-trip signal propagation time T_{RT} can more generally be described as the difference between a) the elapsed time between the time of transmission of the outbound ranging message and the time of arrival of the reply ranging message and b) the turn around time ΔT_{TA} .

APPLE-1005, 8:65-9:23. McCrady’s calculation (equation 1 in the above citation) also accounts for “turn around time (ΔT_{TA}),” which includes “the reference radio transmitter and receiver delays T_{rt} and T_{rr} determined from the calibration process and ***the estimated antenna delay T_a*** .” *Id.*, 11:28-31. Accordingly, just as the

propagation delay determination is based on the time of transmission (TT) and time of arrival (TOA), it is also based on the estimated antenna delay (Ta) for the antenna type, which, as I discussed for [1.a.i]-[1.a.iii], comports with the '779 Patent's claimed "known device latency."

130. To the extent that the Board deems that the claimed propagation delay does not correspond to McCrady's two-way or round-trip propagation time (T_{RT}), a POSITA would have recognized that McCrady's T_{RT} , when divided by two as described by McCrady, provides a one-way propagation delay. McCrady describes this division to determine the one-way delay part (that is $(T_{RT})/2$) of the range equation in Eq. 2:

Once the two-way signal propagation time is determined, the range is then readily calculated as the velocity of the signal through the propagating medium (e.g., the speed of light through air) multiplied by the one-way propagation time.

$$\text{Range} = (\text{Velocity})(T_{RT})/2 \quad (2)$$

APPLE-1005, 9:24-30. *See also id.*, 9:31-56.

131. As I discussed in Section IX.A, the First and Second Combination Theories each involve averaging multiple propagation delays obtained by conducting multiple ranging message exchanges and calculating a propagation delay for each exchange. A POSITA, in my opinion, would have understood that averaging multiple delays requires ascertaining individual delays for separate message exchanges.

[1.d.iii] estimating a range to said target wireless communications device based upon a plurality of determined propagation delays.

132. It is my opinion that the McCrady-Raphaeli combination provides [1.d.iii]. For example, McCrady discloses an equation (Eq. 2) based on the propagation delay (e.g., round-trip propagation time T_{RT} , per [1.d.ii]) to estimate a range to the target wireless communications device (McCrady's reference radio, per [1.a.i]):

Once the two-way signal propagation time is determined, *the range is then readily calculated as the velocity of the signal through the propagating medium (e.g., the speed of light through air) multiplied by the one-way propagation time.*

$$\text{Range} = (\text{Velocity})(T_{RT})/2 \quad (2)$$

APPLE-1005, 9:24-30.

133. As I previously discussed, the First and Second Combination Theories each involve averaging determined propagation delays and using the average delay in the range estimation equation. APPLE-1006, 19:1-40 (describes averaging, see citation above in VIII.B).

134. Let $T_{RT-average}$ be an average of multiple delays and $Range_{average}$ be the average range. In the McCrady-Raphaeli combination, McCrady's range estimation formula converts to: $Range_{average} = (\text{Velocity})(T_{RT-average})/2$. A POSITA would have understood that using an average of measured delays is just one example of how a range can be "based upon a plurality of determined propagation delays" and that other examples are possible.

2. Claim 13

135. Claim 13 is an independent system claim that parallels the system claim recited in claim 1 but with the additional limitation that the devices are WLAN devices (claims 1 and 10) and an average is used to estimate the range (claim 2). The limitations of claims 1, 2, and 10 and the limitations of claim 13 are substantially similar. As such, the limitations of claim 13 are rendered obvious by the McCrady-Raphaeli combination for the same reasons that I discussed for claims 1, 2, and 10. Any minor differences in claim language between claims 1, 2, and 10 and claim 13 are addressed in the following analysis.

[13.pre] A wireless communications system comprising:

136. It is my opinion that the McCrady-Raphaeli combination provides [13.pre]. *See* Section IX.B ([1.pre]).

[13.a.i] a plurality of wireless local area network (WLAN) devices each having a device type associated therewith from among a plurality of different device types,

137. It is my opinion that the McCrady-Raphaeli combination provides [13.a.i]. *See* Section IX.B ([1.a.i], [10]). For the reasons I discuss above, McCrady additionally discloses a target WLAN device and that the target WLAN device is from among said plurality of WLAN devices. *Id.*

[13.a.ii] each WLAN device having a unique identifier (UID) associated therewith, and

138. It is my opinion that the McCrady-Raphaeli combination provides [13.a.ii]. *See* Section IX.B ([1.a.ii]).

[13.a.iii] each device type having a known device latency associated therewith; and

139. It is my opinion that the McCrady-Raphaeli combination provides [13.a.iii]. *See* Section IX.B ([1.a.iii]).

[13.b.i] a wireless device locator comprising at least one antenna and a transceiver connected thereto, and

140. It is my opinion that the McCrady-Raphaeli combination provides [13.b.i]. *See* Section IX.B ([1.b.i]).

[13.b.ii] a controller for cooperating with said transceiver for transmitting a plurality of location finding signals to a target WLAN device from among said plurality of WLAN devices and inserting the UID for said target wireless communications device in each of the location finding signals;

141. It is my opinion that the McCrady-Raphaeli combination provides [13.b.ii]. *See* Section IX.B ([1.b.ii], [10]).

[13.c] said target WLAN device transmitting a respective reply signal for each of said location finding signals based upon the UID in the location finding signals;

142. It is my opinion that the McCrady-Raphaeli combination provides [13.c]. *See* Section IX.B ([1.c], [10]).

[13.d] said controller of said wireless device locator also for

143. It is my opinion that the McCrady-Raphaeli combination provides

[13.d]. *See* Section IX.B ([1.d]).

[13.d.i] cooperating with said transceiver for receiving the reply signals,

144. It is my opinion that the McCrady-Raphaeli combination provides

[13.d.i]. *See* Section IX.B ([1.d.i]).

[13.d.ii] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of said target WLAN device, and

145. It is my opinion that the McCrady-Raphaeli combination provides

[13.d.ii]. *See* Section IX.B ([1.d.ii], [10]).

[13.d.iii] estimating a range to said target WLAN device based upon an average of a plurality of determined propagation delays.

146. It is my opinion that the McCrady-Raphaeli combination provides

[13.d.iii]. *See* Section IX.B ([1.d.iii], [2], [10]).

3. Claim 18

147. Claim 18 is an apparatus claim that only includes the wireless device locator aspect of claim 1, and in this regard, the limitations of claims 1 and 18 are substantially similar. As such, the limitations of claim 18 are rendered obvious by the McCrady-Raphaeli combination for the same reasons that I discussed for claim 1. Any minor differences in claim language between claim 1 and claim 18 are addressed in the following analysis.

[18.pre] A wireless device locator for locating a target wireless communications device having a unique identifier (UID) associated therewith, the wireless device locator comprising:

148. It is my opinion that the McCrady-Raphaeli combination provides [18.pre]. *See* Section IX.B ([1.a.i]-[1.a.iii], [1.b.i]).

[18.a] at least one antenna and a transceiver connected thereto; and

149. It is my opinion that the McCrady-Raphaeli combination provides [18.a]. *See* Section IX.B ([1.b.i]).

[18.b] a controller for cooperating with said transceiver for

150. It is my opinion that the McCrady-Raphaeli combination provides [18.b]. *See* Section IX.B ([1.b.ii]).

[18.c] transmitting a plurality of location finding signals to the target wireless communications device,

151. It is my opinion that the McCrady-Raphaeli combination provides [18.c]. *See* Section IX.B ([1.b.iii]).

[18.d] inserting the UID for the target wireless communications device in each of the location finding signals, and

152. It is my opinion that the McCrady-Raphaeli combination provides [18.d]. *See* Section IX.B ([1.b.iv]).

[18.e] receiving a respective reply signal for each of said location finding signals generated by the target wireless communications device based upon the UID in the location finding signals,

153. It is my opinion that the McCrady-Raphaeli combination provides

[18.e]. *See* Section IX.B ([1.d.i], [1.c]).

[18.f] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon a known device latency of the target wireless communications device, and

154. It is my opinion that the McCrady-Raphaeli combination provides

[18.f]. *See* Section IX.B ([1.d.ii], [1.a.iii]).

[18.g] estimating a range to the target wireless communications device based upon a plurality of determined propagation delays.

155. It is my opinion that the McCrady-Raphaeli combination provides

[18.g]. *See* Section IX.B ([1.d.iii]).

4. Claim 27

156. Claim 27 is an independent method claim that mirrors the system claim recited in claim 1. The limitations of claim 1 and claim 27 are substantially similar. As such, the limitations of claim 27 are rendered obvious by the McCrady-Raphaeli combination for the same reasons that I discussed for claim 1. Any minor differences in claim language between claim 1 and claim 27 are addressed in the following analysis.

[27.pre] A method for locating a target wireless communications device from among a plurality of wireless communications devices, each wireless communications device having a device type associated therewith from among a plurality of different device types, each WLAN device having a unique identifier (UID) associated therewith, and each device type having a known device latency associated therewith, the method comprising:

157. It is my opinion that the McCrady-Raphaeli combination provides [27.pre]. *See* Section IX.B ([1.a.i]-[1.a.iii]).

[27.a] transmitting a plurality of location finding signals to the target wireless communications device, inserting the UID for the target wireless communications device in each of the location finding signals, and

158. It is my opinion that the McCrady-Raphaeli combination provides [27.a]. *See* Section IX.B ([1.b.iii]).

[27.b] inserting the UID for the target wireless communications device in each of the location finding signals, and

159. It is my opinion that the McCrady-Raphaeli combination provides [27.b]. *See* Section IX.B ([1.b.iv]).

[27.c] receiving a respective reply signal for each of the location finding signals generated by the target wireless communications device based upon the UID in the locations signals;

160. It is my opinion that the McCrady-Raphaeli combination provides [27.c]. *See* Section IX.B ([1.d.i], [1.c]).

[27.d] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of the target wireless communications device; and

161. It is my opinion that the McCrady-Raphaeli combination provides [27.pre]. *See* Section IX.B ([1.d.ii]).

[27.e] estimating a range to the target wireless communications device based upon a plurality of determined propagation delays.

162. It is my opinion that the McCrady-Raphaeli combination provides [27.pre]. *See* Section IX.B ([1.d.iii]).

C. Claims 2, 19, 28

[2] The wireless communications system of claim 1 wherein said controller estimates the range based upon an average of the propagation delays.

163. It is my opinion that the McCrady-Raphaeli combination provides [2]. As I discussed for Claim 1, the McCrady-Raphaeli combination includes a controller (see analysis at [1.b.ii], [1.d]). This controller determines multiple propagation delays (see analysis at [1.d.ii]) and estimates the range based upon an average of the propagation delays using the equation: $Range_{average} = (Velocity)(T_{RT-average})/2$ (see analysis at [1.d.iii]). As I discuss above, $T_{RT-average}$ is an average of multiple delays and $Range_{average}$ is the average range.

[19] The wireless device locator of claim 18 wherein said controller estimates the range based upon an average of the propagation delays.

164. It is my opinion that the McCrady-Raphaeli combination provides [19]. *See* discussion above for [2].

[28] The method of claim 27 wherein the controller estimates the range based upon an average of the propagation delays.

165. It is my opinion that the McCrady-Raphaeli combination provides [28]. *See* discussion above for [2].

D. Claims 8, 22

[8] The wireless communications system of claim 1 wherein said at least one antenna comprises at least one directional antenna.

166. It is my opinion that the McCrady-Raphaeli combination provides [8].

Raphaeli describes, for example:

The transmission of the wide band broadcast interrogation signal may be performed at a high repetition rate, for example: every tenth of a second, so as to substantially continuously monitor the vicinity of reader 2. Alternatively, the transmission of the wide band broadcast interrogation signal may be performed at a low repetition rate, for example: according to a predetermined scheme and/or under human control. *The wide band broadcast interrogation signal may be transmitted in a specific direction, by using for example a directional antenna*, or may be transmitted in all directions. Hereinafter, the term signal refers to one signal or to a plurality of signals transmitted in one logical transmission period.

APPLE-1006, 8:50-62.

167. A POSITA would have recognized that directional antennas were often used in devices (such as McCrady's radios) to transmit/receive signals in specific directions. See, e.g., APPLE-1006, 8:50-62 (describing that a "signal may be transmitted in a specific direction, by using for example a directional antenna"). Multipath signals may arrive from different directions (a copy of the signal is reflected off a building) compared to the direct path signal, and accordingly receiving signals from a specific direction can reduce interference and improve accuracy. APPLE-1007, 3:59-67 ("multi-path signals produced by reflection and diffraction due to buildings and the like especially in an urban environment.").

Additionally, devices located in different directions, for example, may try to respond at the same time, which would cause collisions; and transmitting in a specific direction enables only devices in that direction to respond and hence reduces air traffic and collisions. In sum, the predictable benefits of transmitting/receiving signals in specific directions would have prompted a POSITA to employ a directional antenna in McCrady's master radio. Such benefits included reducing collisions among devices, interference, air traffic, or a combination thereof.

168. Raphaeli describes "It is also desirable to have a collision overcoming method consuming minimal time that is almost not increasing with the number of tags participating in the collision." APPLE-1006, 4:12-14. Raphaeli also describes "Whereby the at least one additional wide band broadcast interrogation signal is initiating a new communicating session between the reader and the plurality of RF tags in order to reduce the collision probability between the plurality of wide band response signals transmitted by the tags." APPLE-1006, 4:52-57. Raphaeli further discusses that a response signal's pulses are timed "so as not to be interfered by [another] signal." APPLE-1006, 14:61-67. Raphaeli also describes:

Tag 4 determines reader 2 identity by either using reader 2 ID, if presents in the signal received by tag 4, or by physical properties of the signal that identify reader 2, such as for example: carrier frequency or time slot. This mechanism is advantageous in two aspects: saving the power consumed by tag 4 when transmitting the wide band response signal, and *reducing the traffic on the air, reducing interference to other tags that need to respond or to other wireless devices thereby*

reducing the collision probability.

APPLE-1006, 16:45-54.

169. Additionally, McCrady discusses the desirability to “reduce multipath interference and improve position measurement accuracy in a position location system” and “to separate multipath interference from direct path signals to accurately determine the time of arrival of the direct path signal to accurately determine range.” APPLE-1005, 4:9-17.

[22] The wireless device locator of claim 18 wherein said at least one antenna comprises at least one directional antenna.

170. It is my opinion that the McCrady-Raphaeli combination provides [22].

See discussion above for [8].

E. Claims 9, 23

[9] The wireless communications system of claim 1 wherein said wireless device locator further comprises a portable housing carrying said at least one antenna, said transceiver, and said controller.

171. It is my opinion that the McCrady-Raphaeli combination provides [9]. As I discussed for [1.b.i]-[1.b.ii], McCrady discloses a wireless device locator (e.g., “master radio”) which includes components, e.g., antenna, transceiver, and controller. McCrady describes:

“Referring to FIG. 1, a position location system 10 includes a target or “master” mobile communication device or “radio” 12 communicating with four reference communication devices 14, 16, 18 and 20. As used herein and in the claims, *a mobile communication device or mobile*

radio is any portable device capable of transmitting and/or receiving communication signals, including but not limited to: a handheld or body-mounted radio; *any type of mobile telephone* (e.g., analog cellular, digital cellular or satellite-based); a pager or beeper device; a radio carried on, built into or embedded in a ground-based or airborne vehicle; or *any portable electronic device equipped with wireless transmission and reception capabilities.*”

APPLE-1005, 6:44-56. McCrady further describes:

Finally, as explain in greater detail hereinbelow, one or more of the reference radios relied upon by a particular target radio can be another *mobile communication device* similar or identical to the master radio, wherein the reference radio determines its own position in accordance with the technique of the present invention (in this case, *the “reference” radio functions as both a reference radio for other radios and as its own “master” radio*). The fact that each reference radio could potentially be a *mobile radio is indicated in FIG. 1 by the designation “(MOBILE)”* next to each of reference radios 14, 16, 18 and 20.

APPLE-1005, 7:2-13. McCrady also describes “The system of the present invention also has application in locating the position of *cellular telephones*.” APPLE-1005, 17:41-42. A POSITA would have recognized that a portable electronic device, such as McCrady’s mobile device/telephone, has a housing that carries its components. A POSITA would have further recognized that a housing for a portable device has to be portable itself because the device is portable/mobile.

[23] The wireless device locator of claim 12 wherein said wireless device locator further comprises a portable housing carrying said at least one antenna, said transceiver, and said controller.

172. It is my opinion that the McCrady-Raphaeli combination provides [23].

See discussion above for [9].

F. Claims 10, 24, 32

[10] The wireless communications system of claim 1 wherein said wireless communications devices comprise wireless local area network (WLAN) devices.

173. It is my opinion that the McCrady-Raphaeli combination provides [10].

See discussion above for [1.a.ii].

[24] The wireless device locator of claim 18 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

174. It is my opinion that the McCrady-Raphaeli combination provides [24].

See discussion above for [10].

[32] The method of claim 27 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

175. It is my opinion that the McCrady-Raphaeli combination provides [32].

See discussion above for [10].

G. Claims 12, 26, 34

[12] The wireless communications system of claim 1 wherein said wireless communications devices comprise cellular communications devices.

176. It is my opinion that the McCrady-Raphaeli combination provides [12].

As I discussed for [1.a.i], McCrady discloses wireless communications devices, e.g., master or reference radios. McCrady further describes:

Referring to FIG. 1, a position location system 10 includes a target or “master” mobile communication device or “radio” 12 communicating

with four reference communication devices 14, 16, 18 and 20. As used herein and in the claims, a mobile communication device or mobile radio is any portable device capable of transmitting and/or receiving communication signals, including but not limited to: a handheld or body-mounted radio; ***any type of mobile telephone (e.g., analog cellular, digital cellular or satellite-based)***; a pager or beeper device; a radio carried on, built into or embedded in a ground-based or airborne vehicle; or any portable electronic device equipped with wireless transmission and reception capabilities.

APPLE-1005, 6:44-56. The reference (“REF”) devices can also be their own master radios:

Finally, as explain in greater detail hereinbelow, one or more of the reference radios relied upon by a particular target radio can be another mobile communication device similar or identical to the master radio, wherein the reference radio determines its own position in accordance with the technique of the present invention (in this case, ***the “reference” radio functions as both a reference radio for other radios and as its own “master” radio***). The fact that each reference radio could potentially be a mobile radio is indicated in FIG. 1 by the designation “(MOBILE)” next to each of reference radios 14, 16, 18 and 20.”

APPLE-1005, 7:2-13. McCrady further describes:

The system of the present invention ***also has application in locating the position of cellular telephones***. By building into a conventional mobile telephone the ranging and position location capabilities of the present invention, the location of the telephone can be determined when an emergency call is made or at any other useful time. This capability could also be used to assist in cell network management (i.e., in cell handoff decisions).

APPLE-1005, 17:41-48. A POSITA would have recognized that a mobile

device/radio such as a mobile/cellular telephone is a cellular communications device.

[26] The wireless device locator of claim 18 wherein the target wireless communications device comprises a cellular communications device.

177. It is my opinion that the McCrady-Raphaeli combination provides [19].

See discussion above for [12].

[34] The method of claim 27 wherein the target wireless communications device comprises a cellular communications device.

178. It is my opinion that the McCrady-Raphaeli combination provides [34].

See discussion above for [12].

X. Claims 1, 3-6, 10-11, 13-17, 20-21, 24-25, 29-33 are Rendered Obvious by McCrady, Raphaeli, and Rofheart (GROUND 2)

A. McCrady-Raphaeli-Rofheart Combination

179. A POSITA would have been motivated to make the McCrady-Raphaeli combination as I discussed in Section IX.A. In my opinion, a POSITA would have been further motivated to integrate Rofheart's teaching that the wireless devices used WLAN or MANET devices into the McCrady-Raphaeli combination for several reasons. Additionally, a POSITA would also have been further motivated to integrate Rofheart's teaching about an independent signal into the McCrady-Raphaeli combination for several reasons.

180. **WLAN/MANET:** A POSITA would have incorporated Rofheart's teaching on WLAN or MANET devices based on McCrady's instruction that its master/reference radios can be implemented as "*any* portable electronic device

equipped with *wireless* transmission and reception capabilities.” APPLE-1005, 6:44-7:13, 17:41-42. A POSITA would have taken this instruction from McCrady as a cue to seek out analogous references like Rofheart that provide additional types of suitable device types. As such, the POSITA would have recognized that Rofheart’s WLAN/MANET devices implicate the broad class of wireless portable devices that McCrady prescribed. APPLE-1009, 17:13-30 (describing that the local device “may be a mobile device such as a mobile telephone, a laptop computer or [PDA]”), 26:40-50 (describing that the PDA can be held by a user).

181. Further, a POSITA would have been motivated to provide compatibility for many different device types, including those disclosed by Rofheart, for the purpose of expanding McCrady’s system to function in a variety of diverse applications. APPLE-1005, 1:19-64 (“The capability to rapidly and accurately determine the physical location of a mobile communication device would be of great benefit in a variety of applications.”).

182. **Independent Signal:** A POSITA would have incorporated Rofheart’s teaching on the use of an independent signal because, in addition to indicating the existence of a target device, Rofheart’s independent signal provides relevant information about the target device, including its radio type and unique identifier (UID). APPLE-1009, 24:36-55 (“...*the local device 201 receives information from each remote device about the radio type of the remote device*, as part of the reply

and/or response received from the remote devices as discussed with respect to steps 507 and 707 respectively. Alternatively, *the type information may be received as part of an independent signal sent by the remote devices....*”); *see also* [3.a] below.

183. Upon receiving the kind of independent signal taught by Rofheart, McCrady’s master device would discover a new device or rediscover an old device which could subsequently serve as one of McCrady’s reference radios. Indeed, McCrady teaches that it is advantageous to acquire new devices which could be used as reference radios, and the POSITA would have been motivated to utilize Rofheart’s teaching on independent signals as a mechanism for new-device acquisitions.

Further, the system of the present invention is self-healing. Unlike conventional systems which require communication with a certain Set of fixed-location reference radios, the system of the present invention can use a set of reference radios that includes fixed and/or mobile radios, wherein the set of radios relied upon to determine the location of a mobile communication device can vary over time depending on transmission conditions and the location of the mobile communication device. Any combination of fixed or mobile radios of known positions can be used as the reference radios for another mobile radio in the system, thereby providing adaptability under varying conditions.

APPLE-1005, 5:28-39.

184. Further, it is my opinion that the use of Rofheart’s independent signal to convey device information would have been one of the obvious variations that McCrady envisioned.

...it will be understood that the messaging scheme of the present invention is not limited to any particular protocol, and any suitable message structure that permits transmission of an outbound ranging message and a reply ranging message can be used to implement the present invention.

APPLE-1005, 7:65-8:3. *See also id.*, 16:1-16 (describing that “variations in the TOA processing scheme fall within the scope of the invention”). It is also my opinion that transmitting independent signals such as Rofheart’s independent signal is consistent with known protocols such as IEEE 802.11 which allow for devices to independently access the wireless medium and with other position-related systems. Inclusion of one or more address fields (e.g., source and/or destination address) in a data frame allows for a receiving device to determine whether it is the intended recipient itself or to know which device sent the frame. APPLE-1030, Sections 7.1.3.3.4 (entitled “Destination Address (DA) field,” describing that “The DA field contains an IEEE MAC individual or group address that identifies the MAC entity or entities intended as the final recipient(s) of the MSDU (or fragment thereof) contained in the frame body field”), and 7.1.3.3.5 (entitled “Source Address (SA) field,” describing that “The SA field contains an IEEE MAC individual address that identifies the MAC entity from which the transfer of the MSDU (or fragment thereof) contained in the frame body field was initiated”), 7.2.2 (“Data frames”); APPLE-1027, [0049], [0064], [0042]-[0044]. In sum, the fact that independent signals are well-known in protocols such as IEEE 802.11 and in other position-related systems further

reinforces the point that they would have been one of McCrady's obvious variations.

185. **Reasonable Expectation of Success:** In my opinion, a POSITA would have had a reasonable expectation that the McCrady-Raphaeli-Rofheart combination would produce a successful outcome. When contemplating McCrady's system, the POSITA would have been familiar with similar references like Rofheart on the subject of determining a distance to a wireless device via ranging message exchanges. The POSITA would have also followed McCrady's teaching that its ranging message exchanges are compatible with "any" type of wireless device, including the WLAN/MANET devices disclosed by Rofheart. APPLE-1005, 6:44-7:13.

186. It is also my opinion that a POSITA would have reasonably expected a successful outcome from combining Rofheart's teaching about an independent signal with McCrady's description of a position location system. Rofheart's independent signal would serve the same purpose in the context of McCrady as it does in Rofheart, e.g., facilitating discovery (or rediscovery) of a remote target device by a local device.

187. As I explain in more detail below through my feature-by-feature analysis, McCrady in combination with Raphaeli and Rofheart renders obvious each of claims 1, 3-6, 10-11, 13-17, 20-21, 24-25, and 29-33.

B. Claims 1, 13

188. McCrady-Raphaeli-Rofheart provides claims 1 and 13 as I discussed in

Section IX.A. Alternatively, McCrady-Raphaeli-Rofheart provides claims 1 and 13 through integration of Rofheart’s teachings regarding WLAN devices.

189. In regard to [1.a.ii] and [13.a.ii], Rofheart further discloses that the devices are WLAN devices. Section X.G ([10]). In regard to [13.b.ii], [13.c], [13.d.ii], and [13.d.iii], Rofheart additionally discloses a target WLAN device and that the target WLAN device is from among said plurality of WLAN devices. *See* Section X.G ([10]).

C. Claims 3, 14, 20, 29

1. Claim 3

[3.a] The wireless communications system of claim 1 wherein said target wireless communications device generates unsolicited signals including the UID thereof;

190. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides the “said target wireless communications device generates unsolicited signals” aspect of [3.a] based on Rofheart’s teachings regarding “independent signals.” For example, Rofheart describes that:

the local device 201 receives information from each remote device about the radio type of the remote device, as part of the reply and/or response received from the remote devices as discussed with respect to steps 507 and 707 respectively. *Alternatively*, the type information may be received as part of an *independent signal* sent by the remote devices. APPLE-1009, 24:36-55. A POSITA would have understood that Rofheart’s use of the “independent” modifier (which I bolded in the above quote) teaches and suggests

that the “signal” is an unsolicited signal. That is, as an *alternative to* receiving “type information” in a “reply and/or response,” the local device can receive this “type information” without prompting from the remote device as part of an “independent signal.” Thus, the POSITA would have recognized that Rofheart’s independent signal is “unsolicited” because it is *not* in reply/response to another signal.

191. The analysis above satisfies [3.a] including under an interpretation that requires the claimed “target wireless communications device” to have the capability to send “unsolicited signals.” Element [3.a] is also satisfied under an interpretation that requires the device to send multiple “unsolicited signals.” A POSITA would have recognized that multiple unsolicited signals are generated/sent in Rofheart. This is because a device entering or reentering (after exiting the network temporarily) would cause multiple respective signals to be generated and sent, e.g., one signal for the first entry, and a second signal for the second entry. APPLE-1009, 19:17-62 (describing that “[a]fter dropping links with remote devices that have exited the network, the local device executes a loop 407 in which the local device 301 establishes a unique link with new devices that have entered the network.”), 19:63-20:9 (describing that “the loop [of Fig. 4] serves to update distance information for linked remote devices”), 24:36-55, Fig. 4.

192. It is my opinion that the McCrady-Raphaeli-Rofheart combination further provides the “including the UID thereof” aspect of [3.a]. McCrady describes

that a message can include a source of the message (in addition to the message's destination address), which a POSITA would have understood to be a source address. APPLE-1005, 8:50-53 ("In the data portion of the TOA message, the reference radio identifies the destination master radio *and may also identify itself as the message source.*"); 8:38-46 ("The data portion of the RTS-T message includes a *Destination Address* 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The *Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message.* ..."). Further, McCrady's description of source/destination addresses shows that they are used to uniquely identify different message sources/destinations, *i.e.*, reference radios, within the network. *See also* Section IX.B ([1.a.ii]).

193. It is also my opinion that it would have been obvious to a POSITA to include a UID in the above-discussed independent (unsolicited) signal from McCrady's reference (target) device to achieve the predictable benefit of enabling McCrady's master device to associate information in the signal to the corresponding reference device. A POSITA would have understood that McCrady's teachings about including a source address (UID) in a message applies to any of the messages between the master and reference devices, including the independent (unsolicited) signal. Moreover, it was well-known to include UIDs such as source addresses in messages to identify the source of the message. APPLE-1005, 8:50-53 ("In the data

portion of the TOA message, the reference radio identifies the destination master radio and may also identify itself as the message source.”), 8:38-46 (“The data portion of the RTS-T message includes a *Destination Address* 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The *Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message. ...*”); APPLE-1009, 20:62-21:5; 24:36-55; APPLE-1030, 7.1.3.3.5 (entitled “Source Address (SA) field,” describing that “The SA field contains an IEEE MAC individual address that identifies the MAC entity from which the transfer of the MSDU (or fragment thereof) contained in the frame body field was initiated”), 7.2.2 (“Data frames”).

[3.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from said target device; and

194. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [3.b]. As I discuss above, McCrady discloses a controller ([1.b.ii]) that cooperates with the transceiver ([1.d.i], [1.b.ii]) to receive signals ([1.d.i]). A POSITA would have recognized that the above-discussed controller/transceiver is not limited to receiving reply signals from the target device and is capable of receiving other types of signals including the unsolicited signal discussed at [3.a]. APPLE-1005, 7:19-21 (“The antenna, transmitter and receiver of each radio *may also be used for other communications, such as voice and data messages.*”).

[3.c] wherein said controller determines the UID for said target wireless communications device from the at least one unsolicited signal.

195. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [3.c]. As I discussed for [3.a]-[3.b], the unsolicited signal includes the UID of the target device. A POSITA would have understood and expected that processing a received message (*see* [3.b]) containing data fields such as a UID (*see* [3.a], e.g., the field containing the source address) includes extracting one or more fields from the message and determining their corresponding values, e.g., a controller ([1.b.ii]) determines the UID based on the corresponding UID data field. APPLE-1005, 8:50-53 (“In the data portion of the TOA message, the reference radio identifies the destination master radio and *may also identify itself as the message source.*”), 8:38-46 (“The data portion of the RTS-T message includes a *Destination Address* 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The *Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message.* ...”); APPLE-1009, 20:62-21:5.

196. It is also my opinion that it would have been obvious to a POSITA to determine (e.g., decode, extract, identify, etc.) the UID from the received unsolicited signal (*see* [3.a]-[3.b]) in order to determine which device sent the signal. APPLE-1005, 8:50-53 (“In the data portion of the TOA message, the reference radio identifies the destination master radio and *may also identify itself as the message source.*”), 8:38-46 (“The data portion of the RTS-T message includes a *Destination*

Address 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The *Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message. ...*”); APPLE-1009, 20:62-21:13, 24:36-55. A POSITA would have been motivated to determine which device sent the signal so that information in the signal, such as the device type, can be associated with the appropriate device for later use. APPLE-1009, 20:62-21:13, 24:36-55.

2. Claim 14

[14.a] The wireless communications system of claim 13 wherein said target WLAN device generates unsolicited signals including the UID thereof;

197. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [14.a]. *See* Section X.C ([3.a]).

[14.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from said target WLAN device; and

198. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [14.b]. *See* Section X.C ([3.b]).

[14.c] wherein said controller determines the UID for said target WLAN device from the at least one unsolicited signal.

199. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [14.c]. *See* Section X.C ([3.c]).

3. Claim 20

[20.a] The wireless device locator of claim 18 wherein the target wireless communications device generates unsolicited signals including the UID thereof;

200. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [20.a]. *See* Section X.C ([3.a]).

[20.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from the target device; and

201. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [20.b]. *See* Section X.C ([3.b]).

[20.c] wherein said controller determines the UID for the target wireless communications device from the at least one unsolicited signal.

202. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [20.c]. *See* Section X.C ([3.c]).

4. Claim 29

[29.a] The method of claim 27 wherein the target wireless communications device generates unsolicited signals including the UID thereof; and further comprising:

203. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [29.a]. *See* Section X.C ([3.a]).

[29.b] receiving at least one unsolicited signal from the target device; and

204. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [29.b]. *See* Section X.C ([3.b]).

[29.c] determining the UID for the target wireless communications device from the at least one unsolicited signal.

205. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [29.c]. *See* Section X.C ([3.c]).

D. Claims 4, 15, 30

[4] The wireless communications system of claim 3 wherein said controller determines the device type of said target wireless communications device based upon the UID thereof.

206. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [4]. For example, Rofheart determines a device type of a target wireless communications device. APPLE-1009, 24:36-55 (describing that “*the local device 201 receives information from each remote device about the radio type of the remote device*, as part of the reply and/or response” and that “*the type information may be received as part of an independent signal* sent by the remote devices. With the remote device type known, the local device 301 then refers to a look up table (LUT) stored in memory 207 or ROM 209 to determine a predefined processing delay *for the radio type*.”).

207. A POSITA would have recognized that Rofheart’s determination of a device type is “based upon the UID thereof,” because storing and retrieval of information pertaining to a remote device in Rofheart is based on the remote device’s UID. APPLE-1009, 24:10-21 (describing that “[e]ach transmit time t1 is associated with one of the unique identifiers stored in step 609 based on the unique link over

which the distance determining message was transmitted. The transmit times *and associated identifiers are then stored* in the main memory 207 of local device 301 so that the transmit times *may be retrieved* to determine the distance to each remote device.”), 24:22-35 (describing that “each receive time t_2 *is associated with the unique identifier* of a respective link and *stored in main memory* 207 for use in calculating a distance from the local device 201 to each remote device 202 through 200N.”), 25:1-8 (describing that “the local device 301 calculates the round trip time T_{rt} *for each linked remote device* 302 through 200N” and “retrieves the transmitting time t_1 , receiving time t_2 , and processing delay time d of a particular unique link to a remote device from main memory 207 and ROM 209 as discussed above.”). In more detail, a POSITA would have recognized that after Rofheart’s local device receives an “independent signal” that provides the device/radio type of the remote device (see claim 3), Rofheart’s local device would store the device type under the remote device’s UID. Rofheart’s local device would then be able to determine the device type by using the remote device’s UID to retrieve the stored device type.

208. Alternatively, it would have been obvious to a POSITA to store the device type (just like other information about the device such as transmit/receive times for ranging/response signals) in the device’s memory based on the UID such that the device type can be retrieved using the UID when the controller determines a propagation delay (*e.g.*, computes the round trip time). Indeed, it is well-known to

a POSITA to store additional information about a device based on its UID including its device type. *See, e.g.*, APPLE-1009, 24:10-55, 25:1-8; APPLE-1028, [0071] (discussing the storing of a UID called a MAC address together with an associated device type), [0055]-[0056], [0058], [0060], Figs. 4-5, 8. Moreover, a POSITA would have been motivated to store the device type and retrieve it based on UID (and accordingly, determine the device type based on UID) because a POSITA would have wanted to track such information using UIDs in order to use the right device type (as opposed to a device type for some other device having a different UID).

[15] The wireless communications system of claim 14 wherein said controller determines the device type of said target WLAN device based upon the UID thereof.

209. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [15]. *See* Section X.D ([4]).

[30] The method of claim 29 further comprising determining the device type of the target wireless communications device based upon the UID thereof.

210. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [30]. *See* Section X.D ([4]).

E. Claims 5, 16

1. Claim 5

[5a] The wireless communications system of claim 4 wherein the UIDs comprise media access control (MAC) addresses of respective wireless communications devices, and

211. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [5a]. As I discussed for claims 1 and 3, McCrady's devices have UIDs, *e.g.*, addresses, which are used as a message's source or destination address. McCrady's addresses are consistent with a POSITA's understanding of a MAC address (*i.e.*, an address that is used to identify a device on a network). APPLE-1028, [0081]; APPLE-1029, 20-21; APPLE-1030, Sections 7.1.3.3.4, 7.2.2. Alternatively, it would have been obvious to implement McCrady's source addresses as MAC addresses, which are well-known. For example, Rofheart discloses that "[t]he transmitting and receiving steps are preferably performed *in accordance with a Media Access Control (MAC) protocol.*" APPLE-1009, 3:66-4:1, 18:20-25 ("the *MAC protocol* provides the capability for local device 301 to establish unique and independent UWB links ... with remote devices"), 20:17-21; APPLE-1028, [0081]; APPLE-1029, 20-21; APPLE-1030, Sections 7.1.3.3.4, 7.2.2. A POSITA would have understood that the source address of a message sent in accordance with a MAC protocol is a MAC address.

[5b] wherein said controller determines the device type of said target wireless communications device based upon the MAC address thereof.

212. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [5b]. As I discussed for claim 4, the McCrady-Raphaeli-Rofheart

combination determines the device type of said target wireless communications device based upon the UID thereof, which applies here because a MAC address is a type of UID.

2. Claim 16

[16a] The wireless communications system of claim 15 wherein the UIDs comprise media access control (MAC) addresses of respective WLAN devices, and

213. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [16a]. *See* Section X.E ([5a]).

[16b] wherein said controller determines the device type of said target WLAN device based upon the MAC address thereof.

214. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [16b]. *See* Section X.E ([5b]).

F. Claims 6, 17, 21, 31

1. Claim 6

[6.a] The wireless communications system of claim 1 wherein said at least one antenna comprises a plurality of antennas; and

215. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [6.a]. Rofheart describes a phased antenna and specifically multiple antennas on a local device that can produce directional antenna patterns and/or electronically alter composite antenna patterns:

In other embodiments, *multiple antennas* on the local device 901 may provide the relevant spatial information to resolve the distance. For

example, *a phased antenna* may be used to electronically alter the composite antenna pattern as one way to determine location. Also, the *separate antennas* may be used in separate location operations such as by performing a switching operation between *antennas*. Thus, the spatial separation between the antennas is enough to resolve position information, in combination with the known range information. Furthermore, by having *multiple antennas* that produce a *directional antenna pattern*, or simply by using a single antenna with a known antenna pattern it possible to resolve the spatial locations of the remote device, although multiple range/location readings may be required by rotating the device. From these examples it should be clear that any number of methods for obtaining the reference points necessary to obtain positional data on remote devices may be used with a wireless UWB device that determines distance to remote devices in accordance with the present invention.

APPLE-1009, 31:19-38.

[6.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target wireless communications device based upon at least one of the received reply signals.

216. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [6.b]. Rofheart describes:

In other embodiments, *multiple antennas* on the local device 901 may provide the relevant spatial information to resolve the distance. For example, a phased antenna may be used to electronically alter the composite antenna pattern as one way to determine location. Also, the separate antennas may be used in separate location operations such as by performing a switching operation between antennas. Thus, the spatial separation between the antennas is enough to *resolve position information*, in combination with the known range information. Furthermore, *by having multiple antennas that produce a directional antenna pattern*, or simply by using a single antenna with a known

antenna pattern *it [is] possible to resolve the spatial locations of the remote device*, although multiple range/location readings may be required by rotating the device. From these examples it should be clear that any number of methods for obtaining the reference points necessary to obtain positional data on remote devices may be used with a wireless UWB device that determines distance to remote devices in accordance with the present invention.

APPLE-1009, 31:19-38.

217. Further, like McCrady, Rofheart uses a received reply signal to estimate the range to a target device, as I discussed for claim 1 in Section XII.B. A POSITA would have recognized that Rofheart’s “position information”/“spatial location” provides at least a *bearing* to the target device. This understanding is further confirmed by Rofheart’s “local device [which] displays a graphical map of the *position of remote devices in relation to the local device*.” APPLE-1009, 31:39-43.

218. A POSITA would have been motivated to incorporate into the McCrady-Raphaeli combination Rofheart’s teachings about using multiple antennas and their to determine “position information”/“spatial location” (*e.g.*, a “bearing”) based on the received signals (see the APPLE-1009, 31:19-43 citations above) for the purpose of increasing the accuracy, efficiency, or both of McCrady’s system.

2. Claim 17

[17.a] The wireless communications system of claim 13 wherein said at least one antenna comprises a plurality of antennas; and

219. It is my opinion that the McCrady-Raphaeli-Rofheart combination

provides [17.a]. *See* Section X.F ([6.a]).

[17.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target WLAN device based upon at least one of the received reply signals.

220. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [17.b]. *See* Section X.F ([6.b]).

3. Claims 21, 31

[21.a] The wireless device locator of claim 18 wherein said at least one antenna comprises a plurality of antennas; and

221. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [21.a]. *See* Section X.F ([6.a]).

[21.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to the target wireless communications device based upon at least one of the received reply signals.

[31] The method of claim 27 further comprising determining a bearing to the target wireless communications device based upon at least one of the received reply signals.

222. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [21.b]. *See* Section X.F ([6.b]). It is also my opinion that the McCrady-Raphaeli-Rofheart combination provides [31].

G. Claims 10, 24, 32

[10] The wireless communications system of claim 1 wherein said wireless communications devices comprise wireless local area network (WLAN) devices.

223. It is my opinion that the McCrady-Raphaeli-Rofheart combination

McCrady-Raphaeli-Rofheart provides [10] through integration of Rofheart's teachings regarding WLAN devices. For example, Rofheart describes an embodiment where its wireless network 300 is a WLAN. Rofheart describes:

FIG. 3 discloses a wireless network 300 in which a plurality of wireless devices may exchange information. *The wireless network 300 may be WPAN, WLAN or some other wireless network* in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a *first remote device 302, a second remote device 303 and N number of additional remote devices 300N* via UWB links 312, 313, and 315N respectively.

APPLE-1009, 17:13-22, Fig. 3. Devices that communicate within a WLAN are consistent with a POSITA's understanding of WLAN devices.

[24] The wireless device locator of claim 18 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

224. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [24]. *See* Section X.G ([10]).

[32] The method of claim 27 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

225. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [32]. *See* Section X.G ([10]).

H. Claims 11, 25, 33

[11] The wireless communications system of claim 1 wherein said wireless communications devices comprise mobile ad-hoc network (MANET) devices.

226. It is my opinion that the McCrady-Raphaeli-Rofheart combination

provides [11] through integration of Rofheart's teachings regarding MANET devices. For example, Rofheart discloses:

The wireless network 300 may be *WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet*. The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. *Each of the wireless devices 301 through 300N may be a mobile device such as a mobile telephone, a laptop computer or personal digital assistant (PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices. It is to be understood that device 301 is referred to as a "local device" and devices 302-400N are referred to as "remote devices" for purposes of description only, and that the present invention is not limited to an infrastructure system having an access point and **may be implemented in an ad hoc system wherein any device in the network can act as a master and/or a slave device and no access point is needed.***

APPLE-1009, 17:13-37.

227. A POSITA would have recognized that these point-to-point or point-to-multipoint network connections can be formed on an ad-hoc basis by mobile devices such as PDAs. Rofheart's devices enter and leave the wireless network 300, and accordingly, wireless links are created and dropped. For example, Rofheart describes that "[i]n step 401, the local device 301 establishes a link with each remote device 302 through 300N using a media access control (MAC) protocol." Rofheart

further describes a network for which “[i]n step 405, *the local device 301 periodically determines which linked remote devices have exited the network and drops those links.*”APPLE-1009, 19:17-38.

228. Rofheart additionally describes how PDAs establish ad-hoc wireless links. For example, Rofheart describes “the local device 301 of FIG. 3 is assumed to be a local PDA held by a first user, while remote devices 302-300N are assumed to be remote PDAs.” 26:40-50. Rofheart further describes that “the local PDA 301 synchronizes and establishes a unique link with each digital camera using a MAC protocol as described in FIG. 5” and that “the local PDA301 will enable communications links 312 and 313 and store the unique identifier associated with remote devices 302 and 303 to the ID list.” APPLE-1009, 26:51-27:7. Rofheart discuss a general network deployment of FIG. 9 and describes that “[a]s with the network of FIG. 3, while device 901 is referred to as a ‘local device’ and all other devices of FIG. 9 are referred to as ‘remote devices’, this nomenclature is for purpose of description only and it is to be understood that the embodiment shown in FIG. 9 is not limited to an access point system and may be implemented in an ad hoc system”.

[25] The wireless device locator of claim 18 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

229. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [25]. *See* Section X. ([10]).

[33] The method of claim 27 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

230. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [33]. *See* Section X. ([10]).

XI. Claims 6-7, 17, 21, 31 are Rendered Obvious by McCrady, Raphaeli, and Kuwahara (GROUND 3)

A. McCrady-Raphaeli-Kuwahara Combination

231. A POSITA would have been motivated to make the McCrady-Raphaeli combination as I discussed in Section IX.A. It is my opinion that for multiple independent reasons a POSITA would have been further motivated to incorporate into the McCrady-Raphaeli combination Kuwahara's teachings on using multiple antennas to receive signals from a portable terminal device; Kuwahara's teachings on determining, based on the received signals, an incident direction representing an angle (which can be referred to as a "bearing") between Kuwahara's base station and portable terminal; or both.

232. **Multiple Antennas:** A POSITA would have incorporated Kuwaraha's teachings regarding an array antenna, i.e., multiple antennas, in the context of McCrady's master radio based on an understanding that doing so would promote increased position accuracy and combat multi-path signal interference. Kuwahara describes, for example:

It is therefore an object of this invention to provide *a positioning apparatus hardly affected in an urban area.*

It is another object of this invention to provide a positioning apparatus capable of positioning portable terminals without changing cell configurations for portable telephones.

It is still another object of this invention to provide *a positioning apparatus capable of carrying out positioning with high accuracy.*

APPLE-1007, 2:11-19. Kuwahara further describes:

When the incident direction and delay time of a portable terminal PT is estimated from a plurality of demodulation signals received by the array antenna 101, *consideration must be paid on multi-path signals produced by reflection and diffraction due to buildings and the like especially in an urban environment.* Specifically, it is necessary to select a direct wave from among a plurality of incident signals having correlation with each other and to find the incident direction and delay time of the same.

APPLE-1007, 3:59-67. Urban areas with buildings and other obstructions, for example, can cause/reflect multiple copies of a signal, which are the so-called “multi-path” signals. The signal arriving via the line-of-sight (LOS) path is typically called a direct path signal or direct wave. These multi-path signals can cause signal interference. For example, a receiver can receive a combination (e.g., sum) of the direct path signal with one or more multi-path signals, where a portion of a multi-path is received at a different but overlapping time compared to the direct signal which accordingly causes signal interference to the direct signal. *See, e.g.,* APPLE-1007, 3:59-67; APPLE-1023 (Gesbert), 1:36-40 (“For example, when channel performance is degraded the transmitted data may experience excessive corruption yielding unacceptable communication parameters. For instance, transmitted data can

exhibit excessive bit-error rates or packet error rates. The degradation of the channel can be due to a multitude of factors such as general noise in the channel, multi-path fading, loss of line-of-sight path, excessive Co-Channel Interference (CCI) and other factors.”), 1:41-45 (“In mobile Systems, signal degradation and corruption is chiefly due to interference from other cellular users within or near a given cell and multipath fading, in which the received amplitude and phase of a signal varies over time.”). Additionally, these multi-path signals can interfere with receiving/identifying the direct wave. APPLE-1007, 3:59-67.

233. Antennas within Kuwahara’s array antenna provide spatial diversity, which enables separating direct path signals from other multi-path signals during reception. As a result, the array antenna facilitates functionality “to select a direct wave...and to find the incident direction and delay time of the same.” APPLE-1007, 3:59-67 (cited above). Kuwahara additionally describes that “the direct wave and the multipath wave are separately identified so that the portable terminal is positioned on the base of the incident direction and delay time of the direct wave. Therefore, it is possible to prevent the position service of the portable terminal from limitation in an urban area.” APPLE-1007, 10:40-46.

234. McCrady describes: “there remains a need for a commercially viable position location system capable of *quickly and accurately determining the three-dimensional indoor or outdoor position* of a compact mobile communication device

in the presence of severe multipath interference for use in the aforementioned practical applications.” APPLE-1005, 3:46-51. Kuwahara’s accuracy and interference mitigation benefits are consistent with McCrady’s desire “to *quickly and accurately determin[e] the three-dimensional indoor or outdoor position* of a compact mobile communication device.”

235. **Incident Direction (Bearing).** Kuwahara teaches “estimating the incident direction” of received signals. *See, e.g.*, APPLE-1007, 3:10-20. A POSITA would have incorporated Kuwahara’s teachings on “estimating the incident direction” of received signals for the purpose of predictably improving the accuracy and/or efficiency of McCrady’s approach to position determination.

236. McCrady’s master radio performs message exchanges with four different reference radios and determines its own position via trilateration based on the determined ranges from these radios and their reported locations. McCrady for example describes:

The master radio determines its own position from the measured range to each of the reference radios via a trilateration technique which can be for example, a conventional trilateration technique. Once the master radio's position has been determined, the master radio can convey this information to other radios or to a controller or coordinator per forming tracking and/or mapping of the master radio and perhaps other associated mobile radios. The ranging/position location processing can be performed periodically or initiated by the master radio or a system

controller as needed.

APPLE-1005, 16:17-27. *See also* APPLE-1005, 4:52-5:8 (see citation above in VIII.B), 7:14-41 (describing that “[t]he time of arrival (TOA) of ranging messages transmitted between the master and reference radios is used to determine the range to each reference radio, and trilateration is then used to determine from the range measurements the location of the master radio with respect to the reference radios.”).

237. A POSITA would have understood that using Kuwahara’s incident direction would provide not only the distance (range) to a particular reference radio but also the direction of the reference radio relative to the master radio. From the POSITA’s perspective, this additional direction information would enable the master radio to determine its position with greater accuracy and/or by communicating with fewer than all four reference radios (*e.g.*, just one). For example, if the master radio acquires the information of its distance to a single reference radio and its direction relative to the reference radio, then the master radio’s own location can be found from the reference radio’s known location, by following the determined direction relative to the reference radio and adding the determined distance to the reference radio’s location.

238. **Reasonable Expectation of Success.** A POSITA would have had a reasonable expectation that the McCrady-Raphaeli-Kuwahara combination would produce a successful outcome. As I discuss above, a POSITA considering

McCrary's system would have been familiar with references such as Kuwahara directed to the common problem of determining the position/range of wireless devices using estimations of signal delay time. Moreover, McCrary's master radio receives responses from location finding signals using an antenna. *See, e.g., APPLE-1005, 7:14-21.* Given that McCrary's master radio already receives such responses using an antenna, it would have been straightforward for a POSITA to employ Kuwahara's teachings about using a particular antenna type, an array antenna, which includes two or more antennas in a mobile device. Indeed, using a particular antenna type such as an array antenna, or generally two or more antennas, in a mobile device was known by a POSITA before the Critical Date. *See, e.g., APPLE-1023 (Gesbert), 7:21-47* ("Transmit signals TS propagate through channel 22 and there experience the effects of changing conditions of channel 22, as described above. Transmit signals TS are received in the form of receive signals RS by a receive antenna 91A belonging to an **antenna array** 92 of a receive unit 90, shown in FIG. 4. Again referring to FIG. 4, receive unit 90 has N receive antennas 91A, 91B, ..., 91N for receiving receive signals RS from transmit unit 50. Receive unit 90 can be any suitable receiver capable of receiving receive signals RS via the N receive antennas 92. ..."), 4:61-62 (describing that the "receive unit 14 is a **mobile** or stationary **wireless user device**"), 4:64-5:3 ("Exemplary user devices 14 include **mobile receive units such as a portable telephone 14A**, a car phone 14B and a stationary receive

unit 14C. Receive unit 14C can be a wireless modem used at a residence or any other fixed wireless unit. *Receive units 14A and 14C are equipped with multiple antennas or antenna arrays 20.* These receive units can be used in Multiple Input Multiple Output (MIMO) communications taking advantage of techniques such as spatial multiplexing or antenna diversity.”); *see also* APPLE-1009, 17:13-30 (describing that the local device is a wireless device which “may be a mobile device such as a *mobile telephone*, a laptop computer or personal digital assistant (PDA)”), 31:19-38 (describing “*multiple antennas* on the local device 901”). Further, the addition of Kuwahara to the McCrady-Raphaeli combination represents a combination of known elements, each performing the functions it had been known to perform to produce the predictable result of a master radio equipped with an array antenna to augment its position determination capabilities.

239. As I explain in more detail below through my feature-by-feature analysis, McCrady in combination with Raphaeli and Kuwahara renders obvious each of claims 6-7, 17, 21, and 31.

B. Claims 6, 17, 21

1. Claim 6

[6.a] The wireless communications system of claim 1 wherein said at least one antenna comprises a plurality of antennas; and

240. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [6.a]. Kuwahara describes “*an array antenna* for receiving a transmission

signal transmitted by the portable terminal.” APPLE-1007, Abstract. Kuwahara further describes

Referring to FIG. 1, the illustrated cellular base station SB comprises an *array antenna 101 having first through M-th antenna elements 101-1 through 101-M for receiving signals transmitted by the portable terminal PT*, where M represents a positive integer which is not less than one. First through M-th receivers 102-1 through 102-M are for translating signals from the respective antenna elements of the array antenna 101 into baseband signals. First through M-th CDMA demodulators 103-1 through 103-M are for demodulating a transmission signal multiplexed using the CMDA (code division multiple access) method to output demodulated signals in a plurality of systems. A PDA (power delay angle) estimation circuit 104 is for estimating an incident direction, delay time, and relative power from the demodulated signals in a plurality of systems and is for outputting the result of estimation indicating the incident direction, delay time, and relative power. A positioning circuit 105 is for establishing the position of the portable terminal PT on the basis of the incident direction and delay time indicated by the result of estimation output by the PDA estimation circuit 104 and is for outputting the result of position of the portable terminal PT. A transmitter 106 is for transmitting the result of positioning to the portable terminal PT through a transmission antenna 107. The combination of the receivers and CDMA demodulators is referred to as receiving device. Among the above-described components, the transmitter 106 and transmission antenna 107 may be a transmitter and a transmission antenna shared by cellular base stations SB.

APPLE-1007, 2:66-3:27.

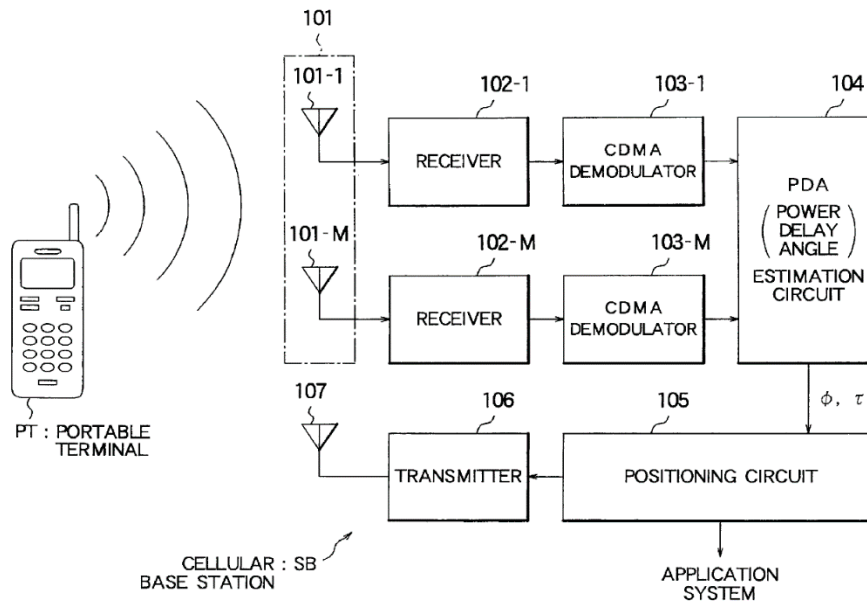


FIG. 1

APPLE-1007, Fig. 1. Kuwahara also describes:

... In FIG. 6, each of signals received by *M antennas* is subjected to Fourier transform and is supplied to a block for spatial average, unitary translation, and factorization into eigenvalues. The block for spatial average, unitary translation, and factorization into eigenvalues is a block that performs the processes at steps S1 to S6 in FIG. 3. ...

APPLE-1007, 8:44-65, Fig. 6. A POSITA would have recognized that an array antenna includes multiple antennas, such as shown by antenna elements 101-1 to 101-M in Fig. 1.

[6.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target wireless communications device based upon at least one of the received reply signals.

241. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [6.b]. As discussed, the combination features a master radio with a

controller ([1.b.ii], [1.d]) and an array antenna (which includes multiple antennas) ([6.a]) to receive signals from a target reference radio (“wireless communications device” per analysis at [1.a.i]). The combination further includes Kuwahara’s teaching about determining, based upon at least one of the received signals, an incident direction (e.g., θ_i). Kuwahara for example describes estimating, among others, an incident direction (bearing):

Referring to FIG. 1, the illustrated cellular base station SB comprises an *array antenna 101 having first through M-th antenna elements 101-1 through 101-M for receiving signals transmitted by the portable terminal PT*, where M represents a positive integer which is not less than one. First through M-th receivers 102-1 through 102-M are for translating signals from the respective antenna elements of the array antenna 101 into baseband signals. First through M-th CDMA demodulators 103-1 through 103-M are for demodulating a transmission signal multiplexed using the CMDA (code division multiple access) method to output demodulated signals in a plurality of systems. *A PDA (power delay angle) estimation circuit 104 is for estimating an incident direction, delay time, and relative power from the demodulated signals in a plurality of systems and is for outputting the result of estimation indicating the incident direction, delay time, and relative power.* A positioning circuit 105 is for establishing the position of the portable terminal PT on the basis of the incident direction and delay time indicated by the result of estimation output by the PDA estimation circuit 104 and is for outputting the result of position of the portable terminal PT. A transmitter 106 is for transmitting the result of positioning to the portable terminal PT through a transmission antenna 107. The combination of the receivers and CDMA demodulators is referred to as receiving device. Among the above-described components, the transmitter 106 and transmission antenna 107 may be a transmitter and a transmission antenna shared by

cellular base stations SB.

APPLE-1007, 2:66-3:27.

242. Kuwahara further discusses “2D-Unitary ESPRIT” “which was conceived to perform two-dimensional parameter estimation (direction/angular height, incident direction/delay time and the like)” and describes that θ_i is the “incident direction of an i-th incident wave” in degrees.

“2D-Unitary ESPRIT” is a method which was conceived to perform two-dimensional parameter estimation (direction/angular height, incident direction/delay time and the like) and which has the followings features.

(A) It requires no knowledge of the response (steering vector) of array elements at the antenna aperture.

(B) It does not require peak search based on the steering vector.

The relationship of rotational invariance in “2D-Unitary ESPRIT” is expressed by the following Equations (1) and (2).

$$\tan \left[\frac{\mu_i}{2} \right] K_{\mu 1} d(\mu_i, v_i) = K_{\mu 2} d(\mu_i, v_i) \quad (1)$$

$$\tan \left[\frac{v_i}{2} \right] K_{v 1} d(\mu_i, v_i) = K_{v 2} d(\mu_i, v_i) \quad (2)$$

The definitions for the parameters used here are as follows. μ_1 and v_i are respectively expressed by Equations (3) and (4).

$$\mu_i = 2\pi f_0 \Delta d \sin \theta_i \quad (3)$$

$$v_i = -2\pi \Delta f \tau_i \quad (4)$$

The symbols in the above Equations (3) and (4) are given by:

f_0 : carrier frequency;

Δd : element interval;

θ_i : incident direction of an i-th incident wave;

Δf : frequency sweep interval;

τ_i : delay time of an i-th incident wave.

$K_{\mu 1}$ and $K_{\mu 2}$ in Equation (1) are expressed by Equation 6.

APPLE-1007, 4:9-45.

243. Kuwahara further describes a determination of the incident direction via equation 38:

$$\begin{aligned}\mu_i &= 2\pi f_0 \Delta d \sin \theta_i = 2 \tan^{-1} w_\mu(i) \\ \theta_i &= \sin^{-1} \left\{ \frac{\tan^{-1} w_\mu(i)}{\pi f_0 \Delta d} \right\}\end{aligned}\tag{38}$$

APPLE-1007, 8:16-23.

244. A POSITA would have recognized that Kuwahara's "incident direction" represents an angle between Kuwahara's base station and portable terminal (*i.e.*, this angle provides a "bearing" to the target device). Kuwahara describes a "direct wave" in "an incident direction of -60 degrees":

FIG. 7 shows examples of the delay time, incident direction, and relative power of reception signals propagated in a multiplex manner from one portable terminal PT and arriving at the base station SB according to the "2D-Unitary ESPRIT" method. The examples in FIG. 7 are examples of five reception signals propagated in a multiplex manner. The five reception signals are referred here as first through fifth reception signals which have respective increasing delay times.

The first reception signal is a signal with a delay time of 2μ seconds in an incident direction of -60 degrees. The second reception signal is a signal with a delay time of 4μ seconds in an incident direction of -40 degrees. The third reception signal is a signal with a delay time of 6μ seconds in an incident direction of 20 degrees. The fourth reception signal is a signal with a delay time of 8μ seconds in an incident direction of 0 degree. The fifth reception signal is a signal with a delay time of 10μ seconds in an incident direction of 0 degree.

In the example shown in FIG. 7, the positioning circuit 105 determines the first reception signal in an incident direction of -60 degrees which arrives first as a direct wave and judges that the distance between the portable terminal PT and the cellular base section SB is 600 meters from the delay time of 2 μ seconds. The result of estimation of the incident direction and delay time is sent to an application system and also transmitted to the portable terminal PT as needed.

APPLE-1007, 8:66-9:25, Fig. 7. The POSITA's understanding is further confirmed by Kuwahara's disclosure about using an incident direction to find a relative position between devices.

The FDA estimation circuit 104 uses the above-described "2D-Unitary ESPRIT" method to estimate the delay time and incident direction of each portable terminal and transmits the result of estimation to the positioning circuit 105. The positioning circuit 105 finds the *positions of the portable terminals relative to the base station* on the basis of the information indicative of the delay time and incident direction of each portable terminal. The positioning circuit 105 supplies the application system and the transmitter 106 *relative position information indicating such relative positions* along with the information of the absolute position of the base station.").

APPLE-1007, 10:1-14.

245. Indeed, Kuwahara's abstract discloses calculating a "terminal position" based on the incident direction estimation result:

A positioning apparatus is provided in a cellular base station for positioning a portable terminal in a cell covered by the cellular base station. The positioning apparatus has a base position indicative of a position of the cellular base station on a map. The positioning apparatus

comprises *an array antenna* for receiving a transmission signal transmitted by the portable terminal to output a plurality of reception signals. A receiver section translates the reception signals into a plurality of baseband signals to demodulate the baseband signals into a plurality of demodulated signals. An estimation section estimates *incident direction* and delay time of the transmission signal on the basis of the demodulated signals to output an estimation result indicative of the incident direction and the delay time. *A position calculating means calculates a terminal position of the portable terminal on the map in accordance with the estimation result and the base position to output a terminal position signal indicative of the terminal position.*

APPLE-1007, Abstract. A POSITA would have recognized that this incident direction represents an angle between Kuwahara's base station and portable terminal, which is a bearing to Kuwahara's wireless communications device, *i.e.*, portable terminal.

246. Additionally, Kuwahara's disclosure is consistent with the dictionary meaning of bearing. Bearing is (A) "The horizontal direction of one terrestrial point from another, expressed as the angle in the horizontal plane between a reference line and the horizontal projection of the line joining two points" and (B) "Azimuth. A bearing is often designated as true, magnetic, compass, grid, or relative, and is dependent upon the reference direction." APPLE-1011 (see definition of bearing).

247. Kuwahara's disclosure is consistent with the specification of the '779 Patent. For example, the '779 Patent depicts an angle θ_t between wireless device locator and target device at point P (shown in Fig. 8, which is reproduced below)

and discusses that this angle is “the target line of *bearing* to the target device.”

In accordance with another advantageous aspect of the invention, multiple antennas **39a**", **39b**" (FIG. 5) may be used to provide target bearing in addition to the estimated range. Referring more particularly to FIG. 8, bearing determination in the case where the antennas **39a**", **39b**" are directional antennas will now be described. The antennas **39a**", **39b**" have respective reception patterns **70a**, **70b**, which may be orthogonal to one another (i.e., the former is directed along the x-axis, while the latter is directed along the y-axis).

The target device is at a point P, which is within the reception patterns **70a**, **70b**. Each of the antenna gain patterns **70a** and **70b** can be measured and known to the locator, and represented by gain functions $G1(\theta)$ and $G2(\theta)$ where θ represents the angle of deviation from a particular reference direction.

As such, to determine the line of bearing to the target device, the received signal strength is measured from each of the antennas **70a**, **70b**, respectively. Based upon this information, the controller **42'** may then find the angle θ_r using the relationship $G1(\theta_r) - G2(\theta_r) = P1 - P2$, where P1 and P2 is the received signal power off antenna **1** and antenna **2**, respectively. In other words, the difference in the signal strength received between the two antennas (P1-P2) should equal the difference in the antenna gain of the two antennas at the angle of the line of bearing ($G1(\theta_r) - G2(\theta_r)$). Thus, the target line of bearing to the target device is at θ_r . It should be noted that it is possible that more than one angle θ may satisfy the relationship $G1(\theta_r) - G2(\theta_r) = P1 - P2$. These multiple angles represent a line of bearing ambiguity that can easily be resolved by making multiple measurements, as can be appreciated by those skilled in the art.

APPLE-1001, 9:3-34.

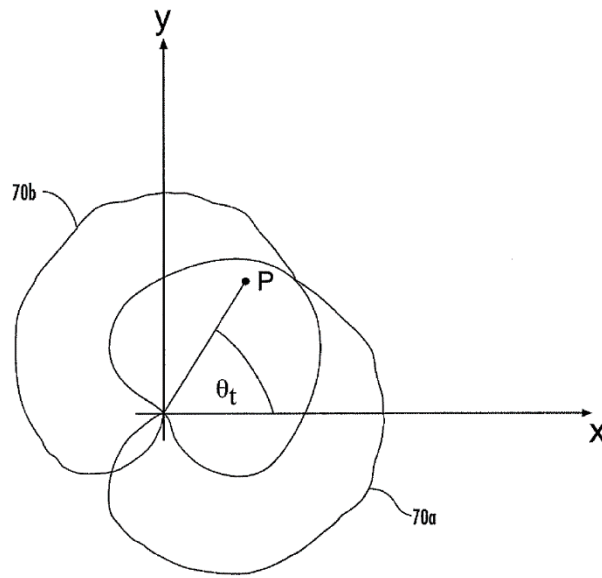


FIG. 8

APPLE-1001, Fig. 8.

2. Claim 17

[17.a] The wireless communications system of claim 13 wherein said at least one antenna comprises a plurality of antennas; and

248. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [17.a]. *See* Section XI.B ([6.a]).

[17.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target WLAN device based upon at least one of the received reply signals.

249. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [17.b]. *See* Section XI.B ([6.b]).

3. Claim 21

[21.a] The wireless device locator of claim 18 wherein said at least one antenna comprises a plurality of antennas; and

250. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [21.a]. *See* Section XI.B ([6.a]).

[21.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to the target wireless communications device based upon at least one of the received reply signals.

251. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [21.b]. *See* Section XI.B ([6.b]).

C. Claim 7

[7] The wireless communications system of claim 6 wherein the bearing is a three-dimensional bearing.

252. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [7]. McCrady discloses, for example, that “there remains a need for a commercially viable position location system capable of quickly and accurately determining the *three-dimensional indoor or outdoor position* of a compact mobile communication device.” APPLE-1005, 3:46-51.

253. As I discussed for [3.b], Kuwahara discloses a determination of a bearing to the target device. Kuwahara describes “2D-Unitary ESPRIT” “which was conceived to perform two-dimensional parameter estimation (*direction/angular height, incident direction*/delay time and the like).” APPLE-1007, 4:9-12. A POSITA would have recognized that Kuwahara’s “direction” and/or “incident

direction” can be expressed as an angle which provides a two-dimensional bearing (e.g., 2D bearing in an X-Y plane), and when combined with angular height (angle based on a device’s height from the X-Y plane) provides a three-dimensional bearing.

D. Claim 31

[31] The method of claim 27 further comprising determining a bearing to the target wireless communications device based upon at least one of the received reply signals.

254. It is my opinion that the McCrady-Raphaeli-Kuwahara combination provides [31]. *See* Section XI.B ([6.b]).

XII. Claims 1-6, 8-34 are Rendered Obvious by Rofheart, Raphaeli, Godfrey (GROUND 4)

A. Rofheart-Raphaeli-Godfrey Combination

255. In my opinion, a POSITA would have been motivated to incorporate into the Rofheart-Raphaeli-Godfrey combination Raphaeli’s teachings about averaging propagation delays for the reasons I discuss herein. The POSITA would have also been motivated to incorporate into the Rofheart-Raphaeli-Godfrey combination Godfrey’s teachings about including, in a frame/message to a target device, a destination MAC address (UID) corresponding to the target device for the reasons I discuss herein.

256. **Averaging:** In the Rofheart-Raphaeli-Godfrey combination, Rofheart’s calculation of the range between devices would have used averaged propagation delay. APPLE-1009, 25:1-31 (distance/range equation). A POSITA

motivated to incorporate an averaging technique, such as described by Raphaeli (see motivations below), would have appreciated the need for Rofheart's system to conduct multiple ranging message exchanges and calculate multiple corresponding propagation delays. In more detail, the POSITA would have contemplated conducting multiple of Rofheart's ranging message exchanges, determining corresponding delays, and averaging those delays as taught by Raphaeli. APPLE-1009, Abstract, 23:59-25:31, Fig. 7; APPLE-1006, 9:3-21 ("interrogation" via "a sequence of pulses"), 19:1-40 (discussing averaging based on "a predetermined number of received pulses").

257. A POSITA motivated to incorporate an averaging technique, such as described by Raphaeli (see motivations below), would have appreciated the need for Rofheart's system to conduct multiple ranging message exchanges and calculate multiple corresponding propagation delays. In other words, the POSITA would have contemplated conducting multiple rounds of Rofheart's ranging message exchanges, determining corresponding delays, and averaging those delays as taught by Raphaeli. Raphaeli, for example, discloses averaging based on "a predetermined number of received pulses":

By DSP 40 calculating an average time delay for collected pulse groups including at least the predetermined number of pulses, the precision of the round trip delay determination is increased relative to a single delay measurement. In an exemplary embodiment of the present invention, the pulse form of each received pulse is interpolated

from the samples received from A/D converter 60, further enhancing the precision of the round trip delay determination.

APPLE-1006, 19:33-40. *See generally* APPLE-1006, 19:1-40 (describes averaging, see citation above in VIII.B), 9:3-21 (“interrogation” via “a sequence of pulses”). *See also* APPLE-1009, Abstract, 23:59-25:31 (describing Rofheart’s message exchange among other things), Fig. 7.

258. **Averaging-based Motivations:** A POSITA looking to improve Rofheart’s system would have been familiar with references such as Raphaeli because both describe distance determination of wireless devices. Further, As I discuss above, both describe message exchanges and measuring the round-trip delay. *See* Sections VIII.B, VIII.D. Also, both employ wireless technology such as ultra wide band (UWB). APPLE-1009, 3:61-4:4 (“...transmitting a message from a local device to a remote device via an ultra wide band (UWB) wireless medium”), Abstract; APPLE-1006, 25:19-33 (“instead of transmitting pulses carried on RF signals, the pulses are transmitted without an RF carrier, for example in accordance with UWB (ultra high bandwidth) methods...”). As such, a POSITA would have been motivated to pursue the Rofheart-Raphaeli-Godfrey combination for multiple reasons.

259. In my opinion, a POSITA would have expected Raphaeli’s teaching on averaging multiple propagation delays to predictably improve a similar system like Rofheart’s by enhancing the precision of the estimated range. Raphaeli’s express

disclosure on this precision advantage would have reinforced the POSITA's understanding. APPLE-1006, 19:33-40 ("By DSP 40 calculating an average time delay ..., *the precision of the round trip delay determination is increased* relative to a single delay measurement. ..., the pulse form of each received pulse is interpolated ..., further *enhancing the precision* of the round trip delay determination.").

260. My opinion that Raphaeli's "precision advantage" would also apply to Rofheart is further supported by similarities among Rofheart and Raphaeli. Raphaeli's time delay is analogous to Rofheart's time delay (see discussions above in Sections VIII.B, VIII.D, and XII.A). Further, enhanced precision by averaging is a technique that would improve Rofheart's determination of the round trip time/delay and accordingly the range/distance APPLE-1009, 25:1-31 (describing a round trip time *Trt* calculation), 25:1-31 (describing a range/distance calculation).

261. Even without Raphaeli's observation of improved precision, a POSITA in my opinion would have recognized that unknown/random error(s) exists in the individual propagation delay estimates described by Rofheart/Raphaeli due to channel noises, interferences, measurement errors, etc. It would have been well known to a POSITA that such error can be a result of channel noises and/or interferences (including multi-path interference) which can distort the received signals exchanged for the ranging estimate, thereby causing errors in estimating the

time of arrival (TOA) and consequently the round-trip propagation time (T_{RT}) in McGrady. Similarly, channel noises and/or interferences can distort the received pulses and can cause errors to the round trip delay (RTD). It would have been also well known to a POSITA that any measurement method for TOA or RTD measurement is limited in accuracy, leading to measurement errors. *See, e.g.,* APPLE-1021 (Birchler), 1:33-39 (“propagation delays are measured in practice using transmitted signals, which signals are subject to the effects of various error sources, e.g., noise, multipath interference, distortion, etc. The resultant errors in the delay measurements are translated into errors in the pseudo-ranges and, consequently, into error in the location estimate”). Thus, the POSITA would have sought to employ known methods for the purpose of obtaining a more precise representation of the delay estimate. In this context, Raphaeli’s averaging technique would have been an obvious choice.

262. Indeed, averaging multiple measurements/estimates was a centuries-old and commonly used technique to produce an estimation value that summarizes or represents a set of values with reduced standard deviation (*i.e.*, reduced variance). This POSITA’s knowledge of reduced variance is described in many references including Eisenhart: “it is seen that the precision of the arithmetic mean of n independent measurement is proportional to $\sqrt{n}$ ”. APPLE-1026, 177. And further McGrady which discloses “averag[ing] to reduce the variance” when “performing

an internal delay calibration to reduce the variance of the delay estimate”). APPLE-1005, 10:44-59. I know from personal experience that averaging was a mathematical operation commonly employed by those of skill in the art of wireless communications systems on or around January 2004. Moreover, various patents predating the ’779 Patent show that “averaging” was a known element in the context of range finding systems. *See, e.g.*, APPLE-1019 (Uebayashi), 11:3-42 (“...the mobile station obtains the estimated distance D by averaging...”; APPLE-1020 (Buford), 7:39-43 (“By taking plural sets of information in a relatively short time frame (e.g., 10 times, every 64 chips, across about 500 microseconds), and averaging or otherwise best-fit calculating using the determined positions, position errors can be minimized.”), 9:34-41 (“to allow for averaging to improve accuracy, each base 301, 356 may forward 8 chip/time pairs,...”); APPLE-1021 (Birchler), 5:9-31 (“For each signal, the delay time delimited by the time of transmission indication and the time of reception indication (or an average delay time between multiple sets of time of transmission and reception indications for known symbols within a given signal) is determined. Assuming speed of light propagation (and possibly accounting for atmospheric delays or any other known delays), the pseudo-ranges are readily calculated from the delay times thus determined.”); APPLE-1022 (Jandrell), 17:47-58 (“symbol is capable of serving as a high-resolution ranging pulse. Again, according to the procedure for resolution improvement by multi-measurement

averaging described later, the resolution arrival time of the message is increased. ...”), 56:2-57:20 (“The jitter reduces the resolution of the time-of-arrival estimate of the pulses. However, due to the fact that most of the contributions to the jitter are randomly related variables, it is possible to markedly improve the estimate by making more than one measurement and then averaging the result as shown below. ...”). Applying this well-known concept in the context of Rofheart yields the predictable outcome suggested by Raphaeli, which is taking multiple measurements and averaging the corresponding delay estimates.

263. Even further, a POSITA would have been motivated to incorporate Raphaeli’s averaging technique based on an understanding that the concomitant accuracy and precision benefits of this approach would be particularly advantageous in Rofheart’s system. For example, Rofheart describes embodiments where accuracy and precision are of paramount importance because the ability of a remote device to transact with the local device depends on the relative distance between the two. APPLE-1009, 2:1-8, 3:41-55, 4:22-36, 18:45-54. In other words, the relative distance serves as an “authentication criteria” that determines whether a remote device is “blocked” or “enabled.” *Id.*, 21:23-65. In this context, imprecise or erroneous delay estimates (and thus imprecise or erroneous distance determinations) would cause false positive or false negative authentications, diminishing the system’s effectiveness. Averaging multiple delay estimates instead of using a single

point value would reduce the likelihood of false positive/negative authentications.

264. **MAC Address (UID):** For multiple reasons, a POSITA would have been motivated to incorporate into the Rofheart-Raphaeli-Godfrey combination Godfrey's teachings about including, in a frame/message to a target device, a destination MAC address (UID) corresponding to the target device.

265. A POSITA would have been motivated to incorporate Godfrey's teachings on MAC addresses based on Rofheart's instruction that "any other MAC protocol may be used to practice the present invention." APPLE-1009, 18:15-20 ("It is to be understood that the features and benefits of the present invention do not depend on a particular MAC protocol and *any of the above named protocols or any other MAC protocol may be used* to practice the present invention as will be understood to one of ordinary skill in the art."). A POSITA would have taken this instruction from Rofheart as a cue to seek out similar references like Godfrey that provide additional types of suitable MAC protocols in the context of location-aware systems.

266. As I discuss above, Godfrey's location awareness system describes communications based on a MAC protocol provided by IEEE 802.11 in which UIDs (called MAC addresses) are used to convey information about a frame, particularly regarding its source and destination. In fact, Rofheart describes that IEEE 802.11 includes an exemplary MAC protocol. APPLE-1009, 17:56-18:25 (describing that

“examples of multiple access protocols may be found in the IEEE 802.11 standard”). Thus, Rofheart’s teaching to explore various MAC protocols would have led the POSITA to Godfrey’s teachings on this subject.

267. Further, a POSITA would have been motivated to incorporate Godfrey’s teachings on MAC addresses based on the understanding that MAC addresses were routinely used to identify communications devices. Thus, the POSITA would have recognized that using destination MAC addresses would enable Rofheart’s local device to designate the desired recipient of the distance determining message. Then, as Godfrey teaches, a remote device that receives the distance determining message would be able to independently (e.g., without a dedicated wireless link) confirm whether it is the intended recipient of that message. APPLE-1028, [0081] (discussing “*a frame intended for receipt by the wireless station (e.g., a frame having the MAC address of the wireless station as its destination address), referred to herein as a “receipt intended frame”*”), [0083] (describing that “at step 1208 when [] the wireless station 1106 receives a receipt intended frame, i.e., a frame having the wireless station 1106 as the ultimate destination. The proximity identification module 208 may identify the frame as such by noting that the MAC address in address field A3 matches the MAC address of the wireless station 1106”); APPLE-1029, 20-21.

268. **Reasonable Expectation of Success:** As I discuss above, Rofheart and

Raphaeli both describe systems and techniques for determining the position/range of wireless devices. Moreover, given that Rofheart's device already receives responses from location finding signals, the notion of ascertaining and averaging multiple delays based on a plurality of those responses would have been straightforward from a POSITA's perspective. Godfrey also relates to location/positioning in wireless networks.

269. A POSITA would have been well versed in using averaging techniques. Even beyond Raphaeli, a POSITA's knowledge about averaging is shown in similar references such as McCrady, which discloses averaging and its benefits, *e.g.*, "to reduce the variance of the delay estimate." *See* Section IX.A; APPLE-1005, 10:44-59 (cited above in Section VIII.A). Additionally, averaging sampled values would have been within the skill level of a POSITA because averaging is taught/used in engineering, science, and/or math courses that a POSITA would have had taken as part of the degree requirement for a relevant degree as I discuss in Section III. I have taught many such courses. My lectures in courses such as EEC 161 ("Probabilistic Analysis Of Electrical & Computer Systems") in UC Davis required for BS degree students in Electrical and Computer Engineering often include topics where averaging is taught.

270. It is also my opinion that a POSITA would have known that including MAC addresses in communications messages was well-known and was broadly

applicable across a wide range of wireless protocols. APPLE-1028, [0031] (describing that “using the teachings provided herein, may advantageously implement the disclosed techniques in other wireless networks. Accordingly, reference to techniques and components specific to IEEE 802.11, such as a media access control (MAC) addresses, applies also to the equivalent technique or component in other wireless network standards”), [0081]; APPLE-1029, 20-21; APPLE-1030, Sections 7.1.3.3.4 (entitled “Destination Address (DA) field,” describing that “The DA field contains an IEEE MAC individual or group address that identifies the MAC entity or entities intended as the final recipient(s) of the MSDU (or fragment thereof) contained in the frame body field”), 7.2.2 (“Data frames”). Accordingly, it would have been evident to a POSITA that Godfrey’s teachings on MAC addresses could be incorporated with Rofheart’s teachings without changing the well-known properties of MAC addresses or the positioning functionality of Rofheart.

271. Further, the Rofheart-Raphaeli-Godfrey combination represents a combination of known elements each performing the functions it had been known to perform to produce the predictable result of combining/averaging multiple propagation delay values and messages containing MAC addresses (UIDs). The above-cited patents (APPLE-1019, APPLE-1020, APPLE-1021, APPLE-1022, among others) show that “averaging” was a known element in the context of range

finding systems. As such, a POSITA would have reasonably expected a successful outcome from combining Raphaeli's teachings on averaging propagation delays and Godfrey's MAC addresses with Rofheart's description of a position location system.

272. As I explain in more detail below through my feature-by-feature analysis, Rofheart in combination with Raphaeli and Godfrey renders obvious each of claims 1-6, 8-34.

B. Claims 1, 13, 18, 27

1. Claim 1

273. The Rofheart-Raphaeli-Godfrey combination provides claim 1 for the following reasons.

[1.pre] A wireless communications system comprising:

274. To the extent the preamble is limiting, it is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.pre]. As further discussed below, Rofheart describes a system, *e.g.*, "wireless network 300," which includes wireless communications devices (*e.g.*, remote devices 302, 303, 300N) and a wireless device locator (*e.g.*, local device 301):

The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively.

APPLE-1009, 17:18-22.

[1.a.i] a plurality of wireless communications devices each having a device type associated therewith from among a plurality of different device types,

275. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.a.i]. For example, Rofheart describes a plurality of wireless communications devices:

The wireless network 300 includes a local device 301 linked to *a first remote device 302, a second remote device 303 and N number of additional remote devices 300N* via UWB links 312, 313, and 315N respectively.

APPLE-1009, 17:18-22.

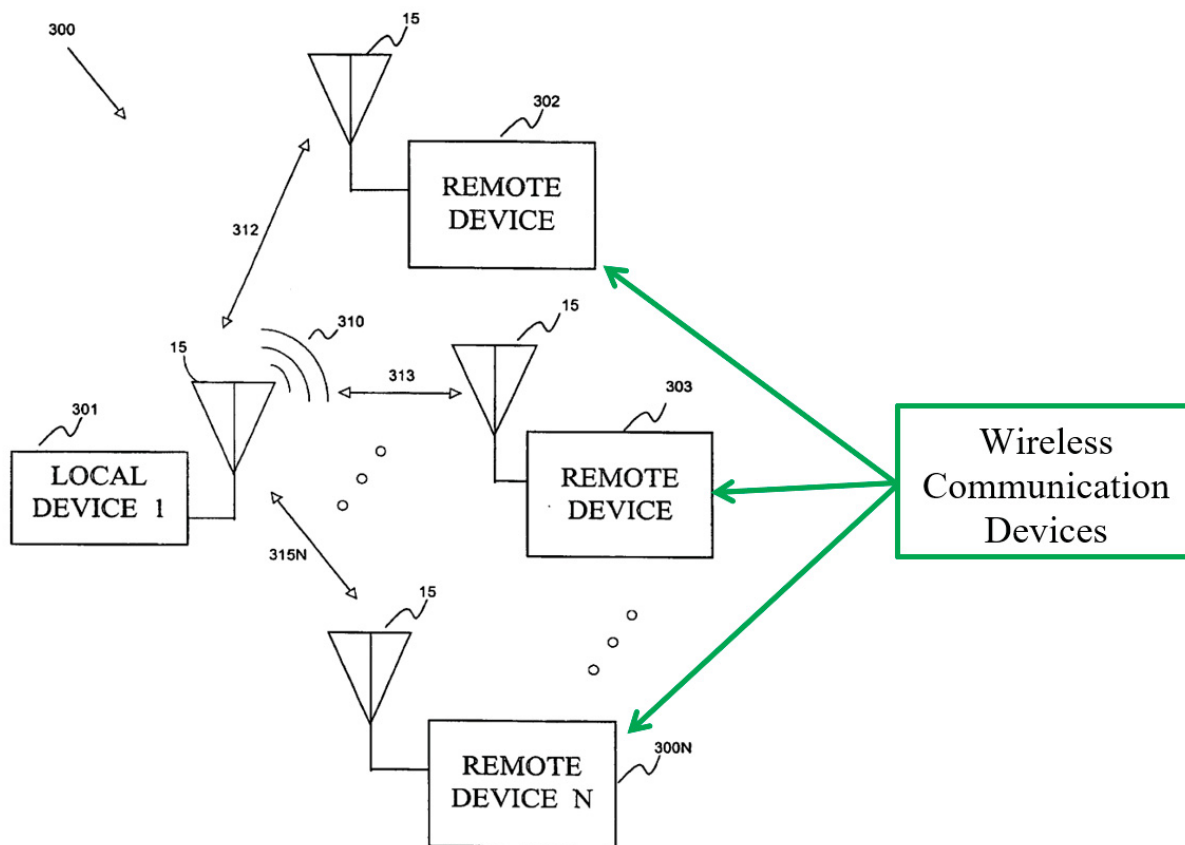


FIGURE 3

APPLE-1009, Fig. 3 (annotated).

276. Each of Rofheart's remote devices (302, 303, 300N) has a device type associated therewith from among a plurality of different device types:

The wireless network 300 may be WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. ***Each of the wireless devices 301 through 300N may be a mobile device such as a mobile telephone, a laptop computer or personal digital assistant (PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices.*** It is to be understood that device 301 is referred to as a "local device" and devices 302-400N are referred to as "remote devices" for purposes of description only, and that the present invention is not limited to an infrastructure system having an access point and may be implemented in an ad hoc system wherein any device in the network can act as a master and/or a slave device and no access point is needed.

APPLE-1009, 17:13-37. Rofheart further discloses:

Before computing a distance to each linked remote device, the local device 201 first determines a processing delay d for each linked remote device as seen in step 711. Processing delay d is the time delay between the remote device receiving the distance determining message and transmitting a response and includes at least the amount of time necessary for the remote device to process the distance determining message and form a response. According to one embodiment, the

processing delay *d* is determined by retrieving the delay from the memory of the local device 201. In this embodiment, ***the local device 201 receives information from each remote device about the radio type of the remote device, as part of the reply and/or response received from the remote devices*** as discussed with respect to steps 507 and 707 respectively. Alternatively, the type information may be received as part of an independent signal sent by the remote devices. With the remote *device type* known, ***the local device 301 then refers to a look up table (LUT) stored in memory 207 or ROM 209 to determine a predefined processing delay for the radio type.***

APPLE-1009, 24:36-55. I note that Rofheart uses the terms “device type” and “radio type” interchangeably. *Id.*

277. Rofheart’s radio type is consistent with a POSITA’s understanding of the ’779 Patent’s claimed “device type.” For example, the ’779 Patent discloses:

Each wireless communications device 34-36 in the WLAN 31 has a device type associated therewith from among a plurality of different device types. More particularly, the device type may signify the particular manufacturer and/or model of a given WLAN card or chip set used therein. In some embodiments, it may also signify the standard the device complies with (e.g., IEEE 802.11).

The device type is important in that different device types will have known device latencies associated therewith. For example, ***different WLAN cards or chip sets will have a certain latency associated with the time they take to process a received signal and generate an acknowledgement reply thereto.*** These delay times may be fairly consistent across different models from a same manufacturer, or they may vary significantly.

APPLE-1001, 5:6-20.

[1.a.ii] each WLAN device having a unique identifier (UID) associated therewith, and

278. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.a.ii]. For example, Rofheart discloses:

Each reply message includes a *unique identifier associated with the remote device* from which the reply is transmitted. The unique identifier may be a device address stored in ROM 209, for example, or a unique delay time for the remote device as will be described below.

APPLE-1009, 20:62-66. A POSITA would have recognized that each of Rofheart's remote devices has an associated UID because the remote device includes its UID in the reply message. Further, Rofheart discloses that the devices are WLAN devices as I discuss in Section X (including for [1] and [10]). *See also* discussion below at [1.b.iv] and [1.c] regarding Godfrey's teachings on UIDs in the form of MAC addresses.

[1.a.iii] each device type having a known device latency associated therewith; and

279. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.a.iii]. Rofheart further discloses that each device type having a known device latency associated therewith. For example, Rofheart acknowledges that the remote devices have a processing delay:

According to another aspect of the invention, the time between the transmitting of the message and the receiving of the response may be used to determine a distance from the local device to the remote device. In this aspect, the time between the transmitting of the message and the receiving of the response is determined by marking a time of the transmitting and receiving as a first time and second time respectively, and determining a difference between the first and second times. A

round trip time is then determined by subtracting a *processing delay* from the difference between the first and second times. The *processing delay may be obtained from a memory of the local device or received from the remote device*. Finally, the distance from the local device to the remote device is determined by multiplying one half of the round trip time by a speed of transmission over the wireless medium. In this aspect, the function performed in the local device is communicating with the remote device based on the distance determined.

APPLE-1009, 4:5-21. Rofheart further discloses:

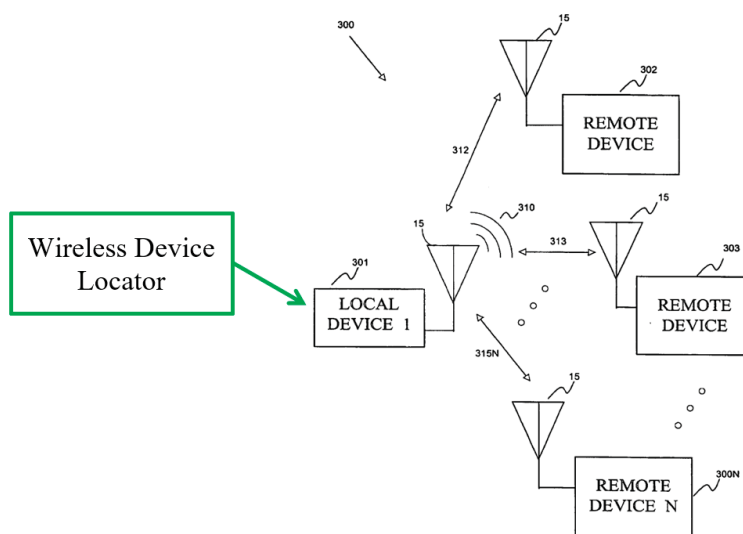
Before computing a distance to each linked remote device, the local device 201 first determines a processing delay *d* for each linked remote device as seen in step 711. *Processing delay d is the time delay between the remote device receiving the distance determining message and transmitting a response and includes at least the amount of time necessary for the remote device to process the distance determining message and form a response*. According to one embodiment, the processing delay *d* is determined by retrieving the delay from the memory of the local device 201. In this embodiment, the local device 201 receives information from each remote device about the radio type of the remote device, as part of the reply and/or response received from the remote devices as discussed with respect to steps 507 and 707 respectively. Alternatively, the type information may be received as part of an independent signal sent by the remote devices. *With the remote device type known, the local device 301 then refers to a look up table (LUT) stored in memory 207 or ROM 209 to determine a predefined processing delay for the radio type*.

APPLE-1009, 24:36-55. Rofheart's "processing delay" is a predefined latency value stored in memory of the local device and keyed to each of the different radio/device types contemplated by Rofheart. As such, Rofheart provides the claimed "known device latency" under each of the parties proposed construction which I discussed in

Section VII.

[1.b.i] a wireless device locator comprising at least one antenna and a transceiver connected thereto, and

280. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.b.i]. For example, Rofheart describes “a *local device 301*.” APPLE-1009, 17:18-22. Rofheart’s “local device [which] displays a graphical map of the position of remote devices in relation to the local device” and that “it [is] possible to resolve the spatial locations of the remote device.” APPLE-1009, 31:19-43. Rofheart’s local device is designed to locate wireless remote devices. This is consistent with a POSITA’s understanding of a wireless device locator.



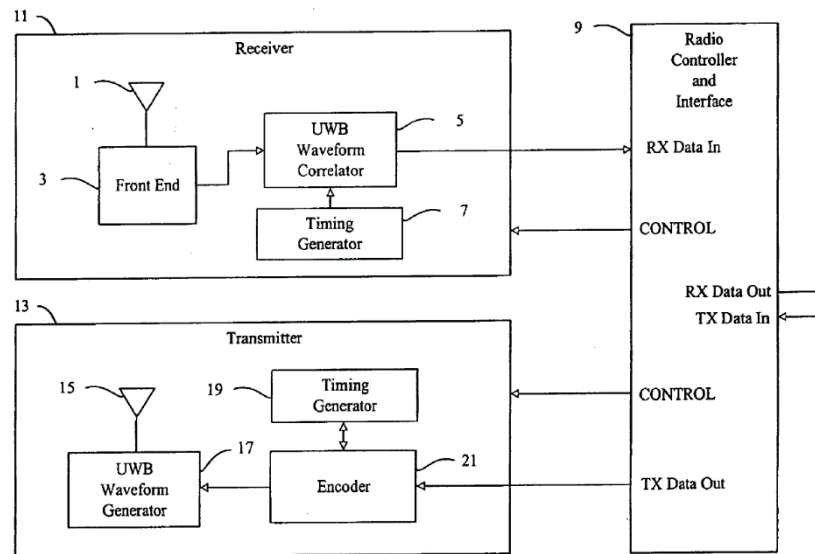
APPLE-1009, Fig. 3 (annotated).

281. Rofheart’s local device includes an antenna and an transceiver connected to the antenna:

- APPLE-1009, 17:38-46 (describing that devices including the local device “includes a processor system, such as the one described in FIG. 2, for inputting, storing, and processing data in accordance with the present invention. Therefore, *local device 301 ... includes a UWB transceiver*, such as the transceiver described in FIG. 1a or 1c, that transmits and receives a UWB signal 310 via a *UWB antenna* such as antenna 1,15 also described in FIGS. 1a and 1c”),
- 5:52-57 (“Referring now to the drawings and more particularly to FIG. 1a thereof, a block diagram of an *ultra-wide band (UWB) transceiver* used in accordance with the present invention is shown. In FIG. 1a, the *transceiver* includes three major components, namely, receiver 11, radio controller and interface 9, and transmitter 13”),
- 5:66-6:1 (“The receiver 11 includes an *antenna 1* that converts a UWB electromagnetic waveform into an electrical signal (or optical signal) for subsequent processing”),
- 10:44-50 (describing that “[t]he output from the UWB generator 17 is then provided to an antenna 15, which then transmits the UWB energy to a receiver”),
- 11:10-16 (describing that “In FIG. 1c, when receiving energy through the antenna 1, 15 (e.g., corresponding antennas 1 and 15 of FIG. 1a) the

energy is coupled in to a transmit/receive (T/R) switch 27, which passes the energy to a radio front end 3.”),

- 15:60-63 (“The processor system 201 can transmit notifications and receive data, including program code, through the network(s), the network link 221 and the communication interface 219.”),
- FIGS. 1a, 1c, 2, 3.



APPLE-1009, FIG. 1c. A POSITA would have recognized that Rofheart’s transceiver is connected to Rofheart’s antenna because both are included in Rofheart’s local device and Rofheart’s transceiver transmits/receives signals via the antenna.

[1.b.ii] a controller for cooperating with said transceiver for

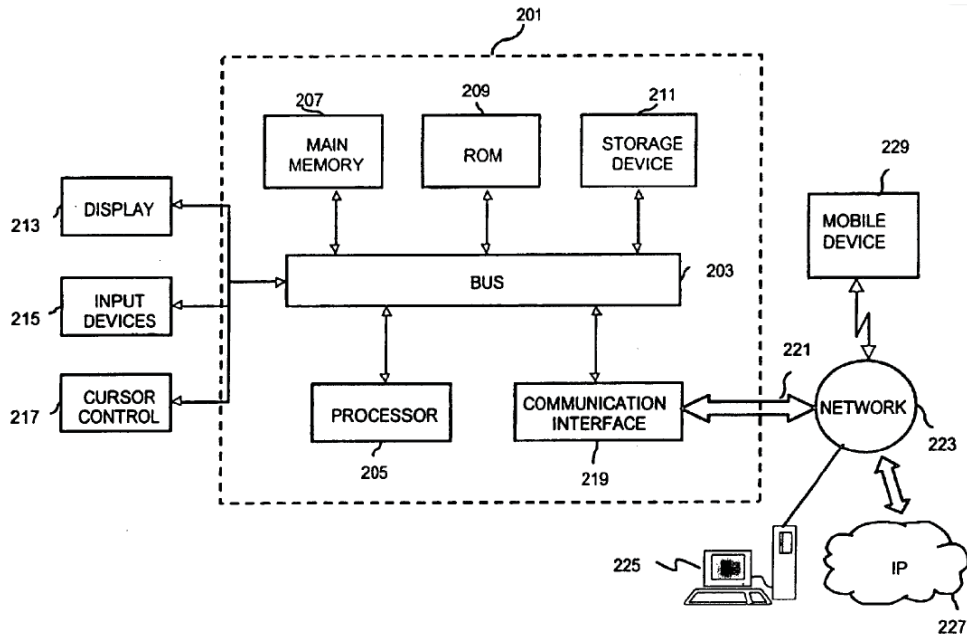
282. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.b.ii]. Rofheart’s local device includes a controller for cooperating with

Rofheart's transceiver:

- APPLE-1009, 14:14-18 (“The *processor system 201* performs a portion or all of the processing steps of the invention in response to the processor 205 executing one or more sequences of one or more instructions contained in a memory, such as the main memory 207”),
- 15:23-43 (describing that “[t]he communications interface 219 provides a two-way UWB data communication coupling to a network link 221”),
- 15:60-63 (“The *processor system 201 can transmit notifications and receive data*, including program code, through the network(s), the network link 221 and the communication interface 219.”),
- 17:38-46 (describing that devices including the local device “includes a *processor system*, such as the one described in FIG. 2, for inputting, storing, and processing data in accordance with the present invention”),
- 5:52-65 (“Referring now to the drawings and more particularly to FIG. 1 a thereof, a block diagram of an ultra-wide band (UWB) transceiver used in accordance with the present invention is shown. In FIG. 1 a, the transceiver includes three major components, namely, receiver 11, *radio controller and interface 9*, and transmitter 13. Alternatively, the system may be implemented as a separate receiver 11 and *radio*

controller and interface 9, and a separate transmitter 13 and *radio controller and interface 9*. The radio controller and interface 9 serves as a media access control (MAC) interface between the UWB wireless communication functions implemented by the receiver 11 and transmitter 13 and applications that use the UWB communications channel for exchanging data with remote devices.”),

- FIGS. 1a, 1c, 2, 3.



APPLE-1009, Fig. 2.

283. In my opinion, a POSITA would have understood that Rofheart’s processor system (which includes processor 205) controls other components of Rofheart’s local device including the communication interface. This interface includes Rofheart’s transceiver, which I discussed for [1.b.i]. APPLE-1009, 15:23-

43 (describing that Rofheart’s communication interface provides “two-way UWB data communication” and “may incorporate the UWB transceiver”). In sum, Rofheart teaches the claimed “controller” which cooperates with said transceiver.

[1.b.iii] transmitting a plurality of location finding signals to a target wireless communications device from among said plurality of wireless communications devices and

284. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.b.iii].

285. Rofheart’s controller (see [1.b.i]) cooperates with the transceiver (see [1.b.ii]) to transmit a plurality of location finding signals to a target wireless communications device and receives associated responses:

- APPLE-1009, 23:59-65 (“FIG. 7 describes the process of determining distance to each linked remote device in accordance with an embodiment of the present invention. In step 701, *a distance determining message* is generated in the local device 301 and *transmitted to each linked remote device 302, 303, and 300N via the unique communication links 312, 313, and 315N.*”),
- 19:63-20:9 (describing, in reference to Fig. 4, that “the *loop serves to update distance information for linked remote devices*” and that “the local device 301 *repeatedly determines distance* to each linked remote device”).

286. In the Rofheart-Raphaeli-Godfrey combination, Rofheart’s ranging message exchange (which includes Rofheart’s UWB *distance determining message* (“location finding signal”)) is performed multiple times to generate multiple propagation delay estimates. These estimates are subsequently combined by Raphaeli’s averaging technique. See discussion above in Sections XII.A, VIII.B; APPLE-1006, 9:3-21 (“interrogation” via “a sequence of pulses”), 19:1-40 (describing averaging based on “a predetermined number of received pulses”).

[1.b.iv] inserting the UID for said target wireless communications device in each of the location finding signals;

287. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.b.iv] through integration of Godfrey’s MAC address (UID) teaching into Rofheart’s distance determining messages (location finding signals per [1.b.iii]). Godfrey discloses a UID called a MAC address in a frame/message. This MAC address corresponds to the address of the frame/message’s intended recipient (UID for said target wireless communications device). For example, Godfrey discloses:

[0081] As provided by IEEE 802.11 and related standards, *frames typically contain several address fields inside the MAC header*, depending on their type (control, data, or management). *The first address field, denoted herein as address field A1, indicates the MAC address of the immediate receiver of the frame.* The second address field, denoted herein as address field A2, contains the MAC address of the transmitter of the frame. The third address field, denoted herein as address field A3, contains either the MAC address of the ultimate source of the frame (for downlink frames), the MAC address of the

ultimate destination (for uplink frames), or the BSSID (for direct link and ad hoc frames). Acknowledgement (ACK) frames typically only have address field A1. Therefore, it will be appreciated that three types of frames may exist within the transmission/reception range of a wireless station: 1) *a frame intended for receipt by the wireless station (e.g., a frame having the MAC address of the wireless station as its destination address), referred to herein as a “receipt intended frame”*; 2) a frame overheard by the wireless station but intended for receipt by another wireless station (e.g., a frame having a MAC address of another wireless station as its destination address), referred to herein as an “overheard frame”; and 3) a frame transmitted by the wireless station for receipt by another station (e.g., a frame having the MAC address of the certain wireless station as the source address), referred to herein as an “originating frame.”

APPLE-1028, [0081]; APPLE-1029, 20-21. *See also* APPLE-1030, Sections 7.1.3.3.4 (entitled “Destination Address (DA) field,” describing that “The DA field contains an IEEE MAC individual or group address that identifies the MAC entity or entities intended as the final recipient(s) of the MSDU (or fragment thereof) contained in the frame body field”), 7.2.2 (“Data frames”).

288. It is my opinion that Godfrey’s “MAC address” is consistent with a POSITA’s understanding of a UID. The POSITA would have appreciated that a MAC address is typically used to identify a device in a communications network. Additionally, Godfrey’s description of a MAC address shows that it is used to uniquely identify different message destinations (“wireless stations,” such as mobile devices, analog to Rofheart’s remote devices) within the network in a manner that ensures the message is directed to and received by the intended station/device.

APPLE-1028, [0033], [0081]; APPLE-1029, 5, 20-21.

289. It is also my opinion that this description is consistent with the specification and claims of the '779 Patent which describes that the UID includes an address of a device.

Additionally, the controller may also determine the device type of the target wireless communications device based upon the UID. By way of example, *the UIDs may include media access control (MAC) addresses of respective wireless communications devices*. Accordingly, the controller may determine the device type of the target wireless communications device based upon the MAC address in some applications.

APPLE-1001, 3:38-45.

Additionally, the controller 42 may also determine the device type of the target wireless communications device 34 based upon the UID thereof. By way of example, *the UIDs may include media access control (MAC) addresses of respective wireless communications devices*. The MAC addresses may be specific to a particular type of device manufacturer, or indicate a particular operational protocol with which the device is operating, as will be appreciated by those skilled in the art. Accordingly, the controller may determine the device type of the target wireless communications device 34 based upon the MAC address thereof in some applications.

APPLE-1001, 6:14-25. *See also id.*, claim 5 (“The wireless communications system of claim 4 wherein *the UIDs comprise media access control (MAC) addresses of respective wireless communications devices, ...*”).

290. A POSITA, in my opinion, would have understood and expected that a

device would insert (include) a MAC address (UID) into a frame/message before transmitting the frame/message containing that MAC address. This would have been a matter of basic common knowledge and common sense for the POSITA. Moreover, Godfrey discloses:

[0081] As provided by IEEE 802.11 and related standards, frames typically contain several address fields inside the MAC header, depending on their type (control, data, or management). The first address field, denoted herein as address field A1, indicates the MAC address of the immediate receiver of the frame. The second address field, denoted herein as address field A2, contains the MAC address of the transmitter of the frame. The third address field, denoted herein as address field A3, contains either the MAC address of the ultimate source of the frame (for downlink frames), the MAC address of the ultimate destination (for uplink frames), or the BSSID (for direct link and ad hoc frames). Acknowledgement (ACK) frames typically only have address field A1. Therefore, it will be appreciated that three types of frames may exist within the transmission/reception range of a wireless station: 1) *a frame intended for receipt by the wireless station (e.g., a frame having the MAC address of the wireless station as its destination address), referred to herein as a “receipt intended frame”*; 2) a frame overheard by the wireless station but intended for receipt by another wireless station (e.g., a frame having a MAC address of another wireless station as its destination address), referred to herein as an “overheard frame”; and 3) a frame transmitted by the wireless station for receipt by another station (e.g., a frame having the MAC address of the certain wireless station as the source address), referred to herein as an “originating frame.”

APPLE-1028, [0081]; APPLE-1029, 20-21. Godfrey further discloses:

[0082] FIGS. 12A-12C illustrate various exemplary methods 1200A, 1200B and 1200C for monitoring frames transmitted within the transmission/reception range of a wireless station (e.g.,

wireless station 1106) to identify potential proximate stations using the address fields A1, A2 and A3 of the frames. Exemplary method 1200A describes a method for monitoring overheard frames, exemplary method 1200B describes a method for monitoring receipt intended frames and exemplary method 1200C describes a method for monitoring originating frames.

[0083] Method 1200A initiates at step 1202 wherein the wireless station 1106 overhears a frame transmitted by another station. The proximity identification module 208 (FIG. 2) may identify the frame as an overheard frame by, for example, noting that the MAC address in address field A1 does not match the MAC address of the wireless station 1106. At step 1204, the MAC address stored in address field A1 of the frame is stored in peer list 1 (PL1) maintained by the proximity identification module 208. At step 1206, the MAC address stored in address field A2 is stored in a peer list 2 (PL2) maintained by proximity identification module 208. Method 1200B initiates at step 1208 *when a [sic] the wireless station 1106 receives a receipt intended frame, i.e., a frame having the wireless station 1106 as the ultimate destination*. The proximity identification module 208 may *identify the frame as such by noting that the MAC address in address field A3 matches the MAC address of the wireless station 1106*. At step 1210, the MAC address in address field A3 is stored in a peer list 3 (PL3) maintained by proximity identification module 208. Method 1200C initiates at step 1212 when the wireless station 1106 transmits a frame. At step 1214, the proximity notification module 208 stores the MAC address of address field A3 of the transmitted frame in PL3.

[0084] In methods 1200A-1200C, filtering of frames that contain a BSSID, multicast address or broadcast address preferably is performed to prevent the storage of such in PL1, PL2 or PL3. Furthermore, PL1, PL2 and PL3 preferably are aged or periodically refreshed to maintain the accuracy of the lists. PL1 and PL2 may be pre-populated when stations periodically transmit a null frame at a low PHY rate; a station's own MAC address stored in address fields A1 and A2 (i.e. Null-to-self). The peer lists may also be pre-populated when other stations join and

authentication or association request/response frames are received. Address information from probe request/response frames preferably is not added to the peer lists because such frames do not indicate the presence of a station on that channel.

[0085] As a result of methods 1200A-1200C, PL1, PL2 and PL3 are populated with the MAC addresses of wireless stations overheard by wireless station 1106 or in communication with the wireless station. To identify wireless stations that potentially are within transmission/reception range of the wireless station 1106, the proximity identification module 208 may implement exemplary method 1300A of FIG. 13A and method 1300B of FIG. 13B.

APPLE-1028, [0082]-[0085], Figs. 12A-12C, [0009] (“The method includes providing network information associated with the first wireless device to a server, the network information including at least a media access control (MAC) address and service set identifier (SSID) of an access point to which the first wireless device is connected.”); APPLE-1029, 15-17, 20-22, Figs. 12A-12C.

291. It is my opinion that Godfrey’s description as discussed above is consistent with the specification of the ’779 Patent which describes inserting/including a UID in a signal (e.g., header packet).

As such, to locate the target device 34, the controller inserts the UID therefor in each of the location finding signals. By way of example, the location finding signal may include the UID of the target device 34 in a header packet and a valid but empty data packet. This will force the target device 34 to generate a reply signal acknowledging receipt of the location finding signal (i.e., an ACK signal). Of course, various other location finding signals could be used to cause the target terminal 34 to generate an ACK signal, as will be appreciated by those skilled in the art. The controller 42 cooperates with the transceiver 41 for receiving the reply signals from the target device 34 via the antenna 39. The

location finding signals and reply signals may be radio frequency (RF), microwave, optical, or other suitable types of signals, as will be appreciated by those skilled in the art.

APPLE-1001, 6:26-30.

292. It is also my opinion that it would have been obvious to a POSITA that Rofheart's local device inserts the MAC address in the message/frame in order for the message/frame to include the address. For example, doing so would have been consistent with IEEE 802.11, which is referenced by Godfrey and Rofheart, which requires the inclusion of MAC addresses in various frames. APPLE-1028, [0081]; APPLE-1029, 20-21; APPLE-1009, 17:56-18:25; APPLE-1030, Sections 7.1.3.3.4, 7.2.2.

[1.c] said target wireless communications device transmitting a respective reply signal for each of said location finding signals based upon the UID in the location finding signals;

293. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.c]. As I discussed for [1.a.i]-[1.a.iii] and [1.b.ii], Rofheart discloses a target wireless communications device (Rofheart's remote device) and transmission of location finding signals (Rofheart's distance determining messages). Rofheart further discloses that the target device transmits a reply signal (Rofheart's response) for each location finding signal.

In step 705, *the linked remote devices 301, 302, and 300N* receive the distance determining message via a respective unique link and *transmit a response to the local device 301 over the same unique link*. As with the distance determining message transmitted in step 701, the response

message from the remote devices may include a communication if the link responded on is an enabled link. In step 707, the local device 301 receives responses sent from the linked remote devices via respective unique links and marks a receive time t2 for each response received as seen in step 709.

APPLE-1009, 24:22-31, *see also* Fig. 7 (step 705).

294. As I discussed for [1.b.iii]-[1.b.iv], the Rofheart-Raphaeli-Godfrey combination provides location finding signals that include a UID for a target wireless communications device. In my opinion, a POSITA would have found it obvious for the target device to base its reply signal upon the UID in the location finding signal. For example, Godfrey discloses a procedure where a recipient device matches a UID called a MAC address in a received frame (e.g., message) to its own MAC address, and *if there is a match*, the device knows that it is the intended recipient of the frame.

[0083] Method 1200A initiates at step 1202 wherein the wireless station 1106 overhears a frame transmitted by another station. The proximity identification module 208 (FIG. 2) may identify the frame as an overheard frame by, for example, noting that the MAC address in address field A1 does not match the MAC address of the wireless station 1106. At step 1204, the MAC address stored in address field A1 of the frame is stored in peer list 1 (PL1) maintained by the proximity identification module 208. At step 1206, the MAC address stored in address field A2 is stored in a peer list 2 (PL2) maintained by proximity identification module 208. Method 1200B initiates at step 1208 *when a [sic] the wireless station 1106 receives a receipt intended frame, i.e., a frame having the wireless station 1106 as the ultimate destination*. The proximity identification module 208 may *identify the frame as such by noting that the MAC address in address field A3 matches the MAC address of the wireless station 1106*. At

step 1210, the MAC address in address field A3 is stored in a peer list 3 (PL3) maintained by proximity identification module 208. Method 1200C initiates at step 1212 when the wireless station 1106 transmits a frame. At step 1214, the proximity notification module 208 stores the MAC address of address field A3 of the transmitted frame in PL3.

APPLE-1028, [0083]; APPLE-1029, 20-21; *see also* APPLE-1030, Section 7.2.2. In

the context of the Rofheart-Raphaeli-Godfrey combination, the POSITA would have recognized that when a recipient device determines that it is the intended recipient of a location finding signal frame (vis-à-vis matching the UID: MAC address), the device would process the frame and transmit a reply based upon the outcome of UID matching.

[1.d] said controller of said wireless device locator also for

295. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.d]. As I discussed for [1.b.ii], Rofheart discloses a controller

[1.d.i] cooperating with said transceiver for receiving the reply signals,

296. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.d.i]. For example, Rofheart describes receiving the reply signals:

In step 707, *the local device 301 receives responses sent from the linked remote devices* via respective unique links and marks a receive time t2 for each response received as seen in step 709. As with the transmit times t1, each receive time t2 is associated with the unique identifier of a respective link and stored in main memory 207 for use in calculating a distance from the local device 201 to each remote device 202 through 200N.

APPLE-1009, 24:28-31, *see also* Fig. 7 (step 707).

[1.d.ii] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of said target wireless communications device, and

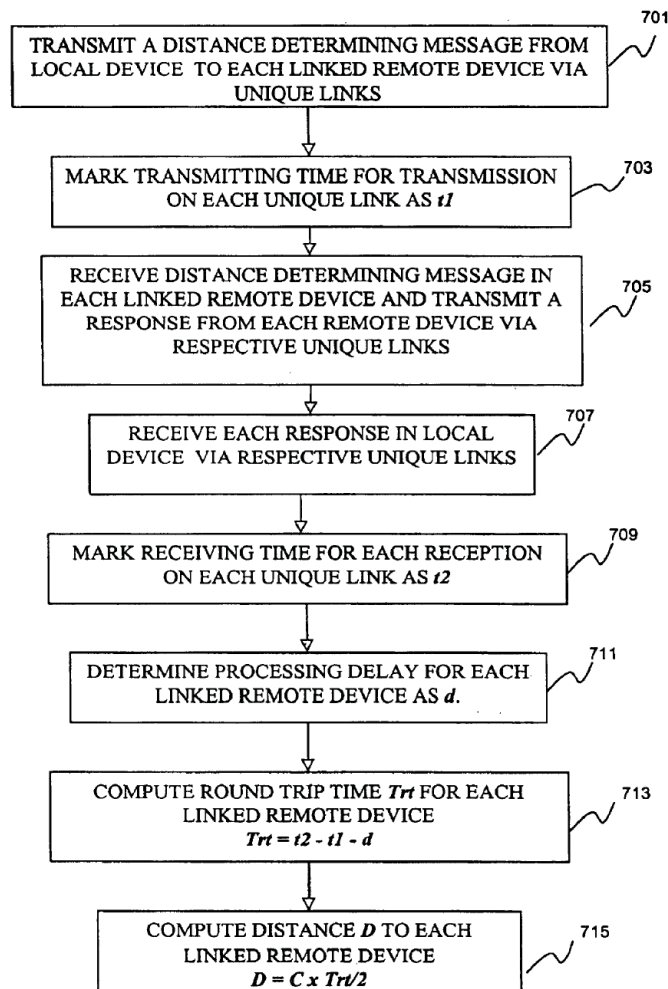
297. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [1.d.ii]. Rofheart determines a propagation delay associated with the transmission of each location finding signal (transmitted at “time t1”) and the respective reply signal (received at “time t2”).

For each distance determining message sent on each unique communications link 302 through 300N, the local device 301 marks a time t1 as the transmitting time that the message was sent out for the particular communications link as shown in step 703. Transmit time t1 is obtained by a system clock in the processor system 201 of the local device 301. Each transmit time t1 is associated with one of the unique identifiers stored in step 609 based on the unique link over which the distance determining message was transmitted. The transmit times and associated identifiers are then stored in the main memory 207 of local device 301 so that the transmit times may be retrieved to determine the distance to each remote device.

In step 705, the linked remote devices 301, 302, and 300N receive the distance determining message via a respective unique link and transmit a response to the local device 301 over the same unique link. As with the distance determining message transmitted in step 701, the response message from the remote devices may include a communication if the link responded on is an enabled link. *In step 707, the local device 301 receives responses sent from the linked remote devices via respective unique links and marks a receive time t2 for each response received as seen in step 709.* As with the transmit times t1, each receive time t2

is associated with the unique identifier of a respective link and stored in main memory 207 for use in calculating a distance from the local device 201 to each remote device 202 through 200N.

APPLE-1009, 24:10-35.



APPLE-1009, Fig. 7.

298. Rofheart discloses a known device latency of said target wireless communications device (*processing delay d*):

Before computing a distance to each linked remote device, the local device 201 first determines a processing delay d for each linked remote device as seen in step 711. Processing delay d is the time delay

between the remote device receiving the distance determining message and transmitting a response and includes at least the amount of time necessary for the remote device to process the distance determining message and form a response. According to one embodiment, the processing delay d is determined by retrieving the delay from the memory of the local device 201. In this embodiment, the local device 201 receives information from each remote device about the radio type of the remote device, as part of the reply and/or response received from the remote devices as discussed with respect to steps 507 and 707 respectively. Alternatively, the type information may be received as part of an independent signal sent by the remote devices. With the remote device type known, the local device 301 then refers to a look up table (LUT) stored in memory 207 or ROM 209 to determine a predefined processing delay for the radio type.

APPLE-1009, 24:36-55. *See also* discussion for [1.a.i]-[1.a.iii].

299. Rofheart uses time t_1 , time t_2 , and delay d to determines a propagation delay (round trip time Trt):

In step 713, the local device 301 ***calculates the round trip time Trt for each linked remote device 302 through 200N.*** In this step, the local device 301 retrieves the transmitting time t_1 , receiving time t_2 , and processing delay time d of a particular unique link to a remote device from main memory 207 and ROM 209 as discussed above. ***The processor 205 of the local device 301 then computes the total round trip time*** according to the following formula:

$$Trt = t_2 - t_1 - d \quad (9)$$

Thus, ***the round trip time is the time that the distance determining signal and the response signal travel through the wireless medium*** and is different for each remote device. ...

APPLE-1009, 25:1-31.

300. To the extent that the Board deems that the claimed propagation delay

does not correspond to Rofheart's "Trt," a POSITA would have recognized that Rofheart's round-trip time Trt, when divided by two, provides a one-way propagation delay. Rofheart's describes this division to determine the one-way delay part (that is Trt/2) of the range equation in Eq. 10:

... Each round trip time Trt is stored to main memory 207 where the processor 205 of the local device 301 retrieves the [Trt]s and ***computes the distance D to each remote device*** according to the following formula:

$$D = c \times Trt/2 \quad (10)$$

where c is the speed of light which is the speed at which an RF signal travels through the wireless medium. The distance D for each remote device 302 through 300N is then associated with the unique identifier of the unique communications link over which the distance was determined and is stored in main memory 207 so that systems software of the local device 301 may retrieve the distance information to enable or block communications with the remote devices based on their distance from the local device 301.

APPLE-1009, 25:1-31.

301. As I discussed in Section XII.A, the Rofheart-Raphaeli-Godfrey combination involves averaging multiple propagation delays obtained by conducting multiple ranging message exchanges and calculating a propagation delay for each exchange. A POSITA would have understood that averaging multiple delays requires ascertaining individual delays for separate message exchanges.

[1.d.iii] estimating a range to said target wireless communications device based upon a plurality of determined propagation delays.

302. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [1.d.iii]. Rofheart discloses a range estimate equation (Eq. 10) which is based on the propagation delay, *e.g.*, round trip time Trt as discussed for [1.d.ii], to estimate a range (which Rofheart calls “distance D”) to the device:

... Each round trip time Trt is stored to main memory 207 where the processor 205 of the local device 301 retrieves the $[Trt]$ s and ***computes the distance D to each remote device*** according to the following formula:

$$D = c \times Trt/2 \quad (10)$$

where c is the speed of light which is the speed at which an RF signal travels through the wireless medium. The distance D for each remote device 302 through 300N is then associated with the unique identifier of the unique communications link over which the distance was determined and is stored in main memory 207 so that systems software of the local device 301 may retrieve the distance information to enable or block communications with the remote devices based on their distance from the local device 301.

APPLE-1009, 25:1-31.

303. As I previously discussed in Section XII.A, the Rofheart-Raphaeli-Godfrey combination involves averaging determined propagation delays and using the average delay value in the range estimation equation. *See, e.g.*, APPLE-1006, 19:1-40 (describes averaging as I discuss above). Let $Trt_{average}$ be an average of multiple delays and $D_{average}$ be the average distance. In the Rofheart-Raphaeli-Godfrey combination, Rofheart’s range estimation formula converts to: $D_{average} = c \times Trt_{average}/2$.

2. Claim 13

304. Claim 13 is an independent system claim that parallels the system claim recited in claim 1 but with the additional limitation that the devices are WLAN devices (claims 1 and 10) and an average is used to estimate the range (claim 2). The limitations of claims 1, 2, and 10 and claim 13 are substantially similar. As such, the limitations of claim 13 are rendered obvious by the Rofheart-Raphaeli-Godfrey combination for the same reasons that I discussed for claims 1, 2, and 10. Any minor differences in claim language between claims 1, 2, and 10 and claim 13 are addressed in the following analysis.

[13.pre] A wireless communications system comprising:

305. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.pre]. *See* Section XII.B ([1.pre]).

[13.a.i] a plurality of wireless local area network (WLAN) devices each having a device type associated therewith from among a plurality of different device types,

306. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.a.i]. *See* Section XII.B ([1.a.i], [10]). For the reasons I discuss above, McCrady additionally discloses a target WLAN device and that the target WLAN device is from among said plurality of WLAN devices. *Id.*

[13.a.ii] each WLAN device having a unique identifier (UID) associated therewith, and

307. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [13.a.ii]. *See* Section XII.B ([1.a.ii]).

[13.a.iii] each device type having a known device latency associated therewith; and

308. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.a.iii]. *See* Section XII.B ([1.a.iii]).

[13.b.i] a wireless device locator comprising at least one antenna and a transceiver connected thereto, and

309. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.b.i]. *See* Section XII.B ([1.b.i]).

[13.b.ii] a controller for cooperating with said transceiver for transmitting a plurality of location finding signals to a target WLAN device from among said plurality of WLAN devices and inserting the UID for said target wireless communications device in each of the location finding signals;

310. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.b.ii]. *See* Section XII.B ([1.b.ii], [10]).

[13.c] said target WLAN device transmitting a respective reply signal for each of said location finding signals based upon the UID in the location finding signals;

311. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.c]. *See* Section XII.B ([1.c], [10]).

[13.d] said controller of said wireless device locator also for

312. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.d]. *See* Section XII.B ([1.d]).

[13.d.i] cooperating with said transceiver for receiving the reply signals,

313. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.d.i]. *See* Section XII.B ([1.d.i]).

[13.d.ii] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of said target WLAN device, and

314. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.d.ii]. *See* Section XII.B ([1.d.ii], [10]).

[13.d.iii] estimating a range to said target WLAN device based upon an average of a plurality of determined propagation delays.

315. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [13.d.iii]. *See* Section XII.B ([1.d.iii], [2], [10]).

3. Claim 18

316. Claim 18 is an apparatus claim that only includes the wireless device locator aspect of claim 1, and in this regard, the limitations of claims 1 and 18 are substantially similar. As such, the limitations of claim 18 are rendered obvious by the Rofheart-Raphaeli-Godfrey combination for the same reasons that I discussed for claim 1. Any minor differences in claim language between claim 1 and claim 18 are addressed in the following analysis.

[18.pre] A wireless device locator for locating a target wireless communications device having a unique identifier (UID) associated therewith, the wireless device locator comprising:

317. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [18.pre]. *See* Section XII.B ([1.a.i]-[1.a.iii], [1.b.i]).

[18.a] at least one antenna and a transceiver connected thereto; and

318. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.a]. *See* Section XII.B ([1.b.i]).

[18.b] a controller for cooperating with said transceiver for

319. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.b]. *See* Section XII.B ([1.b.ii]).

[18.c] transmitting a plurality of location finding signals to the target wireless communications device,

320. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.c]. *See* Section XII.B ([1.b.iii]).

[18.d] inserting the UID for the target wireless communications device in each of the location finding signals, and

321. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.d]. *See* Section XII.B ([1.b.iv]).

[18.e] receiving a respective reply signal for each of said location finding signals generated by the target wireless communications device based upon the UID in the location finding signals,

322. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.e]. *See* Section XII.B ([1.d.i], [1.c]).

[18.f] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based

**upon a known device latency of the target wireless communications device,
and**

323. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.f]. *See* Section XII.B ([1.d.ii], [1.a.iii]).

[18.g] estimating a range to the target wireless communications device based upon a plurality of determined propagation delays.

324. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [18.g]. *See* Section XII.B ([1.d.iii]).

4. Claim 27

325. Claim 20 is an independent method claim that mirrors the system claim recited in claim 1. The limitations of claim 1 and claim 20 are substantially similar. As such, the limitations of claim 20 are rendered obvious by the Rofheart-Raphaeli-Godfrey combination for the same reasons that I discussed for claim 1 in Section XII.B. Any minor differences in claim language between claim 1 and claim 20 are addressed in the following analysis.

[27.pre] A method for locating a target wireless communications device from among a plurality of wireless communications devices, each wireless communications device having a device type associated therewith from among a plurality of different device types, each WLAN device having a unique identifier (UID) associated therewith, and each device type having a known device latency associated therewith, the method comprising:

326. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [27.pre]. *See* Section XII.B ([1.a.i]-[1.a.iii]).

[27.a] transmitting a plurality of location finding signals to the target wireless communications device, inserting the UID for the target wireless communications device in each of the location finding signals, and

327. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [27.a]. *See* Section XII.B ([1.b.iii]).

[27.b] inserting the UID for the target wireless communications device in each of the location finding signals, and

328. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [27.b]. *See* Section XII.B ([1.b.iv]).

[27.c] receiving a respective reply signal for each of the location finding signals generated by the target wireless communications device based upon the UID in the locations signals;

329. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [27.c]. *See* Section XII.B ([1.d.i], [1.c]).

[27.d] determining a propagation delay associated with the transmission of each location finding signal and the respective reply signal therefor based upon the known device latency of the target wireless communications device; and

330. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [27.pre]. *See* Section XII.B ([1.d.ii]).

[27.e] estimating a range to the target wireless communications device based upon a plurality of determined propagation delays.

331. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [27.pre]. *See* Section XII.B ([1.d.iii]).

C. Claims 2, 19, 28

[2] The wireless communications system of claim 1 wherein said controller estimates the range based upon an average of the propagation delays.

332. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [2]. As I discussed for Claim 1, the Rofheart-Raphaeli-Godfrey combination includes a controller ([1.b.ii], [1.d]) that determines multiple propagation delays ([1.d.ii]), and estimates the range based upon an average of the propagation delays using the equation: $D_{average} = c \times Trt_{average}/2$ ([1.d.iii]) ($Trt_{average}$ is an average of multiple propagation delays and $D_{average}$ is the average distance).

[19] The wireless device locator of claim 18 wherein said controller estimates the range based upon an average of the propagation delays.

333. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [19]. *See* discussion above for [2].

[28] The method of claim 27 wherein the controller estimates the range based upon an average of the propagation delays.

334. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [28]. *See* discussion above for [2].

D. Claims 3, 14, 20, 29

1. Claim 3

[3.a] The wireless communications system of claim 1 wherein said target wireless communications device generates unsolicited signals including the UID thereof;

335. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides the “said target wireless communications device generates unsolicited signals” aspect of [3.a] based on Rofheart’s teachings regarding independent signals as I discussed in Section X.C.

336. Further, it is my opinion that the Rofheart-Raphaeli-Godfrey combination provides the “including the UID thereof” aspect of [3.a]. Like Rofheart’s “reply and/or response,” a POSITA would have understood and expected Rofheart’s “independent signal” (unsolicited signal) would also include a “*unique identifier* associated with the remote device.” APPLE-1009, 20:62-21:5 (“*Each reply message includes a unique identifier associated with the remote device from which the reply is transmitted. The unique identifier may be a device address* stored in ROM 209, ...”); *see also* my discussion for [1.a.ii]. For example, a POSITA would have recognized and expected that even for an independent signal, a remote device still would identify itself through a UID to enable the local device to associate information in the signal with the corresponding remote device.

337. It is also my opinion that it would have been obvious to a POSITA to include a UID in Rofheart’s independent signal such that the local device is able to associate information within the signal to the corresponding remote device. Moreover, it was well-known to include UIDs such as source addresses in signals to identify the source. For example, Rofheart discloses:

Each reply message includes a unique identifier associated with the remote device from which the reply is transmitted. The unique identifier may be a device address stored in ROM 209, for example, or a unique delay time for the remote device as will be described below. Thus, in step 505, each of the remote devices 302 through 300N encodes its unique identifier information and attaches the information to a reply message to be transmitted back to the local device 301. The local device 301 then receives each reply and synchronizes with each remote device that sent a reply as seen in step 507.

APPLE-1009, 20:62-21:5. *See also id.*, 24:36-55; APPLE-1028, [0081] (“The second address field, denoted herein as address field A2, contains the MAC address of the transmitter of the frame...”); APPLE-1029, 20-21. *See also* APPLE-1005, 8:50-53 (“In the data portion of the TOA message, the reference radio identifies the destination master radio *and may also identify itself as the message source.*”), 8:38-46 (“The data portion of the RTS-T message includes a *Destination Address* 28 (16 bits, 64 us) and Other Data (16 bits, 64 us). The *Destination Address field is used to indicate the reference radio to which the master radio is directing the RTS-T message.* ...”); APPLE-1030, 7.1.3.3.5 (entitled “Source Address (SA) field,” describing that “The SA field contains an IEEE MAC individual address that identifies the MAC entity from which the transfer of the MSDU (or fragment thereof) contained in the frame body field was initiated”), 7.2.2 (“Data frames”).

[3.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from said target device; and

338. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [3.b]. As I discuss above, Rofheart discloses a controller ([1.b.ii]) that cooperates with the transceiver ([1.d.i], [1.b.ii]) to receive signals ([1.d.i]) including Rofheart's independent signals (unsolicited signals per [3.a.]). APPLE-1009, 24:36-55 ("the type information may be *received* as part of an *independent signal* sent by the remote device"). A POSITA would have recognized that the above-discussed controller/transceiver is not limited to receiving reply signals from the target device and is also designed to receive other types of signals, including Rofheart's independent signal.

[3.c] wherein said controller determines the UID for said target wireless communications device from the at least one unsolicited signal.

339. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [3.c]. Rofheart discloses that "the type information may be received as part of an *independent signal* sent by the remote device." APPLE-1009, 24:36-55. As I discussed for [3.a]-[3.b], the unsolicited signal includes the UID of the target device. A POSITA would have understood and expected that processing a received signal (*see* [3.b]) containing data fields such as a UID ([3.a]) includes extracting one or more fields from the signal and determining their corresponding values, *e.g.*, a controller ([1.b.ii]) determines the UID based on the corresponding UID data field. APPLE-1009, 20:62-21:5.

340. It is also my opinion that it would have been obvious to a POSITA to determine the UID from the unsolicited signal received (*see* [3.a]-[3.b]) in order to

determine which device sent the signal because it was well-known to do so. APPLE-1009, 20:62-21:13, 24:36-55. Determining the UID can include operations such as decoding, extracting, and/or identifying the UID. In addition to it being well-known to match/filter based on a MAC address, a POSITA would have been motivated to do this so that information in the signal, such as the device type, can be associated with the appropriate device for later use. APPLE-1009, 20:62-21:13, 24:36-55; Section XII.B.1 ([1.c], matching/filtering based on MAC address as described in Godfrey and IEEE 802.11). *See also* Sections XII.E and XII.F.

2. Claim 14

[14.a] The wireless communications system of claim 13 wherein said target WLAN device generates unsolicited signals including the UID thereof;

341. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [14.a]. *See* Section XII.D ([3.a]).

[14.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from said target WLAN device; and

342. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [14.b]. *See* Section XII.D ([3.b]).

[14.c] wherein said controller determines the UID for said target WLAN device from the at least one unsolicited signal.

343. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [14.c]. *See* Section XII.D ([3.c]).

3. Claim 20

[20.a] The wireless device locator of claim 18 wherein the target wireless communications device generates unsolicited signals including the UID thereof;

344. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [20.a]. *See* Section XII.D ([3.a]).

[20.b] wherein said controller cooperates with said transceiver to receive at least one unsolicited signal from the target device; and

345. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [20.b]. *See* Section XII.D ([3.b]).

[20.c] wherein said controller determines the UID for the target wireless communications device from the at least one unsolicited signal.

346. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [20.c]. *See* Section XII.D ([3.c]).

4. Claim 29

[29.a] The method of claim 27 wherein the target wireless communications device generates unsolicited signals including the UID thereof; and further comprising:

347. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [29.a]. *See* Section XII.D ([3.a]).

[29.b] receiving at least one unsolicited signal from the target device; and

348. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [29.b]. *See* Section XII.D ([3.b]).

[29.c] determining the UID for the target wireless communications device from the at least one unsolicited signal.

349. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [29.c]. *See* Section XII.D ([3.c]).

E. Claims 4, 15, 30

[4] The wireless communications system of claim 3 wherein said controller determines the device type of said target wireless communications device based upon the UID thereof.

350. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [4]. *See* Sections X.D ([4]), XII.D.

[15] The wireless communications system of claim 14 wherein said controller determines the device type of said target WLAN device based upon the UID thereof.

351. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [15]. *See* Section X.D ([4]).

[30] The method of claim 29 further comprising determining the device type of the target wireless communications device based upon the UID thereof.

352. It is my opinion that the McCrady-Raphaeli-Rofheart combination provides [30]. *See* Section X.D ([4]).

F. Claims 5, 16

1. Claim 5

[5a] The wireless communications system of claim 4 wherein the UIDs comprise media access control (MAC) addresses of respective wireless communications devices, and

353. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [5a]. As I discussed in Section XII.B.1 ([1.b.iv]), Godfrey describes communications based on a MAC protocol provided by IEEE 802.11 in which a UID in the form of a MAC address within a message frame is used to convey information about the source of a message. APPLE-1028, [0081] (discussing “address field A2, contains the *MAC address of the transmitter [(i.e., source)]* of the frame” and “a frame having the MAC address of the certain wireless station as the *source address*”); APPLE-1029, 20-21. A POSITA would have recognized that *each* device in a network has its own unique source address such that Rofheart’s local device is able to associate information in a received message with the specific device that sent the message.

[5b] wherein said controller determines the device type of said target wireless communications device based upon the MAC address thereof.

354. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [5b]. As I discussed for claim 4, the Rofheart-Raphaeli-Godfrey combination determines the device type of said target wireless communications device based upon the UID thereof, which applies here because a MAC address is a type of UID.

2. Claim 16

[16a] The wireless communications system of claim 15 wherein the UIDs comprise media access control (MAC) addresses of respective WLAN devices, and

355. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [16a]. *See* Section X.B ([5a]).

[16b] wherein said controller determines the device type of said target WLAN device based upon the MAC address thereof.

356. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [16b]. *See* Section X.B ([5b]).

G. Claims 6, 17, 21

1. Claim 6

[6.a] The wireless communications system of claim 1 wherein said at least one antenna comprises a plurality of antennas; and

357. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [6.a]. Rofheart describes:

In other embodiments, *multiple antennas* on the local device 901 may provide the relevant spatial information to resolve the distance. For example, a phased antenna may be used to electronically alter the composite antenna pattern as one way to determine location. Also, the separate antennas may be used in separate location operations such as by performing a switching operation between antennas. Thus, the spatial separation between the antennas is enough to resolve position information, in combination with the known range information. Furthermore, by having multiple antennas that produce a directional antenna pattern, or simply by using a single antenna with a known antenna pattern it possible to resolve the spatial locations of the remote device, although multiple range/location readings may be required by

rotating the device. From these examples it should be clear that any number of methods for obtaining the reference points necessary to obtain positional data on remote devices may be used with a wireless UWB device that determines distance to remote devices in accordance with the present invention.

APPLE-1009, 31:19-38.

[6.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target wireless communications device based upon at least one of the received reply signals.

358. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [6.b]. Rofheart describes, for example:

In other embodiments, *multiple antennas* on the local device 901 may provide the relevant spatial information to resolve the distance. For example, a phased antenna may be used to electronically alter the composite antenna pattern as one way to determine location. Also, the separate antennas may be used in separate location operations such as by performing a switching operation between antennas. Thus, the spatial separation between the antennas is enough *to resolve position information*, in combination with the known range information. Furthermore, by *having multiple antennas that produce a directional antenna pattern*, or simply by using a single antenna with a known antenna pattern *it possible to resolve the spatial locations of the remote device*, although multiple range/location readings may be required by rotating the device. From these examples it should be clear that any number of methods for obtaining the reference points necessary to obtain positional data on remote devices may be used with a wireless UWB device that determines distance to remote devices in accordance with the present invention.

APPLE-1009, 31:19-38.

359. As such, Rofheart discloses the use of directional pattern or known

antenna pattern which makes it possible to resolve the spatial locations of the remote devices based on the directional/antenna pattern which depicts antenna gain variation with respect to incident angle or direction. By using the directional pattern or antenna pattern to resolve the spatial locations, Rofheart discloses a controller that “cooperates with said plurality of antennas to determine a bearing to said target wireless communications device” as claimed.

360. Further, as previously discussed for claim 1, Rofheart uses a received reply signal to estimate the range to a target device. Rofheart’s use of multiple antennas additionally enables a bearing to the target device to be determined. A POSITA would have recognized that Rofheart’s “position information”/“spatial location” provides a *bearing* to the target device. This understanding is further confirmed by Rofheart’s “local device [which] displays a graphical map of the *position of remote devices in relation to the local device.*” APPLE-1009, 31:39-43.

2. Claim 17

[17.a] The wireless communications system of claim 13 wherein said at least one antenna comprises a plurality of antennas; and

361. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [17.a]. Section XII.D ([3.a]).

[17.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to said target WLAN device based upon at least one of the received reply signals.

362. It is my opinion that the Rofheart-Raphaeli-Godfrey combination

provides [17.b]. Section XII.D ([3.b]).

3. Claim 21

[21.a] The wireless device locator of claim 18 wherein said at least one antenna comprises a plurality of antennas; and

363. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [21.a]. Section XII.D ([3.a]).

[21.b] wherein said controller cooperates with said plurality of antennas to determine a bearing to the target wireless communications device based upon at least one of the received reply signals.

364. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [21.b]. Section XII.D ([3.b]).

H. Claims 8, 22

[8] The wireless communications system of claim 1 wherein said at least one antenna comprises at least one directional antenna.

365. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [8]. Rofheart describes, for example:

In other embodiments, *multiple antennas* on the local device 901 may provide the relevant spatial information to resolve the distance. For example, a phased antenna may be used to electronically alter the composite antenna pattern as one way to determine location. Also, the separate antennas may be used in separate location operations such as by performing a switching operation between antennas. Thus, the spatial separation between the antennas is enough *to resolve position information*, in combination with the known range information. Furthermore, by *having multiple antennas that produce a directional antenna pattern, or simply by using a single antenna with a known antenna pattern it [is] possible to resolve the spatial locations of the*

remote device, although multiple range/location readings may be required by rotating the device. From these examples it should be clear that any number of methods for obtaining the reference points necessary to obtain positional data on remote devices may be used with a wireless UWB device that determines distance to remote devices in accordance with the present invention.

APPLE-1009, 31:19-38.

366. It is also my opinion that Raphaeli discloses a directional antenna: “[t]he wide band broadcast interrogation signal may be transmitted in a specific direction, by using for example a *directional antenna*.” APPLE-1006, 8:50-62. As I discussed in Section IX.D, a POSITA would have recognized that directional antennas can be used to transmit and/or receive in specific directions. The known, predictable benefits of transmitting/receiving in specific directions (discussed in Section IX.D) would have prompted a POSITA to utilize a directional antenna in Rofheart’s system. Moreover, Rofheart teaches/suggests a directional antenna: “the spatial separation between the antennas is enough to *resolve position information*, in combination with the known range information” and that “by having *multiple antennas that produce a directional antenna pattern*, ... it [is] possible *to resolve the spatial locations of the remote device*.” APPLE-1009, 31:19-38. APPLE-1009, 31:19-38. This would have also led a POSITA to incorporate Raphaeli’s teaching on a directional antenna.

[22] The wireless device locator of claim 18 wherein said at least one antenna comprises at least one directional antenna.

367. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [22]. *See* discussion above for [8].

I. Claims 9, 23

[9] The wireless communications system of claim 1 wherein said wireless device locator further comprises a portable housing carrying said at least one antenna, said transceiver, and said controller.

368. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [9]. As I discussed for [1.b.i]-[1.b.ii], Rofheart discloses a wireless device locator (e.g., “local device 301”) which includes components, e.g., antenna, transceiver, and controller. Rofheart further describes that the local device “may be a mobile device such as a mobile telephone, a laptop computer or personal digital assistant”:

FIG. 3 discloses a wireless network 300 in which a plurality of wireless devices may exchange information. The wireless network 300 may be WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a *first remote device 302, a second remote device 303 and N number of additional remote devices 300N* via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. Each of the wireless devices 301 through 300N *may be a mobile device such as a mobile telephone, a laptop computer or*

personal digital assistant (PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices.

APPLE-1009, 17:13-22. Rofheart additionally describes:

Revisiting the business card exchange situation discussed above, an example of the embodiment of the present invention shown in FIG. 8 is provided. In this example, the local device 301 of FIG. 3 is assumed to be a local PDA held by a first user, while remote devices 302-300N are assumed to be remote PDAs held by other users within the signal range of the local PDA. Moreover, it is assumed that the local PDA 301 is set with an authentication criteria such that remote PDAs that enter within 1 foot of the local device will be enabled for communications (i.e., the criteria is $D < r$) regardless of the distance thereafter.

APPLE-1009, 26:40-50. A POSITA would have recognized that a portable electronic device, *e.g.*, a mobile telephone, has a housing that carries its components. A POSITA would have further recognized that a housing for a mobile device has to be portable because the device is mobile.

[23] The wireless device locator of claim 12 wherein said wireless device locator further comprises a portable housing carrying said at least one antenna, said transceiver, and said controller.

369. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [23]. *See* discussion above for [9].

J. Claims 10, 24, 32

[10] The wireless communications system of claim 1 wherein said wireless communications devices comprise wireless local area network (WLAN) devices.

370. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [10] through integration of Rofheart's teachings regarding WLAN devices. For example, Rofheart describes an embodiment where its wireless network 300 is a WLAN. Rofheart describes:

FIG. 3 discloses a wireless network 300 in which a plurality of wireless devices may exchange information. *The wireless network 300 may be WPAN, WLAN or some other wireless network* in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a *first remote device 302, a second remote device 303 and N number of additional remote devices 300N* via UWB links 312, 313, and 315N respectively.

APPLE-1009, 17:13-22, Fig. 3. Devices that communicate within a WLAN are consistent with a POSITA's understanding of WLAN devices.

[24] The wireless device locator of claim 18 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

371. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [24]. *See* discussion above for [10].

[32] The method of claim 27 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

372. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [32]. *See* discussion above for [10].

K. Claims 11, 25, 33

[11] The wireless communications system of claim 1 wherein said wireless communications devices comprise mobile ad-hoc network (MANET) devices.

373. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [11] through integration of Rofheart's teachings regarding MANET devices. For example, Rofheart discloses:

The wireless network 300 may be *WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet*. The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. *Each of the wireless devices 301 through 300N may be a mobile device such as a mobile telephone, a laptop computer or personal digital assistant (PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices. It is to be understood that device 301 is referred to as a "local device" and devices 302-400N are referred to as "remote devices" for purposes of description only, and that the present invention is not limited to an infrastructure system having an access point and may be implemented in an ad hoc system wherein any device in the network can act as a master and/or a slave device and no access point is needed.*

APPLE-1009, 17:13-37.

374. A POSITA would have recognized that these point-to-point or point-to-multipoint connections can be formed on an ad-hoc basis by mobile devices such

as PDAs. Rofheart's devices enter and leave the wireless network 300, and accordingly, wireless links are created and dropped. For example, Rofheart describes that "[i]n step 401, the local device 301 establishes a link with each remote device 302 through 300N using a media access control (MAC) protocol." Rofheart further describes that "[i]n step 405, *the local device 301 periodically determines which linked remote devices have exited the network and drops those links.*" APPLE-1009, 19:17-38.

375. Rofheart additionally describes how PDAs establish ad-hoc wireless links. For example, Rofheart describes "the local device 301 of FIG. 3 is assumed to be a local PDA held by a first user, while remote devices 302-300N are assumed to be remote PDAs." 26:40-50. Rofheart further describes that "the local PDA 301 synchronizes and establishes a unique link with each digital camera using a MAC protocol as described in FIG. 5" and that "the local PDA301 will enable communications links 312 and 313 and store the unique identifier associated with remote devices 302 and 303 to the ID list." APPLE-1009, 26:51-27:7.

[25] The wireless device locator of claim 18 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

376. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [25]. *See* discussion above for [11].

[33] The method of claim 27 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

377. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [33]. See discussion above for [11].

L. Claims 12, 26, 34

[12] The wireless communications system of claim 1 wherein said wireless communications devices comprise cellular communications devices.

378. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [12]. As I discussed for [1.a.i]-[1.a.iii], Rofheart discloses wireless communications devices. Rofheart further describes:

FIG. 3 discloses a wireless network 300 in which a plurality of wireless devices may exchange information. The wireless network 300 may be WPAN, WLAN or some other wireless network in which wireless devices make point to point connections, or point to multipoint connections on the shared channel of a piconet. The wireless network 300 includes a local device 301 linked to a first remote device 302, a second remote device 303 and N number of additional remote devices 300N via UWB links 312, 313, and 315N respectively. The UWB links are full duplex communications links that carry data, voice, video, or any other analog or digital information in accordance with the present invention. Each of the wireless devices 301 through 300N may be a mobile device such as a *mobile telephone*, a laptop computer or personal digital assistant (PDA), or a fixed structure device such as a retail store kiosk or some other fixed structure device for delivering information to other wireless devices.

APPLE-1009, 17:13-30. Rofheart also describes: “Moreover, the network link 221 may provide a connection through a PAN 223 to a mobile device 229 such as a personal digital assistant (PDA) laptop computer, or *cellular telephone*.” A POSITA would have recognized that mobile devices such as mobile telephones comprise cellular communications devices, which is

consistent with Rofheart disclosure that a cellular telephone is a type of mobile device.

[26] The wireless device locator of claim 18 wherein the target wireless communications device comprises a cellular communications device.

379. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [26]. *See* discussion above for [12].

[34] The method of claim 27 wherein the target wireless communications device comprises a cellular communications device.

380. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [34]. *See* discussion above for [12].

M. Claim 31

[31] The method of claim 27 further comprising determining a bearing to the target wireless communications device based upon at least one of the received reply signals.

381. It is my opinion that the Rofheart-Raphaeli-Godfrey combination provides [31]. Section XII.G ([6.b]).

XIII. Additional Remarks

382. I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

I hereby declare that all statements made are of my own knowledge, are true and that all statements made on information and belief are believed to be true. I further declare 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 the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this proceeding.

Dated: Nov. 29, 2022

By: _____



Dr. Zhi Ding, Ph.D.
Davis, California

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Ding
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