

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

UNIFIED PATENTS, LLC

Petitioner

v.

SPEIR TECHNOLOGIES LTD.

Patent Owner

IPR2022-00987
U.S. Patent 7,321,777

**DECLARATION OF MICHAEL BRAASCH, PH.D., UNDER 37 C.F.R.
§ 1.68 IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 7,321,777**

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I, Michael Braasch, do hereby declare as follows:

I. INTRODUCTION

1. I have been retained by counsel for Unified Patents Inc. (“Unified” or “Petitioner”) as an independent expert witness for the above-captioned Petition for *Inter Partes* Review (“IPR”) of U.S. Patent No. 7,321,777 (“the ’777 patent”). I am being compensated at my usual and customary rate for the time I spend in connection with this IPR. My compensation is not affected by the outcome of this IPR. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters stated herein.

2. I have been asked to provide my opinions regarding whether claims 1-3 and 5-25 (each a “Challenged Claim” and collectively the “Challenged Claims”) of the ’777 patent are unpatentable as they would have been anticipated by the prior art or obvious to a person having ordinary skill in the art (“POSITA”) as of the earliest claimed priority date of the ’777 patent. It is my opinion that all of the Challenged Claims would have been obvious to a POSITA, after reviewing the prior art discussed below.

3. In preparing this Declaration, I have reviewed:

- a) EX1001, the ’777 patent;
- b) the prior art references discussed below:

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- U.S. Patent Application Publication 2003/0174048 (filed December 13, 2002, published September 18, 2003) (“*McCorkle*” (EX1003));
 - U.S. Patent 7,203,500 (filed August 1, 2003, issued April 10, 2007) (“*Leeper*” (EX1004)); and
 - U.S. Patent 5,381,444 (filed October 30, 1992, issued January 10, 1995) (“*Tajima*” (EX1006));
- c) EX1008, the file history of the ’777 patent; and
- d) any other document cited below.

4. I understand that the ’777 patent issued on January 22, 2008 from U.S. Patent Application No. 11/531,487 (“the ’487 application”), filed on September 13, 2006. I understand that the ’487 application is a continuation of U.S. Application 10/767,794, filed January 29, 2004. The face of the ’777 Patent lists Thomas Jay Billhartz, Vivek Krishna, and Steve Kopman as the purported inventors. I understand that Speir Technologies Ltd. is the current assignee of the ’777 patent.

5. To the best of my knowledge, I have no financial interest in Petitioner. Petitioner’s counsel has informed me that Speir Technologies Ltd. purports to own the ’777 patent. To the best of my knowledge, I have no financial interest in Speir Technologies Ltd. To the best of my knowledge, I similarly have no financial interest in the ’777 patent. To the extent any mutual funds or other investments that I own

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have a financial interest in the Petitioner, Unified Patents, LLC, the Patent Owner, Speir Technologies Ltd., or the '777 patent, I am not aware of, nor do I have control over, any financial interest that would affect or bias my judgment.

6. In forming the opinions expressed in this Declaration, I relied upon my education and experience in the relevant field of art, and have considered the viewpoint of a Person of Ordinary Skill in the Art (POSITA), as of January 29, 2004.

I have also considered:

- a) the documents listed above,
- b) any additional documents and references cited in the analysis below,
- c) the relevant legal standards, including the standards for anticipation and obviousness, and
- d) my knowledge and experience based upon my work in this area as described below.

7. I understand that claims in an IPR are construed according to the same claim construction standard as one would use in a District Court proceeding.

II. BACKGROUND AND QUALIFICATIONS

8. My complete qualifications and professional experience are described in my curriculum vitae, a copy of which is attached as Appendix A to this

declaration. The following is a brief summary of my relevant qualifications and professional experience.

9. I am currently a Professor with tenure in the School of Electrical Engineering and Computer Science at Ohio University.

10. I received my Bachelor of Science and Master of Science degrees in Electrical Engineering from the Ohio University in 1988 and 1989 respectively. In 1992, I received a Ph.D. in Electrical Engineering also from Ohio University. During that time, my post-baccalaureate and doctoral work focused on navigation systems. My M.S. thesis involved the development of a computer simulation of an interrogation-reply ranging system known as the Distance Measuring Equipment (DME).

11. From 1989 to 1993, I was a research engineer in the Avionics Engineering Center at Ohio University. I became an assistant professor in the Department of Electrical and Computer Engineering at Ohio University in 1994 and have been on the faculty at Ohio University since that time. I have held the title of Professor in the School of Electrical Engineering and Computer Science since 2003 and was appointed as the Thomas Professor of Electrical Engineering in 2004. As a professor of Electrical Engineering, I have taught courses in navigation including ranging systems such as DME.

12. I am a Licensed Professional Engineer (P.E.) in the State of Ohio. In my professional career, I have specialized in the areas of electronic navigation receiver design, electronic navigation system engineering, satellite-based navigation systems, inertial navigation systems, and integrated navigation systems.

13. Since the mid 1980s, I have been involved with research related to navigation and transportation systems including navigation system computer modeling and validation; characterization of GPS error sources and development of mitigation strategies; design, development and testing of software-defined GPS receiver architectures; design, development and flight testing of advanced cockpit displays; and analysis of safety-certification issues in unmanned aerial vehicle operations. I have been the recipient of over 65 research grants and contracts, including awards from the U.S. Department of Transportation, Federal Aviation Administration, Air Force Office of Scientific Research and NASA. In 1992 I received the RTCA (formerly known as the Radio Technical Commission for Aeronautics) William E. Jackson Award in recognition of an outstanding aviation electronics publication.

14. I have published over 80 journal articles, book chapters, conference papers, and workshop papers, most of which were related to navigation systems. I have authored or co-authored over 20 academic publications in the areas of graphical display systems, electronic navigation system engineering, satellite-based

navigation systems with emphasis in GPS, and integrated navigation systems. These publications include book chapters in *Global Positioning System: Theory and Applications*, American Institute of Aeronautics and Astronautics, Washington, D.C. (1996). A complete list of my publications is included in my curriculum vitae.

15. I have given numerous presentations at various conferences and universities worldwide on these topics. In particular, I have been invited speak and publish in connection with conference proceedings on the navigation systems at venues around the world. Additional contributions of mine to the field are set forth in my current curriculum vitae.

16. In addition to gaining expertise via my academic training, professional experiences, and research accomplishments described above, I have kept abreast of various sub-disciplines within the field of navigation systems, such as locating technologies, by reading technical literature, attending and presenting at conferences, and attending and presenting at symposia. I have been invited to participate in the peer review process for various technical journals, and conferences, and have reviewed manuscripts submitted by other engineers relating to navigation system technology. Furthermore, I have collaborated with or have communicated with many of the engineers in the field of navigation systems.

17. In summary, I have extensive familiarity with fields involving device locating technologies. I am familiar with what the state of this field was at the relevant time up to the time the '777 patent was filed.¹

III. RELEVANT LEGAL STANDARDS

18. I am not an attorney and offer no legal opinions, but in my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to forming my opinions. My understanding of the law is as follows:

19. I understand that a claim is invalid if it is anticipated or obvious. I understand that anticipation of a claim requires that every element of a claim is disclosed expressly or inherently in a single prior art reference, arranged as in the claim. Petitioner's counsel has informed me that for a claimed limitation to be

¹ I have been informed and understand that the '777 patent was effectively filed on January 29, 2004 because it is a continuation of an application filed on this date. When I refer to the "time the patent was filed" or "time the '777 patent was filed" throughout this Declaration, I am referring to the January 29, 2004 filing date of the '777 patent.

inherently present, the prior art need not expressly disclose the limitation, so long as the claimed limitation necessarily flows from a disclosure in the prior art.

20. Petitioner's counsel has informed me that a patent claim can be considered to have been obvious to a person of ordinary skill in the art at the time the application was filed. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a person of ordinary skill in the art at the time the application was filed.

21. Petitioner's counsel has informed me that a determination of whether a claim would have been obvious should be based upon several factors, including, among others:

- the level of ordinary skill in the art at the time the application was filed;
- the scope and content of the prior art; and
- what differences, if any, existed between the claimed invention and the prior art.

22. Petitioner's counsel has informed me that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a person of ordinary skill in the art.

Alternatively, the teachings of two or more references may be combined in the

same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;
- whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;
- whether a person of ordinary skill would have recognized a reason to combine known elements in the manner described in the claim;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

23. Petitioner's counsel has informed me that one of ordinary skill in the art has ordinary creativity, and is not an automaton. Petitioner's counsel has

informed me that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

IV. THE '777 PATENT

A. Summary and Prosecution History

24. I have reviewed, had input into, and endorse the discussions in the Summary and Prosecution History sections of the Petition (Sections IV.A. and IV.D.), which I hereby incorporate by reference and include in Appendix B below.

B. Background of the Art

25. I have reviewed, had input into, and endorse the discussions in the Background of the Art section of the Petition (Section IV.B.). In addition, I have personal experience related to the background of this technology area as discussed below. As mentioned above, my Master's thesis, published in 1989, dealt with the DME system and thus I gained expertise in the topic of 'two-way ranging' (as will be explained below). In addition, I was formally trained in navigation systems, including DME, through graduate coursework that I completed as part of my M.S. program.

26. The technology of the '777 patent relates to so-called "two-way ranging" that dates back to World War II. EX1010. Specifically, the development of radar led to the need to be able to distinguish enemy aircraft from one's own forces. *Id.*, 10-11, 18-25. One technique to accomplish this task was called

‘identification friend or foe’ (IFF) and continues in use to the present day. *Id.* It involves the transmission of specially coded interrogation signals. *Id.*, 24. A transponder on a friendly aircraft will receive and process the interrogation and then transmit a specially coded reply signal. *Id.* The interrogator concludes the aircraft is friendly if it receives a valid reply. *Id.*

27. Although the technology was originally intended for identification purposes, it soon became apparent that timing circuits could be used to determine the range (distance) from the interrogator to the transponder. After the war, the technology led to the development of secondary surveillance radar (in use throughout the world by air traffic controllers), tactical air navigation systems (abbreviated as TACAN) and the so-called distance measuring equipment (DME). *See e.g.*, EX1010; EX1011 (US 3,302,199); EX1012 (US 3,728,728); EX1013 (US 4,126,859); EX1014 (US 4,677,441). The principle remains the same. A DME interrogator mounted in an aircraft transmits specially coded interrogation signals. EX1010, 22; EX1014, 3:10-14. Fixed-based ground transponders receive the interrogations, and after a processing delay, transmit a reply signal. EX1014, 2:31-4:63. The airborne interrogator measures the elapsed time from its own transmission to the receipt of the ground transponder reply signal. *Id.* The ground transponder processing delay is subtracted from the elapsed time and the result is divided by 2 to determine the one-way time needed for the transmission. *Id.* The

one-way time is then multiplied by the speed of light (i.e., the speed of the radio wave propagation) to determine an estimate of the range. EX1011, 2:17-23. DME technology was developed throughout the 1950s and eventually became an international standard for civil aircraft navigation. EX1010; EX1011; EX1012; EX1013; EX1014.

C. Person of Ordinary Skill in the Art

28. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a person of ordinary skill in the art (“POSITA”) to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art. I understand that one of ordinary skill in the art has ordinary creativity, and is not a robot.

29. It is my opinion that a person of ordinary skill in the art at and before the priority date for the ’777 patent (“POSITA”) would have had a bachelor’s degree in electrical engineering, computer science, computer engineering, physics, or a related subject, and two to three years of work experience in wireless location determination. A lack of experience can be remedied with additional education (e.g., a Master’s degree), and likewise, a lack of education can be remedied with additional work experience (e.g., 5–6 years).

30. Based on my professional experience, I have an understanding of the capabilities of a person of ordinary skill in the relevant field. As mentioned above,

I have 36 years of experience in the research and development of location determination systems including “two-way ranging” systems. Further, as detailed in Section II above, I myself qualified as at least a POSITA at the time the ’777 patent was filed.

31. The analysis set forth herein evaluates anticipation, obviousness, and priority issues consistent with the legal principles provided to me by counsel and through the eyes of one of ordinary skill in the art at the time the ’777 patent was filed.

V. CLAIM CONSTRUCTION

32. It is my understanding that in order to properly evaluate the ’777 patent, the terms of the claims must first be interpreted. It is my understanding that the claims are to be construed according to the same claim construction standard that district courts use. Thus, it is my understanding that claim terms are construed according to their ordinary and customary meaning as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

33. In order to construe the claims, I have reviewed the entirety of the ’777 patent along with portions of the prosecution history of the ’777 patent (EX1008). Consistent with the ’777 patent disclosure, I have given the terms in the Challenged Claims their ordinary and customary meaning, as understood by one of ordinary skill in the art.

34. I reviewed and contributed to the constructions proposed by petitioner in the Petition. The Petition's explanation in Section V as to why these claims should be construed as proposed for this proceeding reflects my understanding of how I use them in this declaration, and I incorporate it herein by reference and include in Appendix B below.

VI. SUMMARY OF OPINIONS²

35. In my opinion, claims 1-3 and 5-25 ("the Challenged Claims") of the '777 patent are unpatentable because they would have been anticipated, or at least obvious, to a POSITA at the time the '777 patent was filed. My opinions are based on my expertise in the technology of the '777 patent at the time the '777 patent was filed, as well as my review of the '777 patent, its file history, and the prior art discussed in the Petition. If the patent owner is allowed to submit additional evidence pertaining to the validity of the '777 patent, I intend to review that as well and update my analysis and conclusions as appropriate and allowed under the rules of this proceeding.

36. I reviewed and contributed to the Petition's explanation as to why these claims are unpatentable. The Petition's explanation in Section VI as to why these

² Unless otherwise specified, all **bold** emphasis below has been added. Text in *italics* is used to signify claim language, while reference names are also *italicized*.

claims are unpatentable reflects my understanding, and I incorporate it herein by reference and include in Appendix B below.

37. The Petition sets forth my reasons for my opinion that the Challenged Claims would have been anticipated or obvious. Below I elaborate on certain points raised in the discussion of the Petition from the perspective of a POSITA at the time of the '777 priority date.

A. Prior Art

38. In my opinion, the systems described in *McCorkle* (as detailed for Grounds 1 and 2), *McCorkle* in view of *Leeper* (as detailed for Ground 3), *McCorkle* in view of *Tajima* (as detailed for Ground 4), and *McCorkle* and *Leeper* in view of *Tajima* (as detailed for Ground 5) had all of the key components and performed all of the same basic functions as the system described in the '777 patent.

1. *McCorkle*

39. An overview of *McCorkle* is provided in the Petition in Section VI.A.1., which I have reviewed, had input into, and adopt herein by reference and include in Appendix B below.

2. *Leeper*

40. An overview of *Leeper* is provided in the Petition in Section VI.A.2., which I have reviewed, had input into, and adopt herein by reference and include in Appendix B below.

3. *Tajima*

41. An overview of *Tajima* is provided in the Petition in Section VI.A.3., which I have reviewed, had input into, and adopt herein by reference and include in Appendix B below.

B. *Device Types*

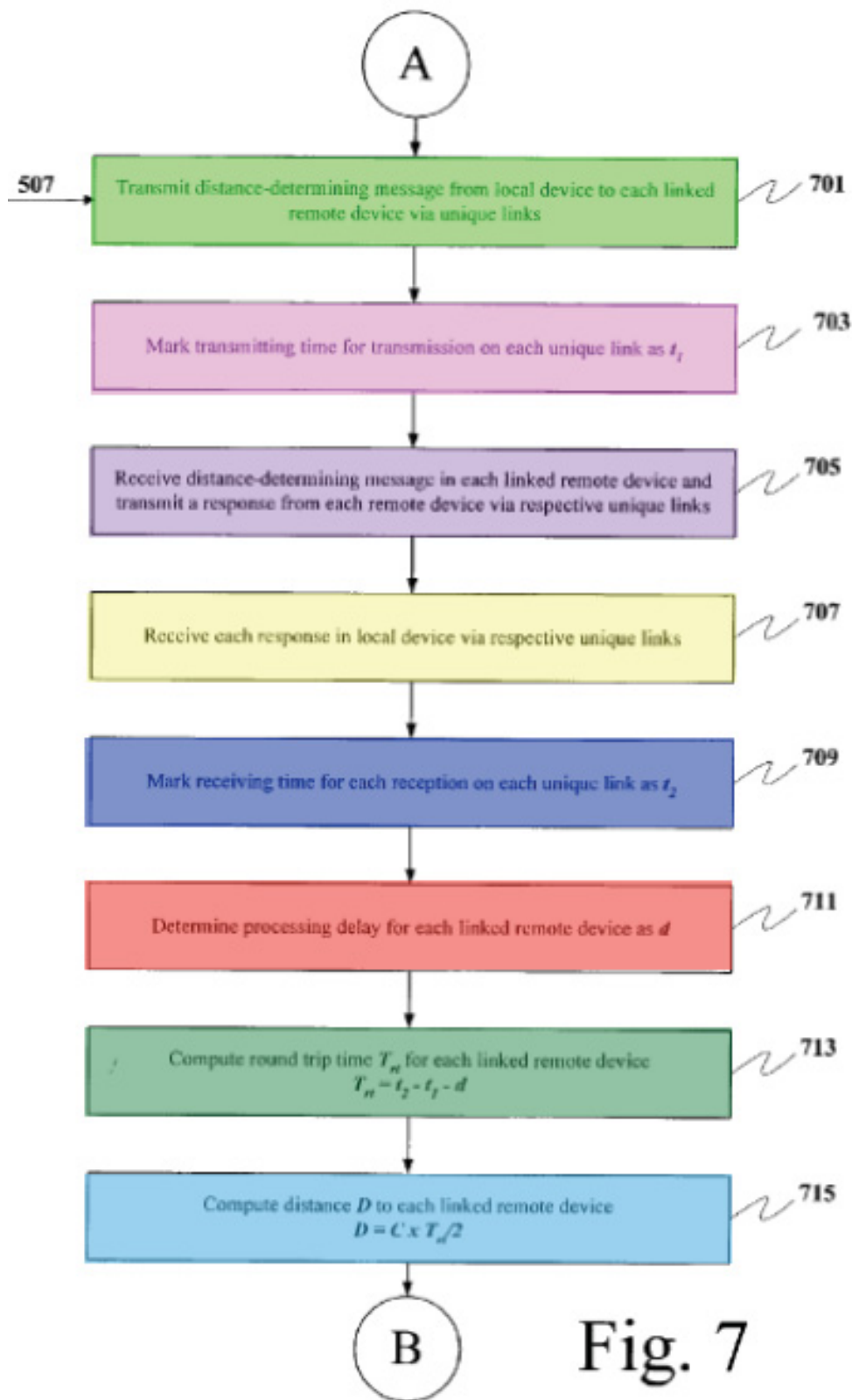
42. *McCorkle* discloses that each remote device 410₁-410_N sends “information about the radio type of the remote device” to local device 405. EX1003, [0124]. Radio types widely used in mobile telephones at the time of the assumed priority date include, for example, CDMA (code division multiple access) and TDMA (time division multiple access)/GSM (global system for mobiles). EX1003, [0103]-[0104] (citing EX1015). A POSITA would understand that CDMA and TDMA are distinctly different technologies even though they are being used for the same ultimate purpose. EX1018. In addition, radio types for laptops and PDAs at the time would have included WiFi (IEEE Standard 802.11b). EX1019; EX1020. As discussed in the ’777 patent, the *device type* may signify the communication standard of the device. EX1001, 5:12-13. This is consistent with my experience that radio type of the device is the key indicator for determining the latency of the device. I have utilized a variety of radio types in my work with communication, navigation, and surveillance systems. This is also consistent with the description in *McCorkle* disclosing that knowing the radio type leads to the “device type [being] known.”

Thus, a POSITA would have understood, or at least found obvious, that the claimed associated *device type* is taught by *McCorkle*'s remote device 410₁-410_N each having an associated radio type (e.g., CDMA devices, TDMA/GSM devices, and/or WiFi devices). EX1003, [0124].

43. This received radio type is used by local device 405 to refer to a look up table (LUT) stored in memory to determine a predefined processing delay associated with that radio type. *Id.* A POSITA would have understood, or at least found obvious, that *McCorkle* describes *a plurality of different device types* because the LUT would include more than one radio type corresponding to, for example, CDMA devices, TDMA/GSM devices, and/or WiFi devices and each radio type having a predefined processing delay. *Id.* For example, a POSITA would have considered cell phones as CDMA devices or TDMA/GSM devices and laptops and PDAs as WiFi devices. EX1003, [0103]-[0104] (citing EX1015); EX1018; EX1019; EX1020. In particular, a POSITA would have understood, or at least found obvious, that a LUT is used where there are multiple radio types to look up. That is, a table would not be needed if each of the remote devices had the same *device type*. For example, in my experience, a typical LUT would include a column of radio types and a corresponding column of processing delays associated with the radio type in the same row.

C. Location Updates

44. *McCorkle* discloses a process for determining the location of remote devices, as shown highlighted in Figure 7 below. EX1003, [0118]-[0128]. The process includes transmitting a distance-determining message from a local device (step 701, highlighted in green); marking a transmitting time for the distance determining message (step 703, highlighted in pink); receiving the distance-determining message at the remote device and transmitting a response to the local device (step 705, highlighted in purple); receiving the response at the local device (step 707, highlighted in yellow); marking the receiving time for each response (step 709, highlighted in dark blue); determining the processing delay of the remote device (step 711, highlighted in red); computing the round trip time (step 713, highlighted in dark green); and computing the distance to the remote device (step 715, highlighted in blue).



45. *McCorkle* discloses that the system continually updates the location of each remote device. EX1003, [0140], [0145], [0152]. To make these continual updates, *McCorkle* discloses that its distance determining process shown in Figure 7 is repeated as loop 507. *Id.*, [0110]-[0111], [0137], [0140], [0166], Figs. 5, 7. A POSITA would have understood, or at least found obvious, that multiple distance-determining messages are sent to each remote device at least so that the location of the remote device can be continually updated, i.e., step 701 is repeated. *Id.* In particular, *McCorkle* describes that “a new distance-determining signal is sent to” the corresponding remote device so that the distance can be updated. *Id.*, [0140]. Similarly, a POSITA would have understood, or at least would have found obvious, that a corresponding response is sent for each distance-determining message that is received, i.e., step 703 is repeated each time step 701 is conducted. *Id.*, [0145], [0152]. That is, each time step 701 is conducted to update the distance, loop 507 is repeated such that each of the other steps are also repeated.

D. *Estimating a Range*

46. Like *McCorkle*, *Leeper* discloses determining a distance or range between two wireless communication devices by sending and receiving signals between the devices and determining a propagation delay of the signals. EX1004, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1. Furthermore, *Leeper* also discloses that

“the process of exchanging messages between the devices may be repeated a number (N) of times and averaged” to reduce errors. *Id.*, 5:34-52.

47. A POSITA would have been motivated to combine the teachings of *McCorkle* with those of *Leeper* with a reasonable expectation of success. First, the references are analogous art to the '777 patent (and each other), as each discloses wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1.

48. Second, combining the teachings of *McCorkle* with *Leeper* would have been no more than the combination of prior art elements according to known methods to yield predictable results. A POSITA reading *McCorkle* would have looked for known ways to make the distance determinations between its wireless devices more accurate. A POSITA would have understood that using *Leeper*'s averaging of multiple calculated propagation delays would have been a beneficial modification to *McCorkle*'s distance-determining system because *Leeper* describes that using the average of multiple calculated propagation delays reduces errors that may occur in the distance calculation. EX1004, 5:34-52. A POSITA would have understood that it would have been beneficial to send multiple distance-determining messages to calculate an averaged distance between the wireless communications

devices based on the averaged propagation delay. This modification allows for an effective way of reducing errors that may occur from a single distance calculation that is inaccurate. Based on my experience, taking averages was a common technique used by engineers to reduce potential errors in measurements. Therefore, a POSITA would have been motivated to implement *Leeper*'s use of averaging with *McCorkle*'s distance-determining system to create a more accurate solution for distance determination between two wireless communications devices.

49. Third, combining the teachings of *McCorkle* with *Leeper* would have been the use of a known technique to improve similar devices in the same way. The devices disclosed in *McCorkle* and *Leeper* are comparable systems. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1. A POSITA would have had a reasonable expectation of success at least because using averages in calculations was well known, and *Leeper* describes the process that would have been beneficial to repeat and average. EX1004, 5:34-52. *Leeper* describes to a POSITA how to implement averaging in a distance-determining system like *McCorkle*'s. Both *McCorkle* and *Leeper* disclose calculating propagation delays of signals sent between electronic devices to determine a distance between those devices. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1.

50. To the extent *Leeper* is interpreted as disclosing averaging the calculated distances instead of the calculated propagation delays that is a difference from the claim, but both in the claim and specification of the '777 patent as well as in *Leeper* the end result is that an average distance is calculated. EX1001, 7:47-65, 11:9-14; EX1003. A POSITA would have understood that both calculations (i.e., (1) calculating multiple distances based on the calculated propagation delays and then averaging the calculated distances and (2) averaging the calculated propagation delays and then calculating the average distance based on the averaged propagation delays) would obtain the same end result (i.e., an average distance). In my experience, using these types of mathematical equations would have been a basic skill of a POSITA. Because there are limited options to try to average in the equation, it would have at least been obvious to try averaging the calculated propagation delays before calculating the distance with a reasonable expectation of success. Here, *Leeper*'s disclosure at least renders obvious averaging the calculated propagation delays because mathematically a POSITA would have recognized that one equation is equivalent to the other and there are a finite number of ways to calculate an average distance.

51. Below are example calculations using both methods that show that the calculated average distance is the same using both methods:

Method 1: Average calculated propagation delays and then calculate average distance

$$\text{Propagation delay 1 (round trip time)} = 2.00 \mu\text{s}$$

$$\text{Propagation delay 2 (round trip time)} = 2.15 \mu\text{s}$$

$$\text{Propagation delay 3 (round trip time)} = 2.20 \mu\text{s}$$

$$\text{Average propagation delay (round trip time)} = 2.12 \mu\text{s}$$

$$\text{Average distance} = 299,792,458 \text{ m/s} \times .00000212 \text{ s} / 2 = 317.28 \text{ m}$$

Method 2: Distance calculated for each propagation delay and then averaged

$$\text{Propagation delay 1 (round trip time)} = 2.00 \mu\text{s}$$

$$\text{Distance 1} = 299,792,458 \text{ m/s} \times .000002 \text{ s} / 2 = 299.79 \text{ m}$$

$$\text{Propagation delay 2 (round trip time)} = 2.15 \mu\text{s}$$

$$\text{Distance 2} = 299,792,458 \text{ m/s} \times .00000215 \text{ s} / 2 = 322.28 \text{ m}$$

$$\text{Propagation delay 3 (round trip time)} = 2.20 \mu\text{s}$$

$$\text{Distance 3} = 299,792,458 \text{ m/s} \times .0000022 \text{ s} / 2 = 329.77 \text{ m}$$

$$\text{Average distance} = 317.28 \text{ m}$$

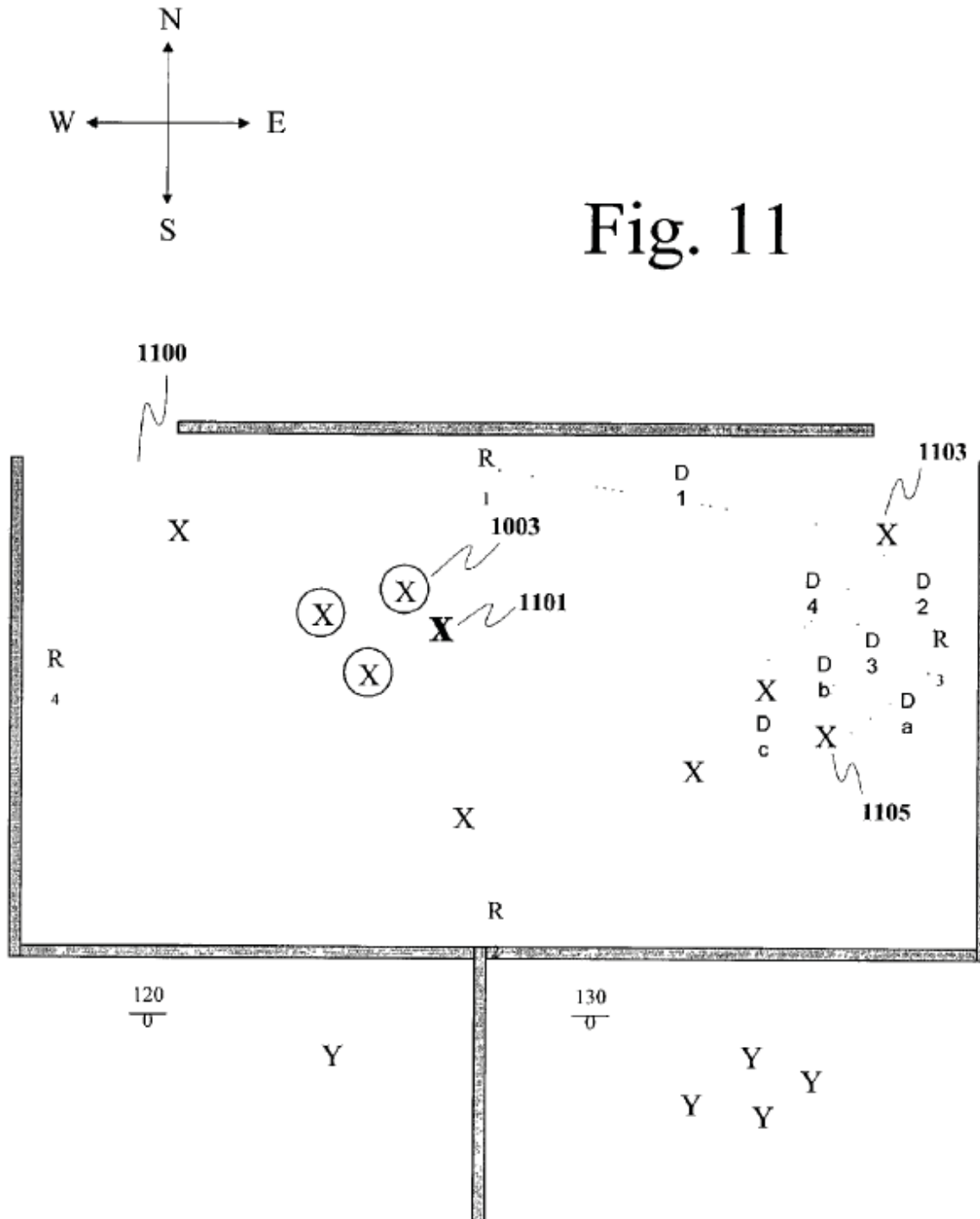
52. Thus, *McCorkle's* system as modified by *Leeper* to include taking an average of multiple propagation delay determinations to estimate the distance renders obvious that the *controller* (e.g., processing unit 301) *estimat[es] a range to the target wireless communications device* (e.g., average distance to remote device

410₁) *based upon a plurality of determined propagation delays* (e.g., multiple determined round trip times T_{rt} from repeated message exchanges between local device 405 and remote device 410₁).

E. *Antennas*

1. *McCorkle*

53. *McCorkle* discloses that antenna 105 may include separate transmitting and receiving antennas (e.g., a plurality of antennas). EX1003, [0045], [0052]. In addition, it would have been obvious to a POSITA that antenna 105 may include multiple antennas for determining a distance and a direction from local device 405 to remote device 410₁. EX1003, [0002], [0153]-[0157], Fig. 11; EX1005, 31:19-47, Fig. 9. *McCorkle* discloses determining both a direction and a distance to remote device 410₁, as shown in Figure 11 below. EX1003, [0002], [0153]-[0157], Fig. 11. Local device 405 corresponds to the X indicating device 1101 and remote devices 410₁ to 410_N correspond to the remaining Xs indicating devices shown in Figure 11. *Id.*, [0153]-[0157], Fig. 11.



54. It would have been obvious for a POSITA to look to related patents to *McCorkle* for determining what type and number of antennas to use for determining

the distance and direction to the remote device. For example, it would have been obvious for a POSITA to look to U.S. Patent 7,058,414 (“*Rofheart*”) which is a parent to *McCorkle* and includes Figure 9 that corresponds to Figure 11 of *McCorkle*. Compare EX1005, Fig. 9 with EX1003, Fig. 11. *Rofheart* is also incorporated by reference into *McCorkle*. EX1003, [0001]. *Rofheart* describes multiple antennas on the local device that may be used to provide the relevant special information and resolve the distance to the remote devices. EX1005, 31:19-47, Fig. 9. For example, *Rofheart* discloses that this may be accomplished by using multiple antennas to receive the reply signal that produce a directional antenna pattern. *Id.* Thus, it would have been obvious to a POSITA to use multiple directional antennas to determine the distance and direction of remote devices from a local device as shown in Figure 11 of *McCorkle*. As evidenced by the disclosure in *Rofheart*, the use of multiple directional antennas for determining distance and direction to a remote object was well-known to a POSITA. Based on my experience, this would have been a simple substitution of known elements to a POSITA.

55. Thus, *McCorkle* renders obvious that said at least one antenna (e.g., antennas 105) comprises a plurality of antennas (e.g., multiple directional antennas).

2. *McCorkle* in View of *Tajima*

56. To the extent Speir argues that *McCorkle* alone does not disclose or render obvious that said at least one antenna comprises a plurality of antennas, it

would have been obvious to modify *McCorkle*'s local device 405 to include a plurality of antennas (including a directional antenna) based on the teachings of *Tajima* to determine the bearing or direction to the remote device.

57. *McCorkle*'s processor unit 301 is connected to a communication interface 313 including the UWB transceiver and antennas 105. EX1003, [0069], [0086], [0101]. Processor unit 301 includes software for performing the processing performed in implementing *McCorkle*'s distance measuring system using UWB transmission. *Id.*, [0080]. *McCorkle* discloses that the local device processes reply signals received from each of the linked remote devices 410₁-410_N using its UWB transceiver and antennas to determine both the distance and direction to each of the linked remote devices 410₁-410_N. *Id.*, [0101], [0126]-[0128], Fig. 11. Like *McCorkle*, *Tajima* discloses determining a distance and direction to a remote wireless device. EX1003, Abstract, 5:5-17, Figs. 1, 3, 4. Furthermore, *Tajima* also discloses that its local device includes both a non-directional antenna and a directional antenna. *Id.*, 5:28-34, 6:35-39, 7:15-38, 10:37-55, Fig. 4. Similarly, the reply signals in *Tajima* are used to determine the distance and direction to the remote device. EX1006, 5:18-34, 7:15-38.

58. A POSITA would have been motivated to combine the teachings of *McCorkle* with those of *Tajima* with a reasonable expectation of success. First, the references are analogous art to the '777 patent (and each other), as each discloses

wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1006, Abstract, 5:5-17, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4.

59. Second, combining the teachings of *McCorkle* with *Tajima* would have been no more than the combination of prior art elements according to known methods to yield predictable results. A POSITA reading *McCorkle* would have looked for known ways to determine the direction that a signal is coming from. A POSITA would have understood that using *Tajima*'s non-directional antenna and directional antenna would have been a beneficial modification to *McCorkle*'s distance-determining system because *Tajima* describes how to use the antennas for determining the direction of the signal in addition to the distance to the remote device. EX1006, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4. A POSITA would have understood that it would have been beneficial to use both a non-directional antenna and a directional antenna for determining the direction to remote device because directional information would be beneficial for a user to have to be able to more accurately locate where the remote device is. And this modification allows for an effective way of determining a direction to the remote device. A POSITA would have been motivated to implement *Tajima*'s use of both a non-

directional antenna and a directional antenna with *McCorkle*'s distance-determining system to determine the direction to the remote device.

60. Third, combining the teachings of *McCorkle* with *Tajima* would have been the use of a known technique to improve similar devices in the same way. The devices disclosed in *McCorkle* and *Tajima* are comparable systems. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1006, Abstract, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4. A POSITA would have had a reasonable expectation of success at least because *McCorkle* discloses that local device 405 may use "any known UWB antenna." EX1003, [0102]. A POSITA would have understood that UWB uses radio signals for transmitting information. EX1003, [0002], [0067]-[0068], [0124]. *Tajima* describes to a POSITA how to implement using radio antennas to determine a distance and direction to a remote device. EX1006, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4. Based on my experience, a POSITA would have been motivated to use the detailed teachings of *Tajima* to improve the antennas of *McCorkle* to accurately determine the distance and direction to the remote device.

61. Thus, *McCorkle*'s system as modified by *Tajima* to include to include a non-directional antenna and a directional antenna renders obvious that said at least one antenna (e.g., antennas 105) comprises a plurality of antennas (e.g., a non-directional antenna and a directional antenna). In addition, a POSITA would have

understood that *McCorkle*'s processor unit 301 would similarly use the reply signals obtained through the non-directional and directional antennas to determine the distance and direction to the remote device.

F. *Portable Housing*

62. *McCorkle* further discloses that local device may be a mobile device such as a mobile telephone, a laptop computer, or a personal digital assistant (PDA) which a POSITA would have understood has a portable housing. EX1003, [0100]; EX1017, Abstract, 7:21-22, Figs. 1, 3. In my experience, by 2004, it was common for mobile telephones, laptop computers, and PDAs to have portable housings. For example, U.S. Patent 7,321,783 describes a "cellphone having a portable housing of a size and weight for being handheld by a person." EX1017, 7:21-22. I had personal experience using handheld telephones, laptop computers, and PDAs by 2004.

G. *Mobile Ad-hoc Network (MANET) Devices*

63. *McCorkle* further discloses that remote devices 410₁-410_N communicate on wireless network 400 which may be a wireless network in which the wireless devices make point-to-point connections or point-to-multipoint connections on the shared channel of a piconet. EX1003, [0098]. A POSITA would have understood that this type of network corresponds to a mobile ad-hoc network (MANET). In a MANET, "the user's mobile devices are the network, and they must cooperatively provide the functionality usually provided by the network

infrastructure (e.g., routers, switches, servers).” EX1007, 5; *see also* EX1016, 2:36-48). The devices may communicate with each other via various well known wireless data transfer protocols. *See, e.g.*, EX1007, Abstract, 8-11; EX1016, 2:40-45. For example, similar to the network disclosed in *McCorkle*, one type of MANET occurs when wireless devices communication with one another via the Bluetooth protocol known as a piconet. EX1007, 10-11; EX1016, 2:45-48. Thus, remote devices 410₁-410_N include *mobile ad-hoc network (MANET) devices*.

VII. AVAILABILITY FOR CROSS-EXAMINATION

64. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

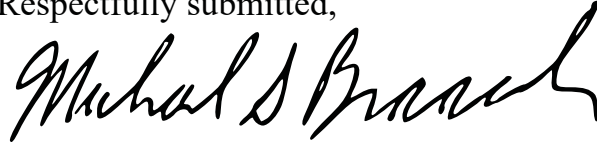
VI. CONCLUSION

65. I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1001.

Declaration of Michael Braasch, Ph.D., Under 37 C.F.R. § 1.68 in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 7,321,777

Date: May 26, 2022

Respectfully submitted,

A handwritten signature in black ink, reading "Michael S. Braasch". The signature is written in a cursive style with a large, stylized "M" and "B".

Michael Braasch, Ph.D.

APPENDIX A

CURRICULUM VITA

Michael S. Braasch

Education:

B.S.E.E., 1988	Ohio University
M.S.E.E., 1989	Ohio University Title of Thesis: <u>Current Developments In Signal Modeling Of The Precision Distance Measuring Equipment.</u>
Ph.D. in E.E., 1992	Ohio University Title of Thesis: <u>On The Characterization Of Multipath Errors In Satellite-Based Precision Approach and Landing Systems.</u>

Professional Registration:

Licensed Professional Engineer (P.E.) in the State of Ohio.

Employment:

Professor, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, September 2003 to present. Appointed as the Neil D. and Bernice E. Thomas Professor of Engineering, September 2004.

Adjunct Professor, Department of EECS, Embry-Riddle Aeronautical University, Daytona Beach, Florida, Fall 2020.

Visiting Erskine Fellow, University of Canterbury, Christchurch, New Zealand, July – November 2017.

Director, Avionics Engineering Center, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, October 2007 to May 2011.

Interim Director, Avionics Engineering Center, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, January 2007 to September 2007.

Associate Professor, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, September 1999 to August 2003.

Assistant Professor, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, January 1994 to August 1999.

Adjunct Assistant Professor, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, July 1993 to December 1993.

Visiting Scientist, Delft University of Technology, Delft, The Netherlands. December 1992 to May 1993.

Research Engineer, Avionics Engineering Center, Ohio University, Athens, Ohio. December 1989 to June 1993.

Graduate Fellow, Avionics Engineering Center, Ohio University, Athens, Ohio. June 1988 to November 1989.

Undergraduate Intern, Avionics Engineering Center, Ohio University, Athens, Ohio, September 1985 to June 1988.

Academic Specialization:

Antenna Theory
Communications and Digital Signal Processing
Electromagnetic Theory

Professional Specialization:

Electronic Navigation Receiver Design
Electronic Navigation System Engineering
Inertial Navigation Systems (INS)
Integrated Navigation Systems
Satellite-Based Navigation Systems with emphasis in GPS
Unmanned Aerial Vehicle (UAV) navigation and safety considerations

Honors:

First runner-up for Best Presentation at the 2nd International Meeting of the Satellite Division of the Institute of Navigation, September 1989.

1992 RTCA William E. Jackson Award (an international award given in recognition of an outstanding publication on aviation electronics).

1997 Ohio University EECS Outstanding Graduate Faculty Award.

1997-98 Ohio University EECS School Research Award.

1997-98 Ohio University Russ Engineering College Outstanding Research Paper Award.

2009 Selected as Fellow of the U.S. Institute of Navigation

2016 Best-of-Session Paper at the Digital Avionics Systems Conference for “Flight-Test Evaluation of Small Form-Factor LiDAR and Radar Sensors for sUAS Detect-and-Avoid Applications,” co-authored with M. Uijt de Haag and C. Bartone.

2019 – present: IEEE Aerospace and Electronic Systems Society Distinguished Lecturer

Professional Memberships:

Member, Institute of Electrical and Electronics Engineers (Senior Member)

Member, Institute of Navigation (Fellow)

Member, Tau Beta Pi

Research Grants and Contracts:

U.S. Department of Transportation (DOT) Volpe National Transportation Systems Center (VNTSC), “DME/P Signal Model Development and Integration with Refined Angle Signal Model,” \$81,000, 1990-92, Principal Investigator: R. Lilley (project was conducted entirely by M. Braasch).

U.S. DOT Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA), “Integrated Avionics Technology Development: Joint University Program in Air Transportation Research,” \$110,000, 1990-91, Principal Investigator: R. Lilley (grant was managed by M. Braasch).

U.S. DOT VNTSC, “Satellite-Based System Precision Approach Issues,” \$264,997, 1991-92, Principal Investigator: F. Van Graas (responsibility for this contract was shared with M. Braasch and T. Skidmore).

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program in Air Transportation Research,” \$75,320, 1991-92, Principal Investigator: R. Lilley (grant was managed by M. Braasch).

U.S. DOT FAA and NASA, “Joint University Program for Air Transportation Research,” \$75,989, 1993-94, Principal Investigator: R. Lilley (grant was managed by M. Braasch).

Boeing Commercial Airplane Company, “D/GPS Signal Model Enhancement and Validation,” \$48,682, 1994-1995, Principal Investigator: M. Braasch.

Mayflower Communications/U.S. Air Force/Wright Lab, “Multipath Mitigation

Investigations to Support Enhanced GPS,” \$35,000, 1995, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program in Air Transportation Research,” \$149,999, 1995-98, Principal Investigator: R. Lilley, co-PI: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, “L1-Band Receivers: Design, Simulation and Implementation,” \$50,000, 1995-1996, Principal Investigator: M. Braasch.

Honeywell, Inc., “Inertial Navigation - GPS/DGPS Studies,” \$15,000, 1995, Principal Investigator: M. Braasch.

Boeing Commercial Airplane Company, “D/GPS Signal Model Enhancement and Validation in Support of GNSS Investigations,” \$99,945, 1996, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, “L1-Band Receivers: Design, Simulation and Implementation,” \$50,000, 1996-1997, Principal Investigator: M. Braasch.

Honeywell, Inc., “Inertial Navigation - GPS/DGPS Studies,” \$80,000, 1996, Principal Investigator: M. Braasch.

Boeing Commercial Airplane Company, “D/GPS Signal Model Enhancement and Validation in Support of GNSS Investigations - Year Two,” \$171,493, 1997, Principal Investigator: M. Braasch.

Honeywell, Inc., “Inertial Navigation - GPS/DGPS Studies,” \$80,000, 1997, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, “L1-Band Receivers: Design, Simulation and Implementation,” \$135,000, 1997-1998, Principal Investigator: M. Braasch, Co-PI: J. Dill.

Megapulse, “Development and Testing of Antenna and Receiver Components Related to Navigation Using Loran-C and GPS,” \$49,000, 1997-1998, Principal Investigator: R. Lilley, co-PI: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$100,000, 1998-99, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Rockwell-Collins, “Multipath Mitigation Studies,” \$50,000, 1998, Principal

Investigator: M. Braasch.

Honeywell, Inc., "Inertial Navigation - GPS/DGPS Studies," \$80,000, 1998, Principal Investigator: M. Braasch.

Boeing Commercial Airplane Group, "GPS Implementation Issues," \$125,255, 1999, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, "L1-Band Receivers: Design, Simulation and Implementation," \$50,000, 1998-1999, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, "Joint University Program for Air Transportation Research," \$107,000, 1999-2000, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Honeywell, Inc., "Inertial Navigation - GPS/DGPS Studies," \$80,000, 1999, Principal Investigator: M. Braasch.

Boeing Commercial Airplane Group, "GPS/INS Integration and VHF Data Broadcast Studies," \$160,000, 2000, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, "L1-Band Receivers: Design, Simulation and Implementation," \$50,000, 1999-2000, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, "Integrated Avionics Technology Development: Joint University Program for Air Transportation Research," \$107,000, 2000-2001, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Honeywell, Inc., "Inertial Navigation - GPS/DGPS Studies," \$40,000, 2000, Principal Investigator: M. Braasch.

SAIC, "AGNS Test Station Architecture Design," \$60,000, 2000-2001, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, "L1-Band Receivers: Design, Simulation and Implementation," \$50,000, 2001, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, "Joint University Program for Air Transportation Research," \$126,666, 2001-2002, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Boeing Commercial Airplane Group, "GPS/INS Integration, VHF Data Broadcast

and Air Traffic Management Studies,” \$160,000, 2001-2002, Principal Investigator: M. Braasch.

Honeywell, Inc., “Inertial Navigation - GPS/DGPS Studies,” \$40,000, 2001, Principal Investigator: M. Braasch, Principal Investigator: M. Braasch.

U.S. DOT FAA, “GPS Interference Mitigation via Exploitation of Software Radio Techniques,” \$198,670, 2001-2002, Principal Investigator: M. Braasch.

Air Force Office of Scientific Research/Wright Lab, “L1-Band Receivers: Design, Simulation and Implementation,” \$50,000, 2002, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$133,666, 2002-2003, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Honeywell, “Inertial Navigation – GPS/DGPS Studies,” \$40,000, 2002-2003, Principal Investigator: M. Braasch.

Honeywell, “GPS Software Radio Support,” \$20,000, 2002-2003, Principal Investigator: M. Braasch.

Honeywell, “GPS Software Radio Support,” \$74,991, 2003-2004, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$133,666, 2003-2004, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Honeywell, “Inertial Navigation – GPS/DGPS Studies,” \$40,000, 2003-2004, Principal Investigator: M. Braasch.

Athena Technologies, Inc., “High Dynamic Flight Testing of Athena Technologies GPS/ADAHRS, \$14,125, 2004, Principal Investigator: M. Braasch.

Honeywell, “Flight Testing of Honeywell (HI) Integrated F-15 GPS/INS Unit,” \$40,661, 2004, Principal Investigator: M. Uijt de Haag, Co-PI: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$133,666, 2004-2005, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Honeywell, “GPS Software Radio Support,” \$75,000, 2004-2005, Principal Investigator: M. Braasch.

Honeywell, “Inertial Navigation – GPS/DGPS Studies,” \$25,000, 2004-2005, Principal Investigator: M. Braasch.

Athena Technologies, Inc., “High Dynamic Flight Testing of Athena Technologies GPS/ADAHRS, \$3,000, 2005, Principal Investigator: M. Braasch.

Honeywell, “The Basic Theory of Dithered versus Non-Dithered Gyros,” \$8,400, 2005-2006, Principal Investigator: M. Braasch.

Honeywell, “Inertial Navigation – GPS/DGPS Studies,” \$25,000, 2005-2006, Principal Investigator: M. Braasch.

U. S. Air Force Office of Scientific Research, “Unmanned Aerial Vehicle Swarming and Formation Flight Navigation via LiDAR/INS,” \$14,976, Principal Investigator: M. Braasch.

U.S. DOT FAA and NASA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$133,666, 2005-2006, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Northrop Grumman, “Precision AIME Program,” \$60,107, 2005-2006, Co-Principal Investigators: M. Braasch and F. van Graas.

Northrop Grumman, “Precision AIME Program,” \$162,842, 2006, Co-Principal Investigators: M. Braasch and F. van Graas.

Northrop Grumman, “Precision AIME Program,” \$95,866, 2006-2007, Co-Principal Investigators: M. Braasch and F. van Graas.

L-3 Communications/Interstate Electronics, “Development of an RF Simulation Capability,” \$77,000, 2006-2007, Principal Investigator: M. Braasch

U.S. DOT FAA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$60,000, 2006-2007, Principal Investigator: J. Rankin, co-PI: M. Braasch.

Rockwell Collins, “Multi-Sensor Integration for Autonomous Vehicle Relative Navigation,” \$80,000, 2007, Principal Investigators: M. Braasch and M. Uijt de Haag.

U.S. DOT FAA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$100,000, 2007-2008, Principal Investigator: M. Braasch.

U.S. DOT FAA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$150,000, 2008-2009, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$129,000, 2009-2010, Principal Investigator: M. Braasch.

Northrop Grumman, “Engineering Support,” \$130,000, 2009-2010, Principal Investigator: M. Braasch

U.S. DOT FAA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$150,000, 2009-2010, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$231,000, 2010-2011, Principal Investigator: M. Braasch.

U.S. DOT FAA, “Integrated Avionics Technology Development: Joint University Program for Air Transportation Research,” \$150,000, 2010-2011, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$245,000, 2011-2012, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$357,000, 2012-2013, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$373,050, 2013-2014, Principal Investigator: M. Braasch.

Kearfott Corporation (Guidance & Navigation Division), “Sensor and System Trade Studies Support,” \$11,549, 2014.

Northrop Grumman, “Scholar-in-Residence Program,” \$323,879, 2015, Principal Investigator: M. Braasch.

Honeywell International, “Inertial Navigation GPS/DGPS Studies,” \$20,000, 2015, Principal Investigators: C. Bartone, M. Braasch, M. Uijt de Haag.

Kearfott Corporation (Guidance & Navigation Division), “Navigation Courses,” \$17,000, 2016, Principal Investigator: M. Braasch.

Northrop Grumman, “Scholar-in-Residence Program,” \$807,766, 2016-2020, Principal Investigator: M. Braasch.

Federal Aviation Administration, "Navigation Programs, RTCA Wide Area Augmentation System Support," \$70,000, 2016-2018, Principal Investigator: M. Braasch

Federal Aviation Administration, "Navigation Programs, Antenna, Navigation, Radar and ILS, Concept Courses," \$751,000, 2017-2018, Principal Investigator: M. DiBenedetto, Co-PIs: S. Odunaiya, M. Braasch (20% responsibility for Braasch)

Honeywell Inc., "Gravity Modeling in Support of RTCA SC-159 WG-2C," \$40,000, 2020-2021, Principal Investigator: M. Braasch

Northrop Grumman, "Scholar-in-Residence Program," \$702,093, 2021-2023, Principal Investigator: M. Braasch.

Supernal, "Supernal Flight Testing," \$223,283, 2022, Co-Principal Investigators: M. Braasch and S. Ugazio.

Publications:

Journal Articles

Braasch, M., "A Signal Model for GPS," Navigation: Journal of The Institute of Navigation, Vol. 37, No. 4, Winter 1990-91.

Van Graas, F. and M. Braasch, "GPS Interferometric Attitude and Heading Determination: Initial Flight Test Results," Navigation: Journal of The Institute of Navigation, Vol. 38, No. 4, Winter 1991-92.

Braasch, M., "Isolation of GPS Multipath and Receiver Tracking Errors," Navigation: Journal of the Institute of Navigation, Vol. 41, No. 4, Winter 1994-95.

Murphy, T., Snow, R. and M. Braasch, "GPS Multipath on Large Commercial Air Transport Airframes," NAVIGATION: Journal of the Institute of Navigation, Vol. 43, No. 4, Winter 1996-97.

Braasch, M., "Autocorrelation Sidelobe Considerations in the Characterization of Multipath Errors," IEEE Transactions on Aerospace and Electronic Systems, Vol. 33, No. 1, January 1997.

McGraw, G. and M. Braasch, "Modeling of Tracking Loop Noise and Dynamics for Efficient Simulation of Spread Spectrum Ranging Systems," IEEE Transactions on Aerospace and Electronic Systems, Vol. 34, No. 3, July 1998.

Braasch, M. and A. J. Van Dierendonck, "GPS Receiver Architectures and Measurements,"

Proceedings of the IEEE, Vol. 87, No. 1, January 1999.

Braasch, M. and M. DiBenedetto, "Spread-Spectrum Ranging Multipath Model Validation," IEEE Transactions on Aerospace and Electronic Systems, Vol., 37, No. 1, January 2001.

Kelly, J., Braasch, M. and M. DiBenedetto, "Characterization of the Effects of High Multipath Phase Rates in GPS," GPS Solutions, Vol. 7, No. 1, 2003, pp. 5 - 15.

Thornberg, D. B., Thornberg, D. S., DiBenedetto, M., Braasch, M., Van Graas, F. and C. Bartone, "The LAAS Integrated Multipath Limiting Antenna (IMLA)," NAVIGATION: Journal of the Institute of Navigation, Vol. 50, No. 2, Summer 2003.

Kalyanaraman, S., Braasch, M. and J. Kelly, "Code Tracking Architecture Influence on GPS Carrier Multipath," IEEE Transactions on Aerospace and Electronic Systems, Vol., 42, No. 2, April 2006, pp. 548 – 561.

Kalyanaraman, S. and M. Braasch, "GPS Adaptive Array Phase Compensation Using a Software Radio Architecture," NAVIGATION: Journal of the Institute of Navigation, Vol. 57, No. 1, Spring 2010.

Refereed Conference Papers

Braasch, M., "Performance Comparison of Multipath Mitigating Receiver Architectures," 2001 IEEE Aerospace Conference, Big Sky, MT, March 2001.

Kelly, J. and M. Braasch, "Validation of Theoretical GPS Multipath Bias Characteristics," 2001 IEEE Aerospace Conference, Big Sky, MT, March 2001.

Cutright, C. and M. Braasch, "GPS and INS Flight Test Instrumentation of a Fully Aerobatic Turbojet Aircraft," 2002 IEEE Aerospace Conference, Big Sky, MT, March 2002.

Burch, D. and M. Braasch, "Multi-View Head-Up Synthetic Vision Display System," 2003 IEEE Aerospace Conference, Big Sky, MT, March 2003.

Chakrabarty, J., Burch, D., Kalyanaraman, S. and M. Braasch, "Multi-View Synthetic Vision Display System for General Aviation," 2004 IEEE Aerospace Conference, Big Sky, MT, March 2004.

Kalyanaraman, S., Braasch, M., Kelly, J. and J. Kacirek, "Influence of GPS Code Tracking on Carrier-Phase Multipath Performance," 2004 IEEE Aerospace Conference, Big Sky, MT, March 2004.

Needham, T. and M. Braasch, "Impact of Gravity Modeling Error on Integrated GNSS/INS Coasting Performance," IEEE/AIAA Digital Avionics Systems Conference, St. Petersburg, FL,

September 2017.

Book Chapters

Braasch, M., "Multipath Effects," Chapter 14 of Global Positioning System: Theory and Applications, Vol. 1, edited by B. Parkinson, J. Spilker, Jr., P. Axelrad and P. Enge, American Institute of Aeronautics and Astronautics, Washington, D.C., 1996.

Van Graas, F. and M. Braasch, "Selective Availability," Chapter 17 of Global Positioning System: Theory and Applications, Vol. 1, edited by B. Parkinson, J. Spilker, Jr., P. Axelrad and P. Enge, American Institute of Aeronautics and Astronautics, Washington, D.C., 1996.

Braasch, M., "Inertial Navigation Systems," Chapter 1 of Aerospace Navigation Systems, edited by A. Nebylov and J. Watson, Wiley, 2016.

Braasch, M., "Multipath," Chapter 15 of Springer Handbook of Global Navigation Satellite Systems, edited by P. Teunissen and O. Montenbruck, Springer International Publishing, Cham, Switzerland, 2017.

Conference Papers

Braasch, M., "A Signal Model For The Global Positioning System," ION GPS '89, Colorado Springs, Colorado, September 1989.

Van Graas, F. and M. Braasch, "GPS Interferometric Attitude and Heading Determination: Initial Flight Test Results," Proceedings of the 47th Annual Meeting of the Institute of Navigation, Williamsburg, VA, June 1991.

Braasch, M. and F. van Graas, "Guidance Accuracy Considerations for Realtime GPS Interferometry," ION GPS-91, Albuquerque, NM, September 1991.

Braasch, M. and F. van Graas, "Mitigation of Multipath in DGPS Ground Reference Stations," Proceedings of the Institute of Navigation National Technical Meeting, San Diego, CA, January 1992.

Braasch, M., "Characterization of GPS Multipath Errors in the Final Approach Environment," Proceedings of ION GPS-92, Albuquerque, NM, September 1992.

Braasch, M., Fink, A. and K. Duffus, "Improved Modeling of GPS Selective Availability," Proceedings of the ION National Technical Meeting, San Francisco, CA, January 20-22, 1993.

Braasch, M., "Isolation of GPS Multipath and Receiver Tracking Errors," Proceedings of the ION National Technical Meeting, San Diego, CA, January 24-26, 1994.

- Braasch, M., "The All-Purpose D/GPS Signal Model," Proceedings of the ION National Technical Meeting, San Diego, CA, January 24-26, 1994.
- Braasch, M., "Optimum Antenna Design for DGPS Ground Reference Stations," Proceedings of ION GPS-94, Salt Lake City, UT, September 1994.
- McGraw, G. and M. Braasch, "GPS Receiver Tracking Loop Modeling to Support Autoland Simulations," Proceedings of the ION National Technical Meeting, Santa Monica, CA, January 22-24, 1996.
- Braasch, M., "GPS Multipath Model Validation," Proceedings of the IEEE Position, Location and Navigation Symposium, PLANS '96, Atlanta, GA, April 22-25, 1996.
- Akos, D. and M. Braasch, "A Software Radio Approach to Global Navigation Satellite System Receiver Design," Proceedings of the ION Annual Meeting, Cambridge, MA, June 19-21, 1996.
- Braasch, M., and W. Huang, "GNSS and the L System: Truly Global Partners," Proceedings of the ION Annual Meeting, Cambridge, MA, June 19-21, 1996.
- Akos, D. and M. Braasch, "Global Navigation Satellite System Software Radio Receiver Implementation," Proceedings of the ION GPS-96, Kansas City, MO, September 17-20, 1996.
- Hill, S. and M. Braasch, "Achieving CAT IIIB Through UHF Augmentation," Proceedings of the ION GPS-96, Kansas City, MO, September 17-20, 1996.
- Huang, W. and M. Braasch, "GNSS and the New Loran: Global Partners for the Next Century," Proceedings of the International Loran Association Technical Symposium, San Diego, CA, November 3-7, 1996.
- Van Dierendonck, A. and M. Braasch, "Evaluation of GNSS Receiver Correlation Processing Techniques for Multipath and Noise Mitigation," Proceedings of the Institute of Navigation National Technical Meeting, Santa Monica, CA, January 14-16, 1997.
- Braasch, M., Akos, D., Caschera, J., Stockmaster, M. and J. Tsui, "Test Results from a Direct L-Band Digitizing GPS/Glonass Receiver," Proceedings of the Institute of Navigation National Technical Meeting, Santa Monica, CA, January 14-16, 1997.
- Braasch, M., Snyder, C. and R. Olin, "Ranging Accuracy Considerations in GPS Interference Suppression," Proceedings of the Tenth International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GPS-97), Kansas City, MO, September 16-19, 1997.
- Braasch, M., Snyder, C. and R. Olin, "GNSS Interference Suppression," Proceedings of the Ninth World Congress of the International Association of Institutes of Navigation, Amsterdam, The Netherlands, November 18-21, 1997.

- Rosen, M. and M. Braasch, "Low-cost GPS Interference Mitigation Using Single Aperture Cancellation Techniques," Proceedings of the Institute of Navigation National Technical Meeting, Long Beach, CA, January 21-23, 1998.
- Kanekal, S. and M. Braasch, "Multipath Mitigation with Gated Signal Technique," Proceedings of the ION Annual Meeting, Denver, CO, June, 1998.
- Seitz, A. and M. Braasch, "High Fidelity GPS Receiver Simulation," Proceedings of the ION Annual Meeting, Denver, CO, June, 1998.
- McGraw, G. and M. Braasch, "GNSS Multipath Mitigation Using Gated and High Resolution Correlator Concepts," Proceedings of the Institute of Navigation National Technical Meeting, San Diego, CA, January 25-27, 1999.
- Kelly, J. and M. Braasch, "Mitigation of GPS Multipath via Exploitation of Signal Dynamics," Proceedings of the Institute of Navigation Annual Meeting, Cambridge, MA, June 28-30, 1999.
- Kelly, J. and M. Braasch, "Validation of GPS Fading Multipath Effects through Modeling and Simulation," Proceedings of the Institute of Navigation National Technical Meeting, Anaheim, CA, January 26-28, 2000.
- Braasch, M., DiBenedetto, M., Braasch, S. and R. Thomas, "LAAS Operations in Support of Airport Surface Movement, Guidance, Control, and Surveillance: Initial Test Results," Proceedings of the IEEE Position, Location and Navigation Symposium (PLANS 2000), San Diego, CA, March 2000.
- Dubinsky, J., Braasch, M. and Uijt de Haag, M., "Advanced Flight Display for General Aviation Aircraft: A Cost-Effective Means to Enhance Safety," Proceedings of the Institute of Navigation Annual Meeting, Albuquerque, NM, June 2001.
- Burns, C., Cutright, C. and M. Braasch, "Investigation of GPS Software Radio Performance in Combating Narrow Band Interference," Proceedings of the Institute of Navigation Annual Meeting, Albuquerque, NM, June 2002.
- Thornberg, D. B., Thornberg, D. S., DiBenedetto, M., Braasch, M., Van Graas, F. and C. Bartone, "The LAAS Integrated Multipath Limiting Antenna (IMLA)," Proceedings of the Fifteenth International Meeting of the Satellite Division of the Institute of Navigation (ION GPS-2002), Portland, OR, September 2002.
- Burch, D. and M. Braasch, "Enhanced Head-Up Display for General Aviation Aircraft," Proceedings of the Digital Avionics System Conference, Irvine, CA, October 2002.
- Cutright, C., Burns, J. and M. Braasch, "Characterization of Narrow-Band Interference Mitigation Performance Versus Quantization Error in Software Radios," Proceedings of the

Institute of Navigation Annual Meeting, Albuquerque, NM, June 2003.

Kalyanaraman, S. and M. Braasch, "GPS Carrier-Phase Multipath Model Validation," Proceedings of the Institute of Navigation Annual Meeting, Albuquerque, NM, June 2003.

B. Schipper, M. Braasch, J. Campbell and S. Nair, "A testbed for frequency domain GPS acquisition and receiver simulation," 2004 IEEE Position, Location and Navigation Symposium (PLANS), Monterey, CA, April 2004.

Kalyanaraman, S. and M. Braasch, "Fading Multipath Reduction via FLL-aided Code Tracking in GPS," Proceedings of the Institute of Navigation Annual Meeting, Dayton, OH, June 2004.

Braasch, M. and F. van Graas, "Avionics Education and Research at Ohio University," Proceedings of the Institute of Navigation Annual Meeting, Dayton, OH, June 2004.

Kephart, J., Cutright, C. and M. Braasch, "Precise Positioning and Attitude Determination in High Dynamic Flight Testing," 2005 American Astronautical Society Guidance and Control Conference, Breckenridge, CO, February 2005.

Braasch, M. and M. Uijt de Haag, "GNSS for LEO, GEO, HEO and Beyond," 2006 American Astronautical Society Guidance and Control Conference, Breckenridge, CO, February 2006.

Kalyanaraman, S. and M. Braasch, "Phase Compensation in GPS Array Processing Using a Software Radio," ION/IEEE PLANS 2006, San Diego, CA, April 2006.

Poonawalla, B., Pandya, S., Kephart, J. and M. Braasch, "Flight Test Evaluation of Synthetic and Peripheral Vision Displays for General Aviation," 25th AIAA/IEEE Digital Avionics Systems Conference, Portland, OR, October 2006.

Kalyanaraman, S. and M. Braasch, "Tight Integration of a GPS Adaptive Array with a Software-Defined Receiver," Proceedings of the 2007 ION National Technical Meeting, San Diego, CA, January 2007.

Vydhyathan, A., Braasch, M. and M. Uijt de Haag, "Multi-Sensor Integration for Autonomous Vehicle Relative Navigation," Proceedings of the Twentieth International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS-2007), Fort Worth, TX, September 25-28, 2007.

Poonawalla, B. and M. Braasch, "Human Factors Studies Evaluating Synthetic and Peripheral Vision Displays in General Aviation," 26th AIAA/IEEE Digital Avionics Systems Conference, Dallas, TX, October 2007.

Kephart, R. and M. Braasch, "Comparison of See-and-Avoid Performance in Manned and Remotely Piloted Aircraft," 27th AIAA/IEEE Digital Avionics Systems Conference, St. Paul, MN, October 2008.

Simon, J. and M. Braasch, "Deriving Sensible Requirements for UAV Sense-and-Avoid Systems," 28th AIAA/IEEE Digital Avionics Systems Conference, Orlando, FL, October 2009.

Vydhyathan, A., Luinge, H., Uijt de Haag, M., Braasch, M., "Integrating GPS/MEMS-based-IMU with single GPS baseline for improved heading performance," Proceedings of the 2012 IEEE Aerospace Conference, Big Sky, MT, March 2012.

Uijt de Haag, M., Bartone, C., Braasch, M., "Flight-Test Evaluation of Small Form-Factor LiDAR and Radar Sensors for sUAS Detect-and-Avoid Applications," IEEE/AIAA Digital Avionics Systems Conference, Sacramento, CA, September 2016.

Needham, T. and M. Braasch, "Gravity Model Error Considerations for High-Integrity GNSS-aided INS Operations," 2018 IEEE/ION Position, Location and Navigation Symposium (PLANS), Monterey, CA, April 2018.

Needham, T. and M. Braasch, "Stochastic Modeling of Gravity Compensation Error in GNSS-aided Inertial Navigation Systems," 2020 IEEE/ION Position, Location and Navigation Symposium (PLANS), Portland, Oregon, April 2020.

Datta, N., Braasch, M., Bruner, C. P., Esfandi, N., Moelich, M., Murphy, L. and G. T. Varty, "Closing the Loop on Model-Based Design: The Baro-Inertial Vertical Channel as a Case Study," ION Joint Navigation Conference, Covington, KY, August 2021.

Technical Memoranda

Braasch, M. and E. Mauer, "Preparations For MLS Azimuth Critical Areas Flight Evaluation Using The MLS Computer Model," Technical Memorandum OU/AEC 27-87TM86:1088.001/2-2, Avionics Engineering Center, Ohio University, November 1987.

Braasch, M., "Microwave Landing System (MLS) Flight Testing For The Purpose Of Validating The MLS Mathematical Model Establishing Azimuth Critical Area Criteria," Precis Number 81, Avionics Engineering Center, Ohio University, July 1988.

DiBenedetto, M. and M. Braasch, "MLS Azimuth and Elevation Volumes of Protection To Be Used In Conjunction With Operational And Obstacle Clearance Requirements In Refining MLS Critical Area Definitions," Technical Memorandum OU/AEC 65-88-TM-00006/9-3/ICAO, Avionics Engineering Center, Ohio University, August 1988.

Braasch, M. and M. DiBenedetto, "Areas Of Protection Derived For An Offset Azimuth Antenna Which Supports A Computed Centerline Approach," Technical Memorandum OU/AEC 90-88TM-00006/9B-1/ICAO, Avionics Engineering Center, Ohio University, August 1988.

DiBenedetto, M. and M. Braasch, "Validation Results Obtained to Date on MLS Critical and

Sensitive Areas," Technical Memorandum OU/AEC 91-88TM-00006/TTD-9B/ICAO, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, August 1988.

DiBenedetto, M. and M. Braasch, "Analysis Of Simulation Data And Flight Data Collected At Standiford Field, Louisville, Kentucky, To Investigate The Effects Of An Interfering Boeing B-747 On The MLS Azimuth and Elevation Signals," Technical Memorandum OU/AEC 97-88TM-00006/9C-1, Avionics Engineering Center, Ohio University, October 1988.

Braasch, M., "Independent Confirmation Of DME/P Signal Modeling Techniques," Technical Memorandum OU/AEC 19-89TM-00006/TTD-25/ICAO, Avionics Engineering Center, Ohio University, May 1989.

Braasch, M., "A DME/P Signal Model Concept," International Civil Aviation Organization, All Weather Operations Panel Working Group A, Working Paper 202, Amsterdam, The Netherlands, November 1989.

Braasch, M., "Current Developments in Signal Modeling of the Precision Distance Measuring Equipment," Technical Memorandum OU/AEC 3-90TM00006/25-FR, Masters Thesis, Avionics Engineering Center, Ohio University, Athens, Ohio, December 1989.

Braasch, M., "MLS Signal Model Refinements," Technical Memorandum OU/AEC 36-90TM00006/39-3/ICAO, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, March 1990.

Braasch, M., "Considerations for Collision Risk Modeling to Support MLS Advanced Procedures," Technical Memorandum OU/AEC 34-90TM00006/39-1/ICAO, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, July 1990.

Braasch, M., "MLS Signal Model Documentation," Technical Memorandum OU/AEC 91-6TM00006/39-4/ICAO, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, February 1991.

Braasch, M. and C. Flynn III, "Light-Lane Structures and MLS Siting Criteria," Technical Memorandum OU/AEC 91-35TM-00006/37-1/ICAO, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, May 1991.

Braasch, M., "DME/P Signal Model Development and Integration with the MLS Signal Model," Technical Memorandum OU/AEC 92-60TM00006/39-FR, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, October 1992.

Van Graas, F., Braasch, M. and T. Skidmore, "Satellite-Based System Precision Approaches," OU/AEC EER 92-4, Avionics Engineering Center, Department of Electrical and Computer

Engineering, Ohio University, Athens, Ohio, October 1992.

Braasch, M., "Manual on the Use of the MLS Signal Model," Technical Memorandum OU/AEC 92-70TM3400/CTA-4, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, November 1992.

Flynn III, C., Braasch, M. and M. DiBenedetto, "DME/P Model: Final Report on IF-filter Development, Implementation, Testing and Documentation," Technical Memorandum OU/AEC 92-83TM3400/CTA-6, Avionics Engineering Center, Department of Electrical and Computer Engineering, Ohio University, Athens, Ohio, January 1993.

Braasch, M. and M. DiBenedetto, "Multipath Mitigation Investigations to Support Enhanced GPS for Combat Systems," OU/AEC EER 96-03, Avionics Engineering Center, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, September 1996.

Kalyanaraman, S. and M. Braasch, "GPS Multipath Mitigation Studies," Technical Memorandum OU/AEC 98-18TM-Rockwell-Collins, Avionics Engineering Center, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, August 1998.

Braasch, M., "Characteristics and Benefits of the GPS Software Radio," Technical Memorandum OU/AEC 03-06TM-B09380044, Avionics Engineering Center, School of Electrical Engineering and Computer Science, Ohio University, Athens, Ohio, July 2003.

Invited Presentations:

"Aircraft Navigation Using GPS and LORAN-C," Tri-State Helicopter Seminar, sponsored by the Federal Aviation Administration, Cincinnati Flight Standards District Office, April 1992.

"Characterization of GPS Multipath Errors in the Final Approach Environment," FALLCON '92 (IEEE Cedar Rapids, Iowa section conference), November 1992.

"GPS Operations," Ohio Avionics Seminar, sponsored by the Federal Aviation Administration, Cincinnati and Columbus Flight Standards District Offices, March 1996.

Two lectures: "Requirements on GNSS for Civil Navigation," and "Signals Integrity," NATO-sponsored lecture series, Moscow State Aviation Institute, Moscow, RUSSIA, March 1997.

Two lectures: "Requirements on GNSS for Civil Navigation," and "Signals Integrity," NATO-sponsored lecture series, Kiev International University of Civil Aviation, Kiev, UKRAINE, March 1997.

Two lectures: "Requirements on GNSS for Civil Navigation," and "Signals Integrity," NATO-sponsored lecture series, Istanbul, TURKEY, March 1998.

“GPS Multipath,” Department of Geomatics Engineering, University of Calgary (Alberta), CANADA, July 1998.

Four lectures: “Requirements on GNSS for Civil Navigation,” “Signals Integrity,” “GNSS Augmentation for High Precision Navigation Services,” and “Attitude Determination,” NATO-sponsored lecture series, Samara State Aerospace University, Samara, RUSSIA, December 1998.

“Airborne Multipath,” presented in the Aircraft Applications session of the International Workshop on Aerospace Applications of the Global Positioning System, sponsored by IFAC, ESA, OU, ION and AAS, Breckenridge, CO, Jan. 31 - Feb. 2, 2000.

“GPS Multipath,” GPS Hot Topics Workshop, Institute of Mathematics and Its Applications, Minneapolis, MN, August 2000.

“Enhanced Flight Test Capability,” Institute of Navigation, Dayton Section Luncheon, Dayton, OH, September 2000.

“Flight Test Instrumentation Package for the L-29 Delfin Turbojet,” Institute of Navigation, Dayton Section Luncheon, Dayton, OH, May 2002.

“Fundamentals of the Global Positioning System (GPS),” Environmental Modeling and Simulation conference, organized by the International Association of Science and Technology for Development (IASTED), St. Thomas, U.S.V.I., November 2004.

“UAV Swarming and Formation Flight Navigation via LiDAR/INS,” with Mikel Miller, WPAFB, presented at the 2006 Joint Navigation Conference, Las Vegas, NV, May 2006.

“Navigation: A Look at the Past, Discussion of the Present & Glimpse at the Future,” presented at the Naval Research Laboratory, Washington, DC, September 2007.

“Iron Stomachs and White Knuckles: Navigation Flight Testing at the Ohio University Avionics Engineering Center,” presented to the Alberta Section of the Institute of Navigation, held at the University of Calgary, Calgary, CANADA, February 6, 2009.

“Iron Stomachs and White Knuckles: Navigation Flight Testing at the Ohio University Avionics Engineering Center,” presented to the Southern California Section of the Institute of Navigation, held at Navcom, Torrance, CA, August 30, 2011.

“GPS Multipath and Inertial Sensor Considerations for Targeting in the Dismounted Soldier Environment,” presented to the Joint Precision Targeting Working Group, U.S. Army Night Vision and Electronic Sensors Directorate, Ft. Belvoir, VA, November 5, 2015.

“GNSS Multipath: Effects on Tracking and Mitigation Techniques,” “GNSS Receiver Processing,” and “Evolutions of GPS,” International GNSS Seminar 2016 on BeiDou/GNSS Technologies and Applications, Beijing, CHINA, May 2016.

“Introduction to Kalman Filtering” and “Inertial Navigation,” International Seminars on Positioning and Navigation, Toulouse, FRANCE, May 2017.

“Fundamentals of Inertial Navigation Systems,” All Ohio Engineering Conference, Ohio Society of Professional Engineers, Columbus, OH, June 17, 2017.

“Global Positioning System,” All Ohio Engineering Conference, Ohio Society of Professional Engineers, Columbus, OH, June 17, 2017.

“System-Level Considerations in Inertial Sensor Performance,” IEEE Inertial Sensors & Systems Symposium, Lake Como, ITALY, March 2018.

“Fundamentals of Inertial Navigation Systems and Aiding,” IEEE/ION Position, Location and Navigation Symposium (PLANS), Monterey, CA, April 2018.

“Inertial Navigation: Free and Aided,” IEEE Inertial Sensors & Systems Symposium, Naples, FL, April 2019.

“Iron Stomachs and White Knuckles: Navigation Flight Testing at the Ohio University Avionics Engineering Center,” presented to the Aviation Museum of Kentucky, Lexington, KY, May 11, 2019.

“Inertial Sensor Technology for Autonomous Navigation,” webinar hosted by Inside GNSS, November 20, 2019.

“Inertial Navigation Systems and Aiding,” MAE Seminar / IEEE AESS Distinguished Lecture, Department of Mechanical and Aerospace Engineering, University of California – Irvine, January 31, 2020.

“Inertial+, the Once and Future Navigation System,” Smead Aerospace Engineering Sciences Researchpalooza / IEEE AESS Distinguished Lecture, University of Colorado – Boulder, February 7, 2020.

“Fundamentals of Inertial Navigation,” Virtual Distinguished Lecture, Baltimore IEEE AESS Chapter, June 3, 2020.

“Inertial+, the Once and Future Navigation System,” IEEE AESS Virtual Distinguished Lecture, December 10, 2020.

“Inertial+, the Once and Future Navigation System,” U.K. Institution of Mechanical Engineers Virtual Lecture, March 23, 2021.

“Characterization and Mitigation of Multipath in GNSS,” IEEE AESS Virtual Distinguished Lecture, October 26, 2021.

Academic Service:

M.S. Advisees

AnnMarie Fink, Thesis: "Investigation of the Selective Availability in the NAVSTAR Global Positioning System," November 1994.

Lap Ho, Thesis: "High Precision Short-Baseline Pointing System Using GPS Interferometry," March 1995.

Chi-Li Soong, Thesis: "Fast Time Domain-Based GPS Acquisition," March 1996.

Steven Hill, Thesis: "DGPS/ILS Integration for an Automatic Landing System Using Kalman Filtering," June 1996.

J. Jeffrey Haubeil, Thesis: "Operational Viability of a Directive Distance Measuring Equipment (DME) Antenna in a National Airspace System (NAS) Approach and Landing Environment," August 1996.

Wen-Jye Huang, Thesis: "Investigation of the Benefits of Multi-Chain Loran-C and Hybrid GPS/Loran-C Positioning," March 1997.

Sunil Bhanot, Thesis: "Implementation and Optimization of a GNSS Receiver," August 1998.

Sunil Kanekal, Thesis: "Spread Spectrum Multipath Mitigation Studies," defended: August 1998.

Chin-Yuan Cheng, "Numerical Electromagnetic Modeling of a Small Aperture Helical-Fed Reflector Antenna," M.S.E.E., 1998

Hao Ding, "Facility Separation Criteria Development and Enhancement for Directive Distance Measuring Equipment in the National Airspace System," M.S.E.E., November 1998.

Mahesh Surathu, "Investigating Global Positioning System Helibowl Antenna Performance Sensitivity with Variation in Design Parameters," M.S.E.E., June 1999.

Sai Kalyanaraman, "A Comparative Study of Advanced Multipath Mitigating Global Positioning System Receiver Architectures," M.S.E.E., August 1999.

Andrew C. Seitz, "A High Fidelity Global Positioning System Receiver Simulation," M.S.E.E., March 2000.

Sridhar Ramaswamy, "An Investigation of Integrated Global Positioning System and Inertial

Navigation System Fault Detection,” M.S.E.E., June 2000.

Azhar H. R. Osmanbhoy, “High Dynamic Simulations for Global Positioning System Receivers,” M.S.E.E., August 2000.

Joseph Kelly, “Investigation of GPS Fading Multipath Bias Characteristics,” M.S.E.E., June 2001.

Joseph Dubinsky, “Advanced Flight Display for General Aviation Aircraft,” M.S.E.E., August 2002.

Jason Burns, “Effects of Quantization Error on the Global Positioning System Software Receiver Interference Mitigation,” M.S.E.E., November 2002.

Douglas Burch, “Implementation and Evaluation of a General Aviation Synthetic Vision Display System,” M.S.E.E., March 2004.

Jahnavi Chakrabarty, “Development, Implementation and Flight Testing of Peripheral Vision Displays for General Aviation,” M.S.E.E., March 2005.

Behlul Poonawalla, “Applications to Synthetic and Peripheral Vision Display Systems for Manned and Unmanned Air Vehicles,” M.S.E.E., November 2007.

Ryan Kephart, “Comparison of See-and-Avoid Performance in Manned and Remotely Piloted Aircraft,” M.S.E.E., November 2008.

Jerry Simon, “A Systems Approach to the Formation of Unmanned Air Vehicle Detect, Sense and Avoid Performance Requirements,” M.S.E.E., November 2009.

Nikhil Gandhi, “ADS-B Enabled, Wake Vortex Mitigation Using Cockpit Display,” M.S.E.E., December 2012.

Mark Phillips, “Antenna Baseline Measurement System (ABMS) – Realizing a Real-Time Kinematic GPS Algorithm in the Physical World,” M.S.E.E., April 2015.

Yuanyan Chen, “Autonomous Unmanned Ground Vehicle (UGV) Follower Design,” M.S.E.E., August 2016 (co-advised with J. Zhu).

Ph.D. Advisees

Dennis M. Akos, “A Software Radio Approach to Global Navigation Satellite System Receiver Design,” Ph.D., August 1997.

Fan Liu, “Analysis of Integrity Monitoring for Local Area Augmentation Systems Using the

Global Navigation Satellite System,” Ph.D., August 1998.

Sai Kalyanaraman: “High Accuracy Phase Tracking Using Software Adaptive Arrays,” Ph.D., August 2009.

Courses Taught (note: 3-digit courses were taught under quarters; 4-digit courses were taught under semesters)

EE 101 (Introduction to Electrical Engineering): Fall 1999, Fall 2000, Fall 2001

EE 232 (Advanced Engineering Mathematics): Fall 1995

EE 310 (Linear Systems, Part 1 of 2): Winter 1994, Winter 1995

EE 312 (Linear Systems, Part 2 of 2): Winter 1996, Winter 1997, Spring 1998, Spring 1999

EE 3223 (Electromagnetics, Part 2 of 2): Spring 2016

EE 395C (Comm and Emag Lecture/Lab Course): Co-taught with Chris Bartone: Spring 2005, Fall 2006

EE 478 (Digital Signal Processing): Fall 2003

EE 490 (Advanced Linear Systems and Introduction to Digital Signal Processing): Winter 2002

EE 495 (Senior Capstone Design): Served as a senior project supervisor during 2000-2001, 2001-2002, 2002-2003, 2003-2004, 2004-2005 and 2006-2007

EE 495A, B, C (Senior Capstone Design): Co-taught with Angie Bukley: 2004-2005, 2006-2007

EE 495C: Spring 2004

EE 4953/4963 (Senior Capstone Design): Served as a project supervisor 2018-2019

EE 5003 (Computational Tools for Engineers): Fall 2013, Spring 2014, Fall 2014, Fall 2015

EE 5853 (Electronic Navigation Systems): Fall 2016, Fall 2018, Fall 2019, Fall 2020 (also during Fall 2020 this course was taught online at Embry-Riddle Aeronautical University as EE 525)

EE 603 (Inertial Navigation Systems I): Winter 1998, Winter 2000, Winter 2002, Winter 2004, Fall 2005, Summer 2007, Winter 2011, Fall 2011

EE 604 (Inertial Navigation Systems II): Spring 2000, Spring 2002, Spring 2004, Winter 2006,

Fall 2007

EE 6033 (Inertial Navigation Systems): Fall 2012, Fall 2013, Spring 2015, Spring 2017, Summer 2018, Fall 2018, Spring 2019, Fall 2019, Fall 2020

EE 605 (Satellite-Based Navigation Systems): Spring 1994, Fall 1995, Fall 1996, Fall 1998, Fall 2002, Winter 2012

EE 6053 (Satellite-Based Navigation Systems): Spring 2013, Spring 2014

EE 606 (Integrated Navigation Systems): Fall 1994, Spring 1996, Winter 1999, Summer 2000; Winter 2008

EE 6063 (Integrated Navigation Systems): Summer 2013, Summer 2014, Summer 2016, Summer 2017, Summer 2018, Summer 2019, Summer 2020, Summer 2021

EE 607 (Navigation Receiver Design): Spring 1995, Spring 1997, Winter 2001, Summer 2002, Spring 2005

EE 612 (GPS Multipath): Spring 2001

EE 690 (Propagation Anomalies in Spread-Spectrum Ranging): Fall 1997

EE 690 (GPS/INS Integration): Fall 2000, Fall 2004

EE 690 (GPS Receiver Design II): Spring 2003

EE 690 (GPS Receiver Signal Processing): Summer 2004

EE 6900 (Attitude and Heading Reference Systems): Spring 2019

EE 790 (GPS Software Receivers): Fall 2003

ENEL 320 (Signals and Communications): Semester II (2017), University of Canterbury

University Committees

Twice elected to the Faculty Senate (serving June 2000 through June 2005); member of the Professional Relations committee (2000 – 2003); member of the Promotion & Tenure committee (2003 – 2005)

Member of the University Council for Research, Scholarship and Creative Activity (Fall 2000 – Spring 2003; Fall 2012 – Spring 2018)

College Committees

Member of the Cooperative Education Committee (Fall 1994 – Spring 1998)

Member of the Robe Leadership Institute Advisory Board (1998 – 2005)

Member of the P&T Committee (2006 – 2015; 2021 - present); Chair: 2008 - 2015

School Committees

Ad Hoc 395A,B,C implementation committee: 2001-2002

Annual Review and Raise Allocation Advisory committee: 2003-2005

Assessment committee: 1997 – 2003

Board of Visitors Implementation committee: 2000-2001

EE Design courses committee (chair): 2003-2005

EE Senior Focus Ad Hoc committee (chair): 2003-2004

Foundations course committee (chair): Fall 2000 – Fall 2004

Graduate committee: 1999 – 2002; 2018 - present

Introductory course committee (interim chair): Jan. 2002 – Dec. 2002

Library committee: 1998 – 2002

P&T committee (elected): Fall 2000 – Spring 2005; Fall 2020 – Spring 2021

P&T committee Chair: Fall 2006 – 2015; 2021 - present

Research committee (chair): 2001 – 2003

Professional Service:

WGA Symposium, October 1993, Session Chairman, "Loran-C and GNSS Interoperability."

Institute of Navigation National Technical Meeting, January 1994, Session Chairman, "Precision Aircraft Positioning and Landing Applications."

Position Location and Navigation Symposium, PLANS '94, April 1994, Session co-chairman, "GPS and Ground-Based NavAids."

Referee for NAVIGATION: Journal of the Institute of Navigation: 1994-present.

Judge for student session paper competition: Institute of Navigation ION GPS-95.

Referee for IEEE Transactions on Aerospace and Electronic Systems: 1995-2005.

Session Chairman: Institute of Navigation ION GPS-96.

Session Chairman: International Loran Association Technical Symposium, November 1996.

Elected 1997-98 Central Region Member-at-Large for the Institute of Navigation.

Session Chairman: Institute of Navigation ION GPS-97.

Technical Program Co-Chair: 54th Annual Meeting of the Institute of Navigation, June 1998.

Elected 1998-99 Central Region Vice President for the Institute of Navigation.

RTCA Special Committee 159 (GPS Standards): 1994-2001, 2015-present.

General Chair: 55th Annual Meeting of the Institute of Navigation, June 1999.

Appointed Finance Chair of the Institute of Navigation, 1999-2004.

Referee for the AIAA Journal of Guidance, Control and Dynamics, 2000.

Referee for GPS Solutions, 1999-present.

Session Chairman: Institute of Navigation ION GPS-2001, ION GPS-2002, ION GNSS-2004, ION GNSS-2011, ION GNSS-2012, ION GNSS-2021

Associate Editor (Navigation) for the IEEE Transactions on Aerospace and Electronic Systems: 2006 – 2009.

Technical Editor (Navigation) for the IEEE Transactions on Aerospace and Electronic Systems: 2010 – 2011.

IEEE Aerospace and Electronic Systems Society liaison to the Position, Location and Navigation Symposium (PLANS) organizing committee: 2014 – present.

Associate Editor (Navigation) for the IEEE Aerospace and Electronic Systems Magazine: 2015 –

2019.

Elected to the IEEE Aerospace and Electronic Systems Society (AESS) Board of Governors, 2017-2022. Elected Vice President – Conferences, 2019-2021. Elected Vice President – Technical Operations, 2022.

Founding Chair of the IEEE AESS Navigation Systems Panel, 2017 – present.

Associate Editor, NAVIGATION: Journal of the Institute of Navigation: 2020-present.

Consulting:

GE/Harris Railway Electronics: 1995.

GPSof LLC, 1996-present.

This work has involved software development and short-course teaching. The software developed consists of the GPSof SatNav Toolbox, INS Toolbox and Navigation System Integration and Kalman Filtering Toolbox for MATLAB. Separately, on-site short-courses in GPS, INS and navigation system integration have been taught at companies such as ITT and Honeywell.

Honeywell: 1995-96.

ITT Industries, Advanced Engineering Services division: 2000.

LinCom: 1996.

Nanyang Enc, 2005 – 2016.

Short courses provided in Singapore on a variety of topics including GPS, INS, integration and unmanned aerial vehicle technology.

NavtechGPS Seminars: 1994-2003; 2010-2016.

Tracking and Imaging Systems, Inc., 2005-2006.

Mining support equipment manufacturer (name withheld by request): 2013-2014 (the consultation involves improving the accuracy of GPS receivers used to survey the location of boreholes).

United Launch Alliance, 2018 – 2020.

Expert Witness Service:

Type of Matter: U.S. ITC, Investigation Number 337-TA-596
Client: Broadcom
Law Firm: WilmerHale
Case Name: In the Matter of Certain GPS Chips, Associated Software and Systems,
and Products Containing Same
Services provided: Expert witness. Expert reports, deposition, testimony at the
hearing
Date: 2007 – 2008 (initial determination in favor of Broadcom)

Type of Matter: U.S. ITC, Investigation Number 337-TA-602
Client: Broadcom
Law Firm: WilmerHale
Case Name: In the Matter of Certain GPS Devices and Products Containing Same
Services provided: Expert witness. Expert reports, deposition, testimony at the
hearing
Date: 2007 – 2011 (initial determination in favor of Broadcom)

Type of Matter: U.S. ITC, Investigation Number 337-TA-657
Client: Honeywell
Law Firm: Robins, Kaplan, Miller & Ciresi
Case Name: In the Matter of Certain Automotive Multimedia Display and Navigation
Systems, Components Thereof, and Products Containing Same
Services provided: Expert witness. Expert reports, deposition, testimony at the hearing
Date: 2009 (initial determination against Honeywell)

Type of Matter: California Central District Court, Intellectual Property - Patent
Client: Broadcom
Law Firm: McAndrews, Held & Malloy; Keker & Van Nest; WilmerHale;
Case Name: Broadcom Corporation v. SiRF Technology, Inc.
Services provided: Expert witness. Expert reports, deposition.
Date: 2008 – 2011 (matter settled)

Type of Matter: Patent Re-examinations
Client: Broadcom
Law Firm: Sterne, Kessler, Goldstein & Fox
Case Name: N/A
Services provided: Expert declarations.
Date: 2010

Type of Matter: U.S. ITC, Investigation Number 337-TA-783
Client: Honeywell
Law Firm: Robins, Kaplan, Miller & Ciresi
Case Name: In the Matter of Certain Navigation Products, Components Thereof, And

Related Software

Services provided: Consulting expert. Expert report.

Date: 2011 – 2012 (matter settled)

Type of Matter: Delaware District Court, Intellectual Property – Patent - Civil Action
No. 10-258-SLR

Client: Apple, Inc.

Law Firm: O'Melveny & Myers

Case Name: MobileMedia Ideas LLC v. Apple, Inc.

Services provided: Expert witness. Expert report, deposition.

Date: 2011 – 2012; 2015 - 2018

Type of Matter: District Court, Intellectual Property – Misappropriation of Trade Secrets

Client: Name withheld by request

Industry: GPS chip manufacturing

General Technology involved: Assisted GPS

Services provided: Expert consulting.

Date: 2010 - 2012

Type of Matter: Eastern District of Michigan, Intellectual Property - Patent

Client: Garmin International, Inc.

Industry: Aviation electronics

General Technology involved: Aviation navigation systems

Services provided: Expert consulting. Expert report, deposition.

Date: 2011 - 2014

Type of Matter: District Court, Intellectual Property - Patent

Client: Name withheld by request

Industry: Automotive electronics

General Technology involved: Original equipment manufacturing of automotive
navigation systems

Services provided: Expert consulting.

Date: 2011 – 2012 (matter settled)

Type of Matter: Re-examination of U.S. Pat. No. 7,149,625

Client: TeleNav, Inc.

Industry: Navigation systems

General Technology involved: Navigation using distributed networked architecture

Services provided: Expert declarations.

Date: 2010 - 2012

Type of Matter: District Court (E.D. Texas), Intellectual Property - Patent

Client: Name withheld by request

Industry: Navigation systems

General Technology involved: Automotive navigation systems

Services provided: Expert consulting. Expert report.
Date: 2011 – 2012 (matter settled)

Type of Matter: District Court (E.D. Texas), Intellectual Property – Patent - Case No. 6:11-cv-00096-LED

Client: AT&T, Cellco, MetroPCS
Industry: Navigation systems
General Technology involved: Wireless location determination techniques
Services provided: Expert consulting. Expert reports, deposition.
Date: 2011 – 2013 (matter settled)

Type of Matter: Re-examination of U.S. Patent No. RE41,983
Client: Google
Industry: Geographic positioning systems
General Technology involved: Organizing and compressing spatial data
Services provided: Expert declarations.
Date: 2012

Type of Matter: USPTO – Inter Partes Review – Case IPR2013-00191
Client: Google Inc. and Apple Inc.
General Technology involved: graphical displays
Services provided: Expert declaration, depositions
Date: March 2013 – January 2014

Type of Matter: District Court (C.D. California), Intellectual Property – Patent – Case No. 11-CV-05210-DDP

Client: AT&T Mobility
General Technology involved: Location reporting systems.
Services provided: Expert consulting, expert report, deposition.
Date: 2012 - 2015

Type of Matter: USPTO – Inter Partes Review – Case IPR2015-00224
Client: Factual, Inc.
General Technology involved: graphical displays
Services provided: Expert declaration, deposition
Date: October 2014 – July 2015

Type of Matter: USPTO – Inter Partes Review – Case IPR2015-00849 and Case IPR2015-00851

Client: Apple Inc., Google Inc. and the Samsung entities
General Technology involved: handheld GPS mapping devices
Services provided: Expert declarations, deposition
Date: February 2015 – May 2016

Type of Matter: USPTO – Inter Partes Review – Case IPR2016-01535, IPR2016-01536

and IPR2016-01537

Client: Google Inc.

General Technology involved: Vehicle route guidance systems

Services provided: Expert declarations and depositions.

Date: June 2016 – March 2018

Type of Matter: USPTO – Inter Partes Review – Case IPR2017-00946

Client: Flir Systems Inc.

General Technology involved: Marine navigation systems

Services provided: Expert declarations and depositions.

Date: December 2016 – March 2018

Type of Matter: District Court (E.D. Texas), Case No. 5:16-cv-00178-RWS and Case No. 5:16-cv-00179-RWS

Client: Maxell, Ltd.

General Technology involved: Mobile device location determination techniques

Services provided: Expert declarations, reports, depositions, testimony at trial.

Date: 2017 - 2019

Type of Matter: District Court (Delaware), C.A. No. 16-706-LPS-CJB

Client: SZ DJI TECHNOLOGY CO., LTD. and DJI EUROPE B.V.

General Technology involved: Drone design

Services provided: Expert declaration, reports, deposition.

Date: April 2017 – August 2021

APPENDIX B

REPRODUCED SECTIONS OF PETITION

IV. U.S. PATENT 7,321,777

A. Summary

The '777 patent is directed to a system and method of using a wireless device locator to location a remote wireless device. EX1001, Abstract. According to a described embodiment, wireless communications system 30 includes a wireless location device (blue) and wireless communications devices 34-36 (orange), as shown in annotated Figure 1 below. *Id.*, 4:56-62, Fig. 1.

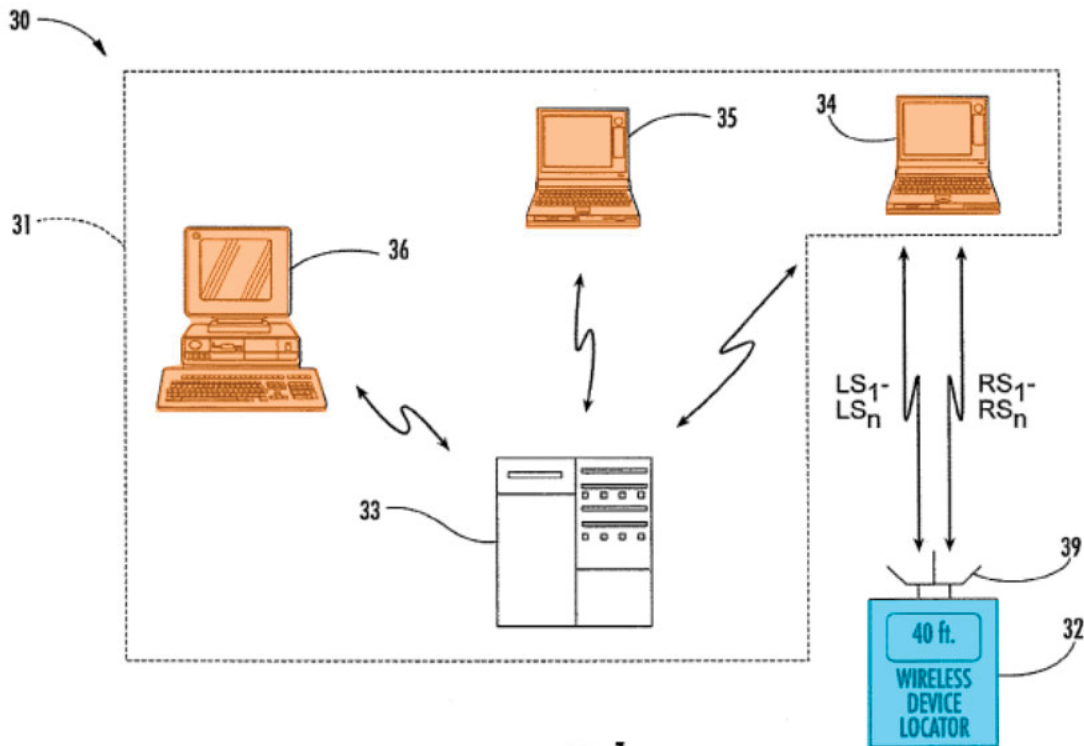


FIG. 1

Wireless device locator 32 includes an antenna 39, transceiver 41 and controller 42. *Id.*, 5:28-30. Controller 42 cooperates with transceiver 41 to send a

plurality of location finding signals to a target wireless communications device (e.g., one of devices 34-36). *Id.*, 5:42-48. Controller 42 further cooperates with transceiver 41 to receive a reply signal from the target device via antenna 39. *Id.*, 6:36-38.

Controller 42 determines the propagation delay associated with the transmission of each location finding signal and respective reply. *Id.*, 6:42-59. To determine the propagation delay, controller 42 must consider the device latency of the target device. *Id.*, 6:50-67. The device latency is the time it takes the target device to receive, process, and transmit the reply signal in response to the location finding signal. *Id.*, 6:65-67. Controller 42 has access to a known device latency of the target device based on its device type which provides a close approximation of the actual device latency. *Id.*, 7:13-20. Controller 42 also knows the transmission time t_1 of the location finding signal and the reception time t_4 of the reply to the location finding signal. *Id.*, 6:50-7:12, Fig. 3. Controller 42 calculates the total propagation time by subtracting the known device latency from the time between times t_1 and t_4 . *Id.*, 7:21-30.

To determine the range from wireless device locator 32 to the target device, the total propagation delay is divided by two to find the one-way propagation delay from wireless device locator 32 to the target device because both the propagation delays to and from the target device may be considered equal or substantially equal for a stationary or a slow moving target device. *Id.*, 7:30-33. The one-way

propagation delay is then multiplied by the speed of light to give an estimated distance to the target device. *Id.*, 7:33-36. To improve the accuracy of the estimated distance to the target device and mitigate the effects of variations in the actual device latency time, controller may estimate the range based on an average of multiple calculated propagation delays between wireless device locator 32 and the target device. *Id.*, 7:47-65.

Such systems for locating a remote wireless device were well known before the '777 patent, as evidenced by the prior art in this Petition and the Braasch Declaration. *See also*, EX1002, ¶¶35-63 (citing EX1003-EX1007; EX1010-EX1020).

B. Background of the Art

The technology of the '777 patent relates to so-called “two-way ranging” that dates back to World War II. EX1010. Specifically, the development of radar led to the need to be able to distinguish enemy aircraft from one’s own forces. *Id.*, 10-11, 18-25. One technique to accomplish this task was called ‘identification friend or foe’ (IFF) and continues in use to the present day. *Id.* It involves the transmission of specially coded interrogation signals. *Id.*, 24. A transponder on a friendly aircraft will receive and process the interrogation and then transmit a specially coded reply signal. *Id.* The interrogator concludes the aircraft is friendly if it receives a valid reply. *Id.*

Although the technology was originally intended for identification purposes, it soon became apparent that timing circuits could be used to determine the range (distance) from the interrogator to the transponder. After the war, the technology led to the development of secondary surveillance radar (in use throughout the world by air traffic controllers), tactical air navigation systems (abbreviated as TACAN) and the so-called distance measuring equipment (DME). *See e.g.*, EX1010; EX1011 (US 3,302,199); EX1012 (US 3,728,728); EX1013 (US 4,126,859); EX1014 (US 4,677,441). The principle remains the same. A DME interrogator mounted in an aircraft transmits specially coded interrogation signals. EX1010, 22; EX1014, 3:10-14. Fixed-based ground transponders receive the interrogations, and after a processing delay, transmit a reply signal. EX1014, 2:31-4:63. The airborne interrogator measures the elapsed time from its own transmission to the receipt of the ground transponder reply signal. *Id.* The ground transponder processing delay is subtracted from the elapsed time and the result is divided by 2 to determine the one-way time needed for the transmission. *Id.* The one-way time is then multiplied by the speed of light (i.e., the speed of the radio wave propagation) to determine an estimate of the range. EX1011, 2:17-23. DME technology was developed throughout the 1950s and eventually became an international standard for civil aircraft navigation. EX1010; EX1011; EX1012; EX1013; EX1014.

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art at and before the priority date for the '777 patent ("POSITA") would have had a bachelor's degree in electrical engineering, computer science, computer engineering, physics, or a related subject, and two to three years of work experience in wireless location determination. A lack of experience can be remedied with additional education (e.g., a Master's degree), and likewise, a lack of education can be remedied with additional work experience (e.g., 5–6 years). EX1002, ¶¶28-31.

D. Prosecution History

The '777 patent issued from U.S. Application 11/531,487. After one Office Action, the claims were allowed. *See generally* EX1008. The Office Action rejected the pending claims on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-24 of U.S. Patent 7,110,779 (the '779 patent) (parent of the '777 patent), provisionally rejected the pending claims on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-25 of U.S. Application 11/058,931 (the '931 application) and rejected the pending claims under 35 U.S.C. § 103 as being obvious over combinations of U.S. Published Application 2004/0266348 ("*Deshpande*"), U.S. Published Application 2003/0191604 ("*Kuwahara*"), and U.S. Published Application 2003/0117320 ("*Kim*"). *Id.*, 103-107. The applicant filed a terminal disclaimer over the '779 patent

and argued that the prior art references used in the Office Action do not disclose “determining a propagation delay associated with the transmission of a location finding signal and a respective reply signal based upon a known device latency of a target wireless communications device” because, for example, *Kuwahara* “merely looks at the time of transmission from a transmitting device and the time of reception at a receiving device” and “simply does not take into account any device latency of the transmitting terminal.” *Id.*, 88-91. The applicant and the examiner conducted an interview, and the claims were allowed. *Id.*, 18-28. The examiner provided no indication regarding which elements rendered the claims allowable. *Id.*, 23-24.

V. CLAIM CONSTRUCTION

Claim terms are construed according to their ordinary and customary meaning as understood by a POSITA in light of the intrinsic record 37 C.F.R. §42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). Petitioner submits that all claim terms should be given their plain and ordinary meaning.

VI. CLAIMS 1-3 AND 5-25 ARE UNPATENTABLE¹

A. Grounds 1-5: Claims 1, 6-9, 12, 16-20, and 23-25 are anticipated by *McCorkle*, claims 1, 3, 5-9, 12, 14-20, and 22-25 are obvious over *McCorkle*, claims 1-3 and 5-25 are obvious over *McCorkle* in view of *Leeper*, claims 3, 5, 14, 15, and 22 are obvious over *McCorkle* in view of *Tajima*, and claims 3, 5, 11, 14, 15, and 22 are obvious over *McCorkle* and *Leeper* in further view of *Tajima*

1. *McCorkle*

Like the '777 patent, *McCorkle* is directed to a system for determining a location of a remote wireless device. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7. The reference is analogous art to the '777 patent, as each discloses wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1002, ¶¶47, 58. *McCorkle* discloses a wireless network 400, such as a wireless local area network (WLAN) or other wireless network, in which a plurality of wireless devices communicate over. EX1003, [0098]. These wireless devices are shown in annotated Figure 4 below and include a local device 405 (blue) and multiple remote devices 410₁ through 410_N (orange). Each device also includes an ultra-wide band (UWB) transceiver having at least one antenna 105 for transmitting

¹ Unless otherwise specified, all **bold** emphasis below has been added. Text in *italics* is used to signify claim language, while reference names are also *italicized*.

and receiving UWB signal 420. *Id.*, [0101].

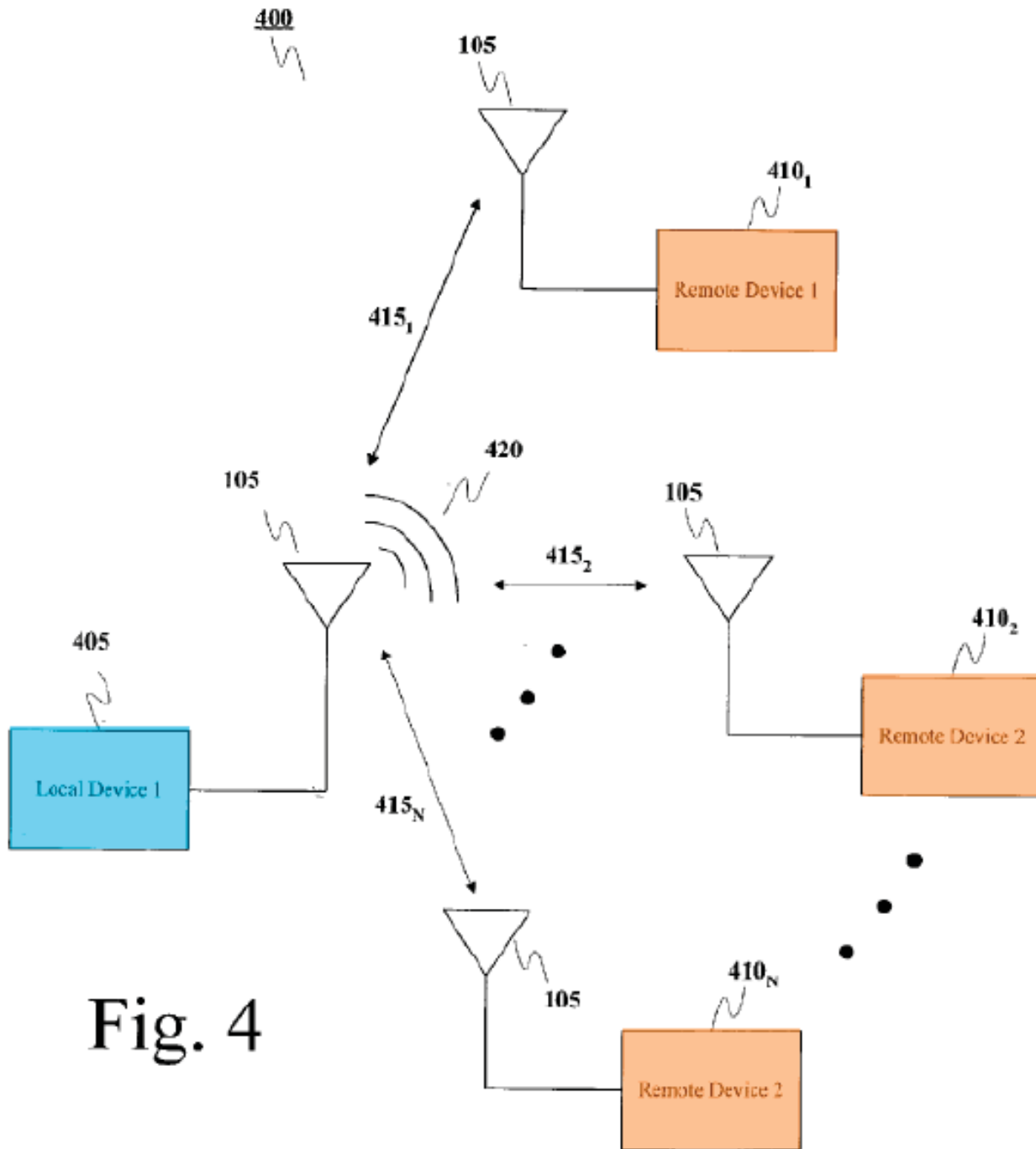


Fig. 4

“Each of the wireless devices 405 and 410₁ through 410_N may be a mobile device such as a mobile telephone, a laptop computer, or personal digital assistant

(PDA).” *Id.*, [0100]. Each of the wireless devices includes a processor system having a processor unit 301 such as the one shown annotated in red in Figure 3 below. *Id.* [0069], [0100], Fig. 3. Processor unit 301 includes, for example, bus 303, processor 305, main memory 307, read only memory (ROM) 309, storage device 311, and communication interface 313. *Id.*, [0069].

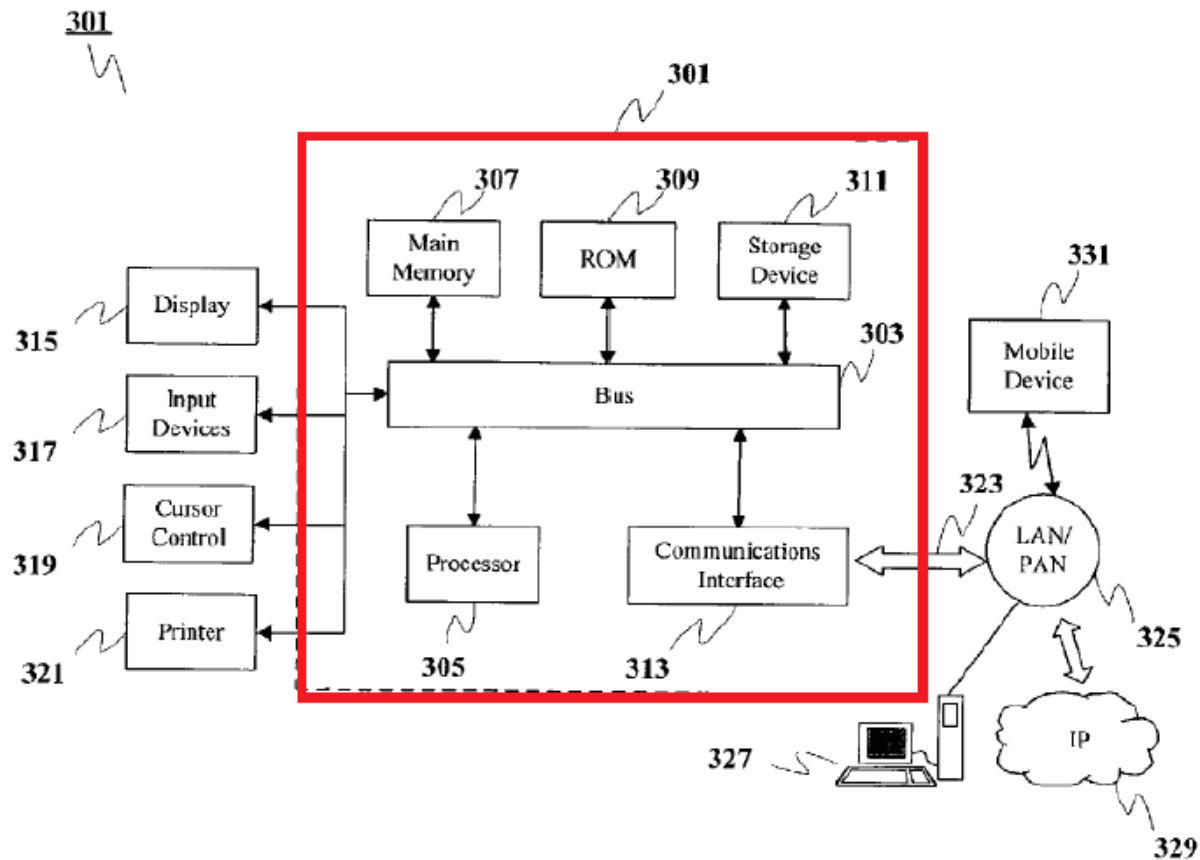


Fig. 3

Local device 405 is linked to remote devices 410₁-410_N via respective UWB links 415₁-415_N, as shown in Figure 6 below. *Id.*, [0098], [0113]-[0116], Fig. 6. To

create the UWB links, local device 405 transmits a join message to all unlinked remote devices within the transmission range of the local device 405. *Id.*, [0113]. Each of the unlinked remote devices receives the join message, synchronizes with local device 405, and transmits a reply to the join message. *Id.*, [0113]-[0115]. Each reply is a UWB signal that includes a unique identifier associated with the respective remote device. *Id.*, [0115]. The unique identifier may be a device address or a unique time delay for the remote device. *Id.* Local device 405 receives the replies and establishes the unique links with the remote devices. *Id.*, [0116]. The unique identifiers of the remote devices are stored in memory 307 of local device 405. *Id.*

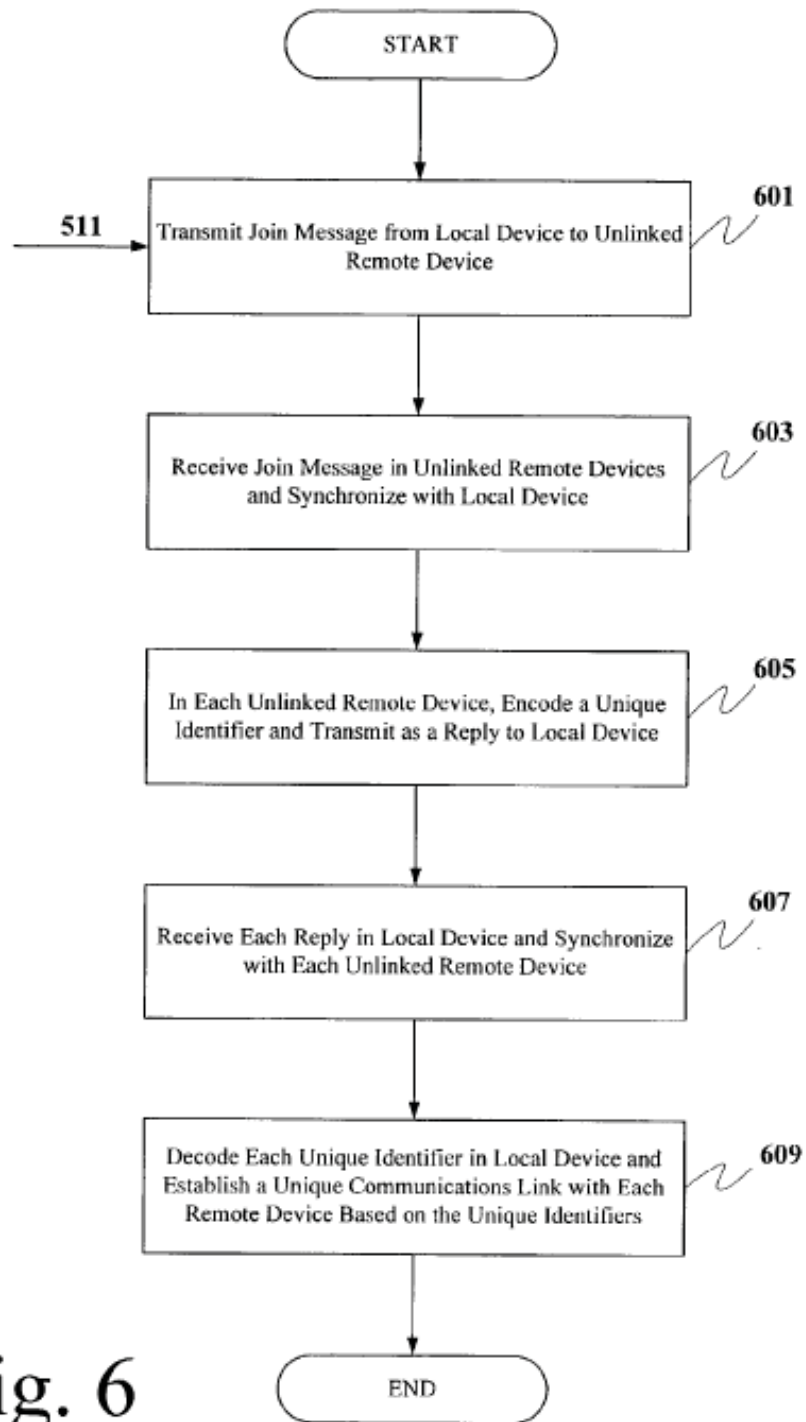


Fig. 6

Once the unique link is established, local device 405 calculates a distance to each linked remote device 410₁-410_N, as shown in Figure 7 below. *Id.*, [0118]-[0128], Fig. 7.

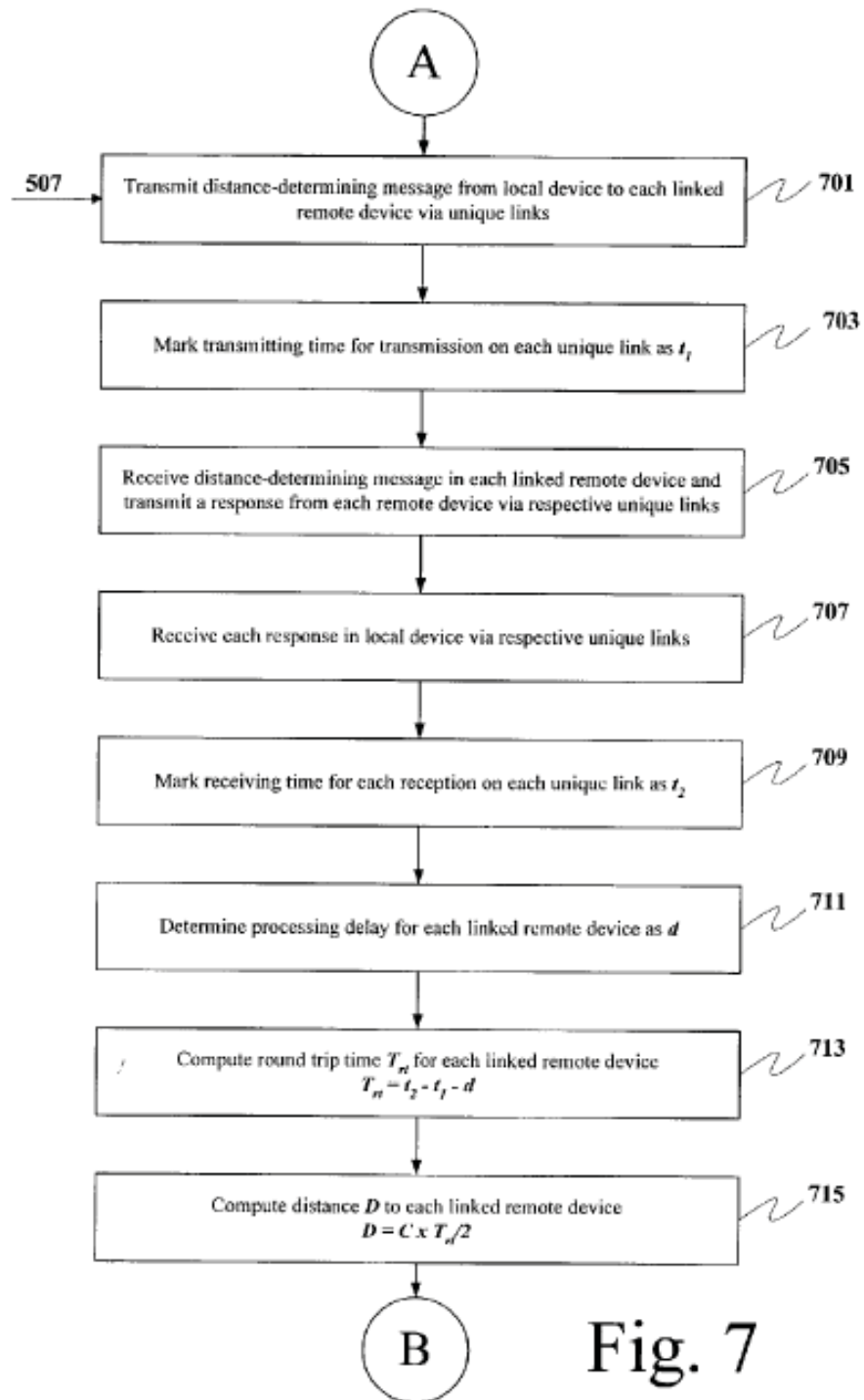


Fig. 7

For example, local device 405 transmits a distance-determining message to linked remote device 410₁ via the unique communication links 415₁. *Id.*, [0118]. Local device 405 determines a transmit time t_1 of the distance-determining message and stores transmit time t_1 in main memory 307 along with the corresponding unique identifier of the corresponding remote device. *Id.*, [0120]. Linked remote device 410₁ receives the distance determining message and transmits a response back to local device 405. *Id.*, [0121]. Local device 405 receives the response, determines a receive time t_2 for the response, and stores the receive time t_2 in main memory 307 along with the corresponding transmit time t_1 . *Id.*, [0122].

Local device 405 determines a processing delay d for remote device 410₁. *Id.*, [0123]. The processing delay d is “the times 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.” *Id.* To determine the processing delay, local device 405 receives information from remote device 410₁ regarding the radio type of remote device 410₁ as part of the unique identifier received when linking the devices. *Id.*, [0124]. Local device 405 uses the known device type in referring to a look up table (LUT) stored in memory 307 or ROM 309 to determine a predefined processing delay for that radio type. *Id.* Alternatively, the processing delay d itself may be transmitted to local device 405 as part of the unique identifier received when

linking the devices. *Id.*, [0125].

Local device 405 then calculates the round trip time T_{rt} for transmitting the distance-determining message to remote device 410₁ and receiving the corresponding response using the following formula in which t_1 is the transmit time of the distance-determining message, t_2 is the receive time of the corresponding response, and d is the processing delay for the remote device:

$$T_{rt} = t_2 - t_1 - d$$

Id., [0126]. Local device 405 then uses the calculated round trip time T_{rt} to compute the distance D to remote device 410₁ using the following formula in which c is the speed of light (e.g., the speed at which an RF signal travels through the wireless medium):

$$D = c \cdot \frac{T_{rt}}{2}$$

Id., [0127]-[0128].

This process may be repeated to continually update the distances to the linked remote devices. *Id.*, [0145], [0152].

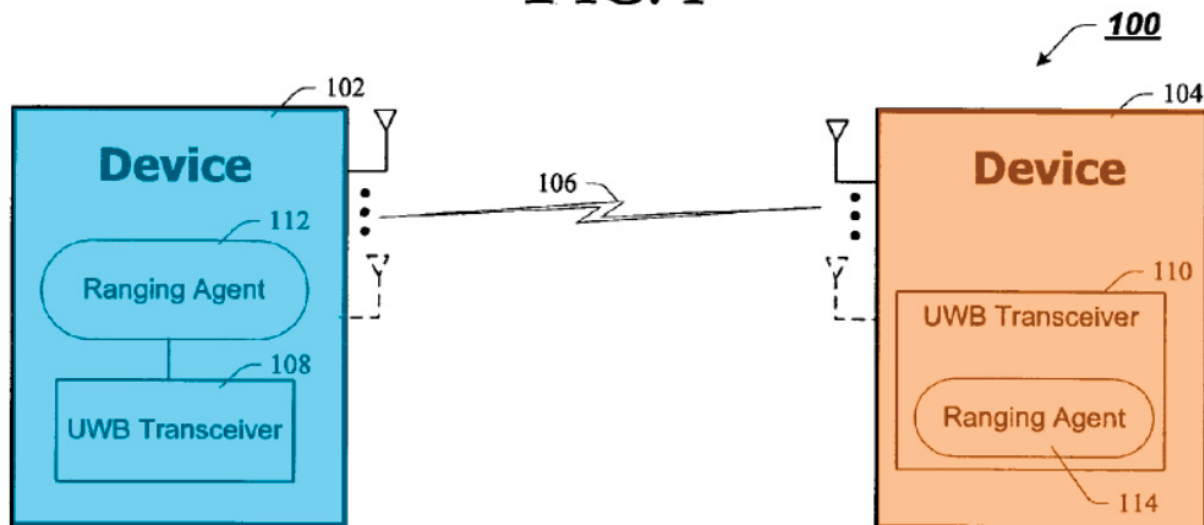
2. *Leeper*

Like the '777 patent, *Leeper* is directed to a system for determining a location

of a remote wireless device. EX1004, Abstract, 2:15-3:9, 4:22-64, 5:29-56, 6:56-7:59, Figs. 1, 4. The reference is analogous art to the '777 patent, as each discloses wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1004, Abstract, 2:15-3:9, 4:22-64, 5:29-56, 6:56-7:59, Figs. 1, 4; EX1002, ¶47.

As shown in annotated Figure 1 below, *Leeper* discloses two or more electronic devices 102 (blue), 104 (orange) that are connected through an UWB wireless communication channel 106. EX1004, 2:46-57. Each electronic device 102, 104 includes an UWB transceiver 108 with an associated antenna for transmitting and receiving UWB signals. *Id.*

FIG. 1



Each electronic device 102, 104 includes a ranging agent 112/114/200 for

determining a range between the electronic devices 102, 104. *Id.*, 2:46-3:9, 4:22-39, Figs. 1, 2. Electronic device 102 sends and receives ranging messages to/from electronic device 104. *Id.*, 4:22-64. Based on this exchange of messages, a propagation delay is calculated based on the time it takes the messages to propagate between the devices. *Id.*, 6:66-7:7, 7:35-59. This propagation delay is used to calculate the distance between the electronic devices 102, 104. *Id.*, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59. The exchanging of messages between the devices may be repeated a number (N) of times and averaged to reduce errors. *Id.*, 5:29-56.

3. *Tajima*

Like the '777 patent, *Tajima* is directed to a system for determining a location of a wireless mobile apparatus. EX1006, Abstract, Figs. 1, 3. This reference is analogous art to the '777 patent, as each discloses wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1006, Abstract, 5:5-17, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4; EX1002, ¶58.

Tajima discloses fixed radio apparatus 1 and mobile radio apparatus 2. *Id.*, 5:5-17. Fixed radio apparatus 1 has a transmission/reception unit 4 for sending and receiving signals from mobile radio apparatus 2. *Id.* Fixed radio apparatus 1 also includes measuring unit 5 for measuring the propagation distance and direction to mobile radio apparatus 2. *Id.*, 5:5-17, 5:43-68.

Transmission/reception unit 4 of fixed radio apparatus 1 has non-directional antenna 11 and directional antenna 12. *Id.*, 5:28-34, 6:35-39, Fig. 4. When the radio wave sent in reply by mobile radio apparatus 2 is received by non-directional antenna 11 and directional antenna 12, fixed radio apparatus uses the reception level from the two antennas to determine the direction to mobile radio apparatus 2. *Id.*, 7:15-38, 10:37-55, Fig. 4.

4. Analysis

a. Claim 1

[1.0] A wireless communications system, comprising:

To the extent limiting, *McCorkle* discloses, or at least renders obvious, the preamble. As shown in annotated Figure 4 below, *McCorkle* discloses a wireless network 400 in which a plurality of wireless devices (e.g., local device 405 (blue) and remote devices 410₁-410_N (orange)) may exchange information. EX1003, [0098]. The local and remote devices communicate over a wireless local area network (WLAN) as well as through ultrawideband (UWB) links. *Id.*, [0098]-[0105], [0113]-[0118], [0120]-[0128].

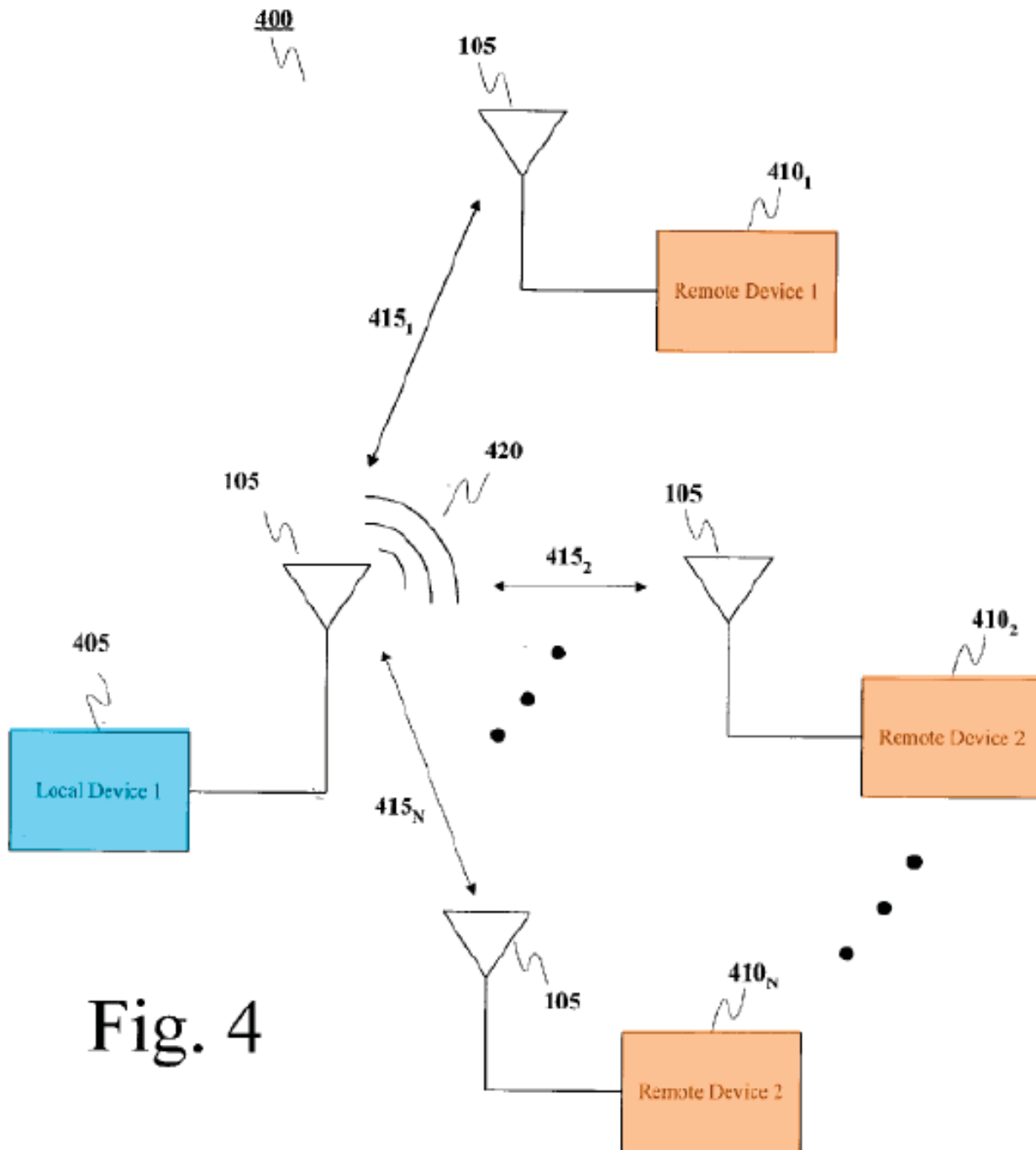


Fig. 4

[1.1] a plurality of wireless communications devices each having a device type associated therewith from among a plurality of different device types, and each device type having a known device latency associated therewith; and

McCorkle discloses, or at least renders obvious, [1.1]. McCorkle discloses a

plurality of wireless communications devices (e.g., remote devices 410₁-410_N (highlighted in orange in Figure 4 above for [1.0])). EX1003, [0098]. For example, remote devices 410₁-410_N may be *wireless communications devices* such as mobile telephones. *Id.*, [0100].

McCorkle discloses that each remote device 410₁-410_N sends “information about the radio type of the remote device” to local device 405. *Id.*, [0124]. Radio types widely used in mobile telephones at the time of the assumed priority date include, for example, CDMA (code division multiple access) and TDMA (time division multiple access)/GSM (global system for mobiles). EX1003, [0103]-[0104] (citing EX1015 (IEEE Standard)); EX1002, ¶42 (citing EX1018). In addition, radio types for laptops and PDAs at the time would have included WiFi (IEEE Standard 802.11b). EX1002, ¶42 (citing EX1019 and EX1020). Thus, a POSITA would have understood, or at least found obvious, that the claimed associated *device type* is taught by *McCorkle*’s remote device 410₁-410_N each having an associated radio type (e.g., CDMA devices, TDMA/GSM devices, and/or WiFi devices). EX1002, ¶42.

This received radio type is used by local device 405 to refer to a look up table (LUT) stored in memory to determine a predefined processing delay associated with that radio type. EX1003, [0124]. A POSITA would have understood, or at least found obvious, that *McCorkle* describes a *plurality of different device types* because the LUT would include more than one radio type corresponding to, for example,

CDMA devices, TDMA/GSM devices, and/or WiFi devices and each radio type having an associated predefined processing delay. EX1002, ¶43. For example, a POSITA would have considered cell phones as CDMA devices or TDMA/GSM devices and laptops and PDAs as WiFi devices. EX1003, [0103]-[0104] (citing EX1015 (IEEE Standard)); EX1002, ¶43 (citing EX1018; EX1019; EX1020). A POSITA would have understood, or at least found obvious, that a LUT is used where there are multiple radio types to look up. EX1002, ¶43. That is, a table would not be needed if each of the remote devices had the same *device type*. *Id.*

McCorkle further discloses that each of the device types is associated with a known predefined processing delay that is in the LUT. EX1003, [0124]. This processing delay 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.” *Id.*, [0123]. This known processing delay corresponds to the claimed *known device latency*. In particular, the ’777 patent describes *latency* as “the time [it takes] to process a received signal and generate an acknowledgement reply thereto.” EX1001, 5:14-19. The ’777 patent further describes that the *known device latency* is a “mean latency” for a “given device type” and “provides a close approximation of the actual device latency.” *Id.*, 5:13-16.

Thus, *McCorkle* discloses, or at least renders obvious, *that a plurality of*

wireless communications devices (e.g., remote devices 410₁-410_N) each having a device type associated therewith (e.g., radio type of each of the remote devices 410₁-410_N) from among a plurality of different device types (e.g., the plurality of device types listed in the LUT), and each device type having a known device latency associated therewith (e.g., processing delay associated with a particular device type).

[1.2] a wireless device locator comprising

McCorkle discloses, or at least renders obvious, [1.2]. As discussed for [1.1], *McCorkle* discloses a local device 405 (highlighted in blue in Figure 4 above for [1.0]) that communicates with remote devices 410₁-410_N. EX1003, [0098]. Local device 405 is configured to determine a distance to remote devices 410₁-410_N and corresponds to the claimed *wireless device locator*. *Id.*, [0098]-[0105] (describing devices in network), [0113]-[0118] (describing process for establishing unique links between a local device and respective remote devices), [0118]-[0128] (describing process for determining distance between the local device and one of the linked remote devices), Figs. 4, 6, 7.

[1.3] at least one antenna and a transceiver connected thereto, and

McCorkle discloses, or at least renders obvious, [1.3]. As discussed for [1.2], local device 405 corresponds to the claimed *wireless device locator*. *McCorkle* discloses that local device 405 includes a UWB transceiver that transmits and receives a UWB signal 420 via a UWB antenna such as antenna 105. EX1003,

[0101], Fig. 4; *see also id.*, [0044]-[0050] (describing antenna and receiving of signal) [0051]-[0059] (describing transceiver in detail), [0060]-[0068] (describing tracking correlators of transceiver).

[1.4] a controller for cooperating with said transceiver for transmitting a plurality of location finding signals to a target wireless communications device from among said plurality of wireless communications devices;

McCorkle discloses, or at least renders obvious, [1.4]. As discussed for [1.2], local device 405 corresponds to the claimed *wireless device locator*. As also discussed for [1.3], local device 405 includes a UWB transceiver that transmits and receives a UWB signal 420 via an UWB antenna such as antenna 105. *McCorkle* discloses that local device 405 includes a processor system/unit 301 (annotated in red in Figure 3 below). EX1003, [0120]. This processor unit corresponds to the claimed *controller*.

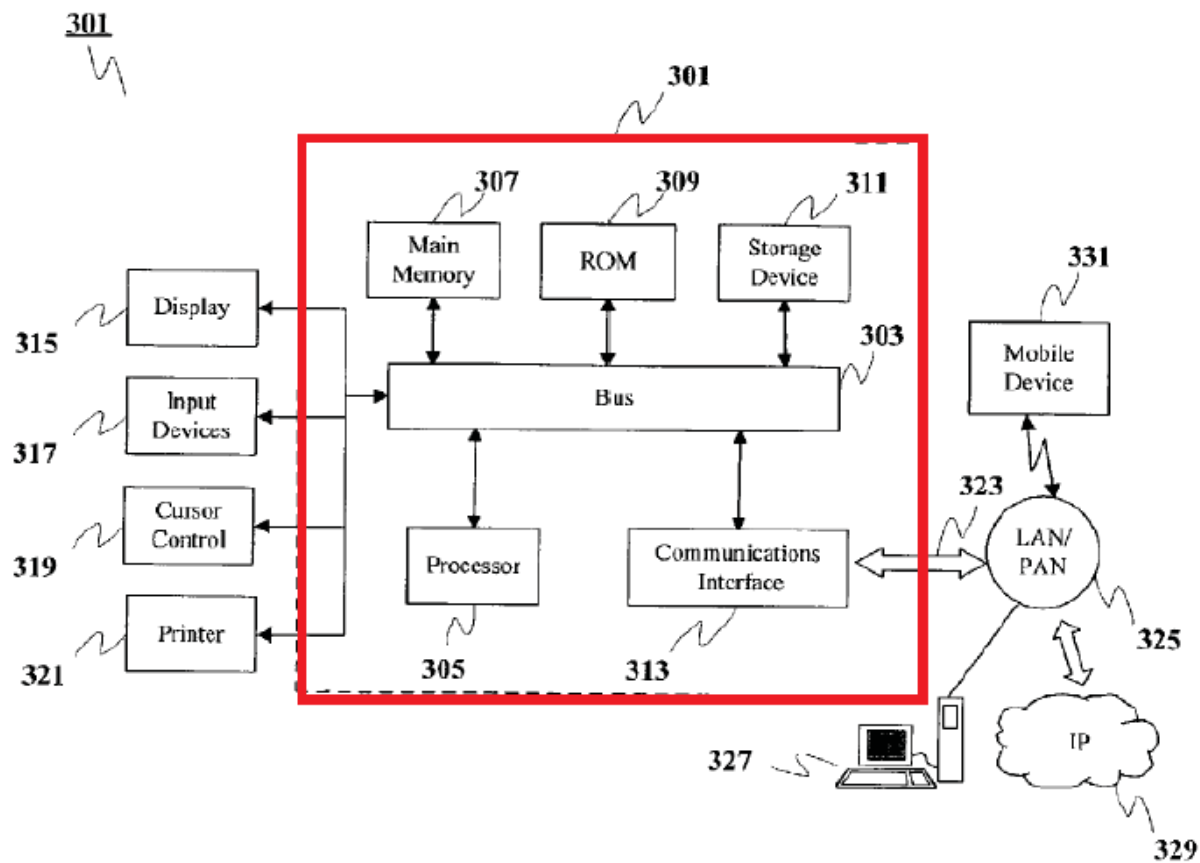
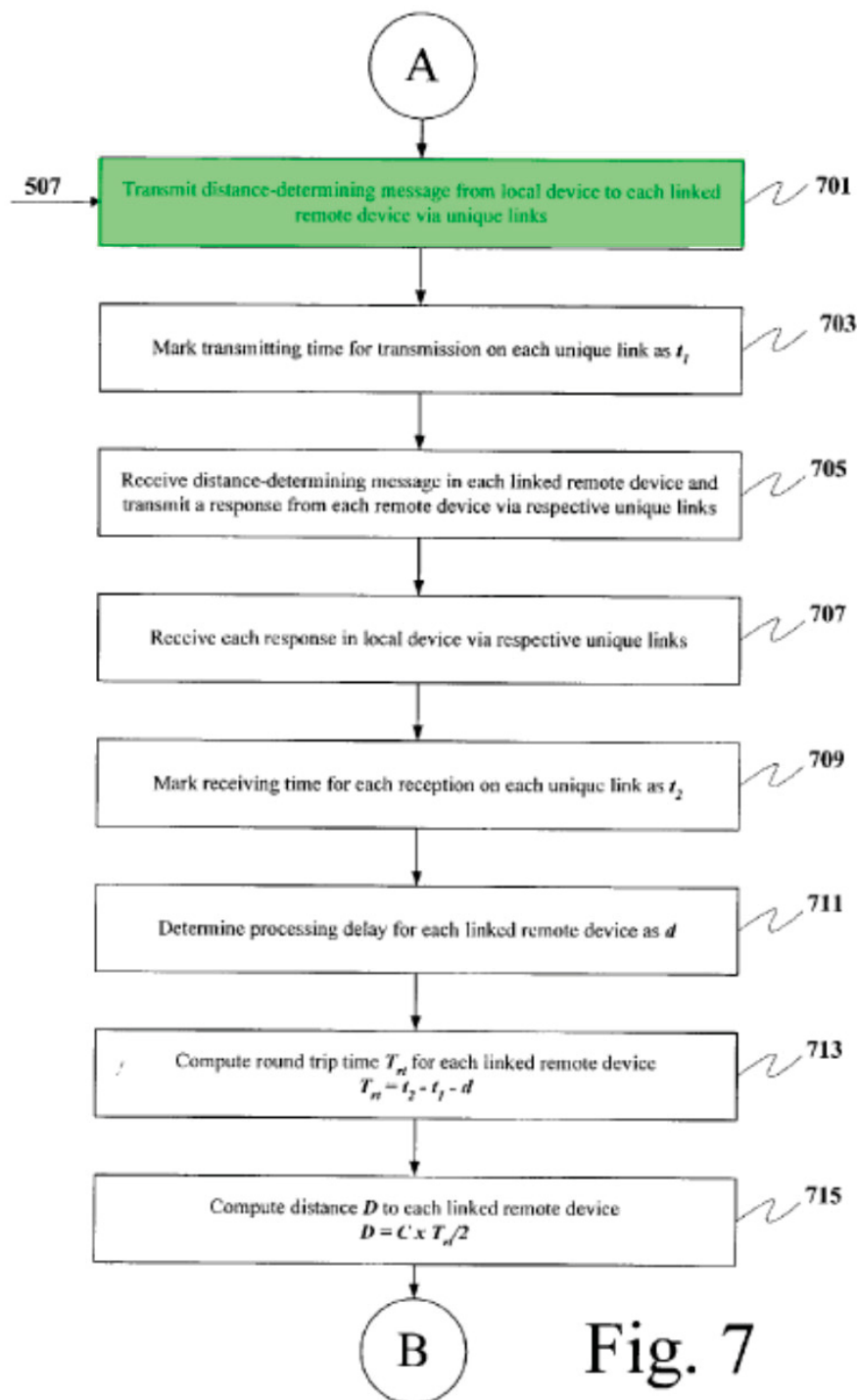


Fig. 3

The processor unit 301 is connected to a communication interface 313 including the UWB transceiver. *Id.*, [0069], [0086]. Processor unit 301 includes software for performing the processing performed in implementing *McCorkle's* distance measuring system using UWB transmission. *Id.*, [0080]. This processing includes the local device generating a distance-determining message and sending, using its UWB transceiver, the message to each of the linked remote devices 410₁-410_N, as shown in step 701 (highlighted in green) in Figure 7 below. *Id.*, [0101],

[0118].



McCorkle discloses that the system continually updates the location of each remote device. *Id.*, [0140], [0145], [0152]. To make these continual updates,

McCorkle discloses that its distance determining process is repeated as loop 507. *Id.*, [0110]-[0111], [0137], [0140], [0166], Figs. 5, 7. Therefore, a POSITA would have understood, or at least found obvious, that multiple distance-determining messages are sent to each remote device at least so that the location of the remote device can be continually updated. *Id.*; EX1002, ¶¶44-45. In particular, *McCorkle* describes that “a new distance-determining signal is sent to” the corresponding remote device so that the distance can be updated. EX1003, [0140].

Thus, *McCorkle* discloses, or at least renders obvious, *a controller* (e.g., processing unit 301 of local device 405) *for cooperating with said transceiver* (e.g., UWB transceiver of local device 405) *for transmitting a plurality of location finding signals* (e.g., distance-determining messages) *to a target wireless communications device* (e.g., remote device 410₁) *from among said plurality of wireless communications devices* (e.g., remote devices 410₁-410_N).

[1.5] said target wireless communications device transmitting a respective reply signal for each of said location finding signals;

McCorkle discloses, or at least renders obvious, [1.5]. As discussed for [1.4], local device 405 transmits *location finding signals* (e.g., distance-determining messages) to a *target wireless communications device* (e.g., remote device 410₁). *McCorkle* discloses that the remote device 410₁ receives the distance-determining message and transmits a response to the local device 405, as shown in step 705

(highlighted in purple) in Figure 7 below. EX1003, [0121]. A POSITA would have understood, or at least would have found obvious, that this occurs for each distance-determining message that is received. *Id.*, [0145], [0152]; EX1002, ¶¶44-45. This is because *McCorkle* describes that its distance-determining process (shown in Figure 7) is repeated in loop 507 to update the determined distance to the remote device. EX1003, [0110]-[0111], [0137], [0140], [0166], Figs. 5, 7. In particular, each transmission of a distance-determining message (step 701) begins loop 507 and each transmission of the distance-determining message by local device 405 is followed by receipt of that message by remote device 410₁ (step 705). *Id.*

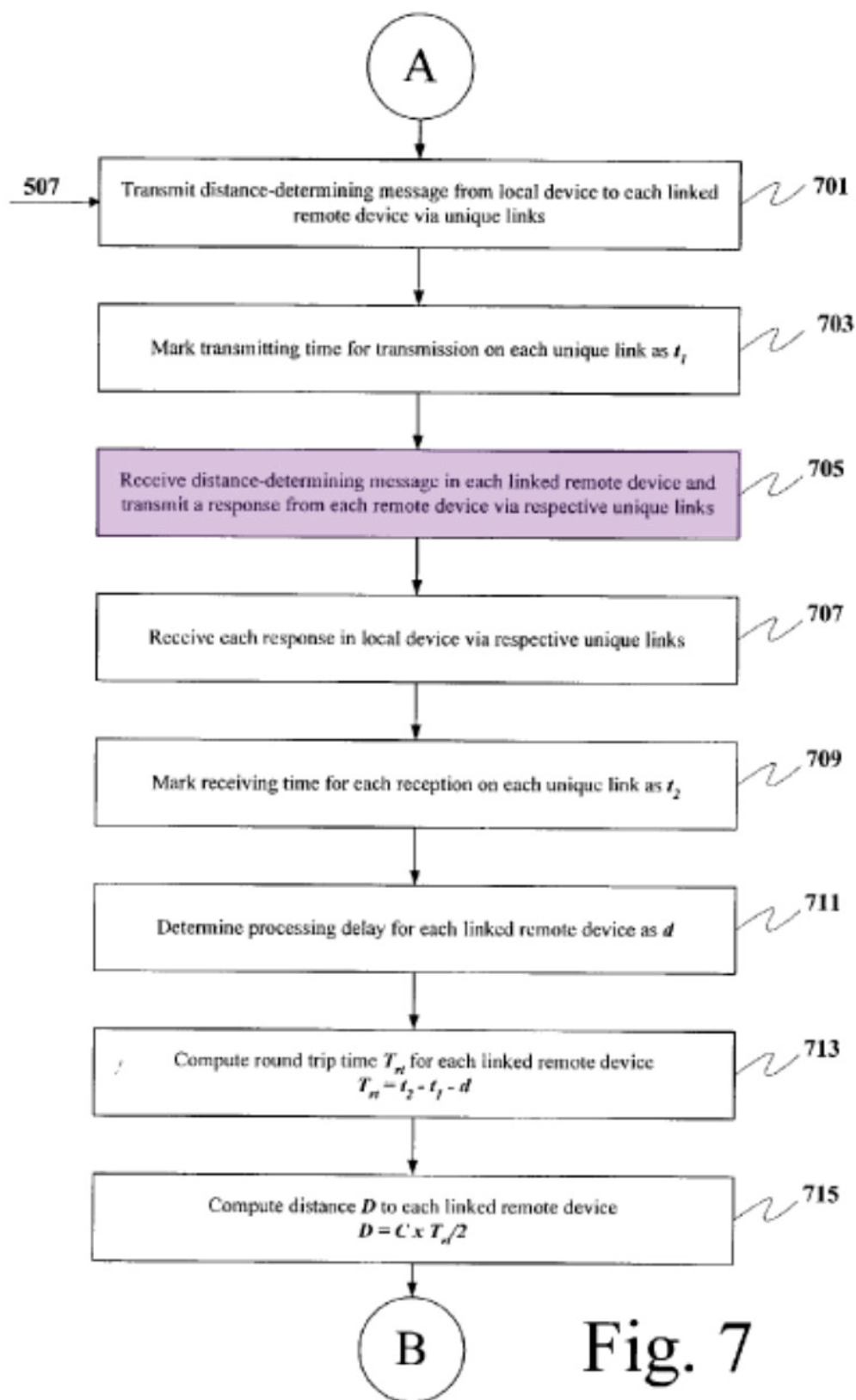


Fig. 7

Thus, *McCorkle* discloses, or at least renders obvious, *said target wireless communications device* (e.g., remote device 410₁) *transmitting a respective reply signal* (e.g., response) *for each of said location finding signals* (e.g., distance-determining messages).

[1.6] said controller of said wireless device locator also for cooperating with said transceiver for receiving the reply signals,

McCorkle discloses, or at least renders obvious, [1.6]. As discussed for [1.4], processor unit 301 of local device 405 includes software for performing the processing performed in implementing *McCorkle*'s distance measuring system using UWB transmission. *Id.*, [0080]. This processing also includes processor unit 301 receiving the responses, using UWB transceiver, from each of the linked remote devices 410₁-410_N, as shown in step 707 (highlighted in yellow) in Figure 7 below. *Id.*, [0101], [0122]-[0125]. In particular, processor unit 301 performs the processing steps described in *McCorkle*, which includes using the received responses to determine the distance to the remote device. *Id.*, [0079]-[0080], [0118]-[0128].

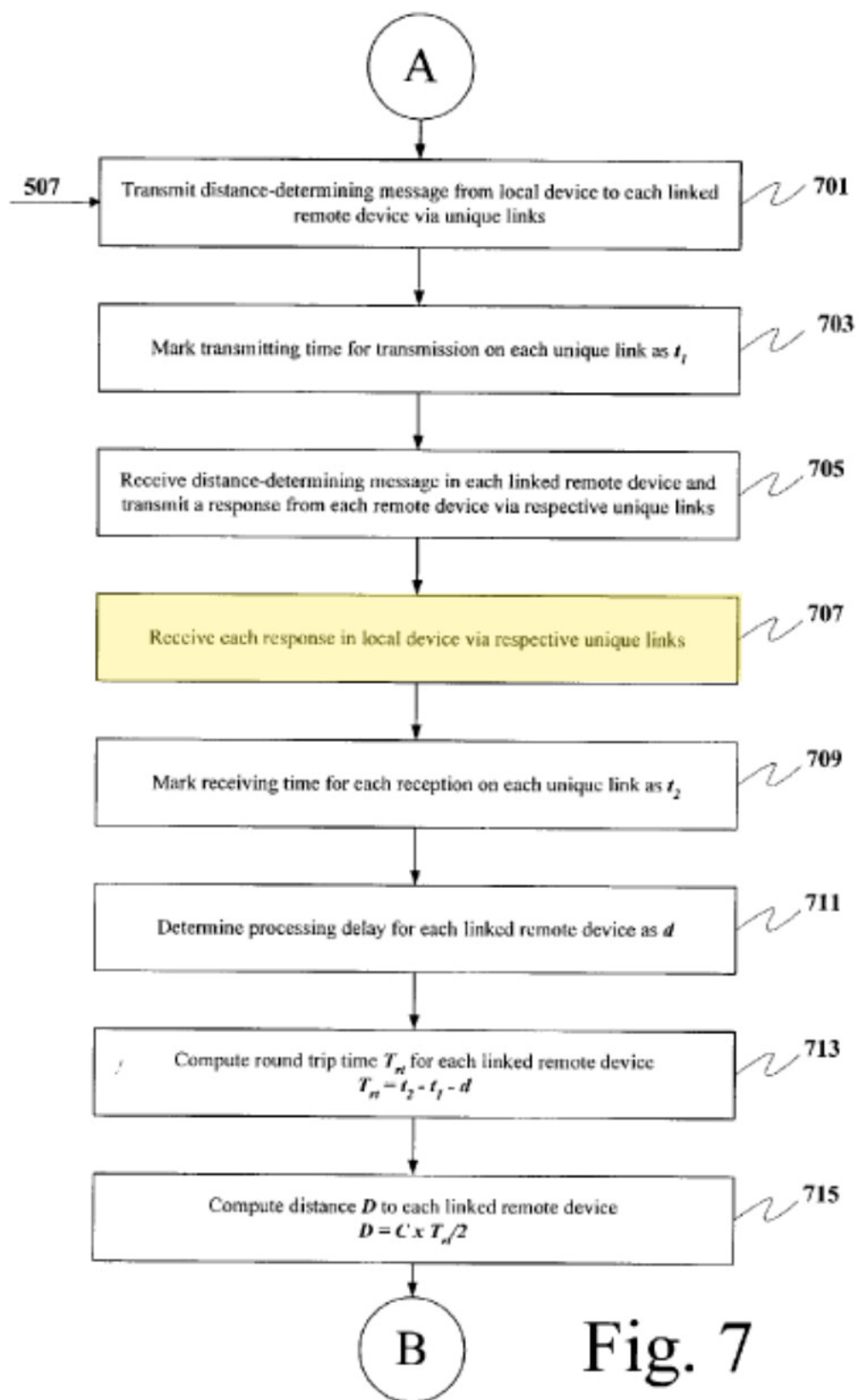


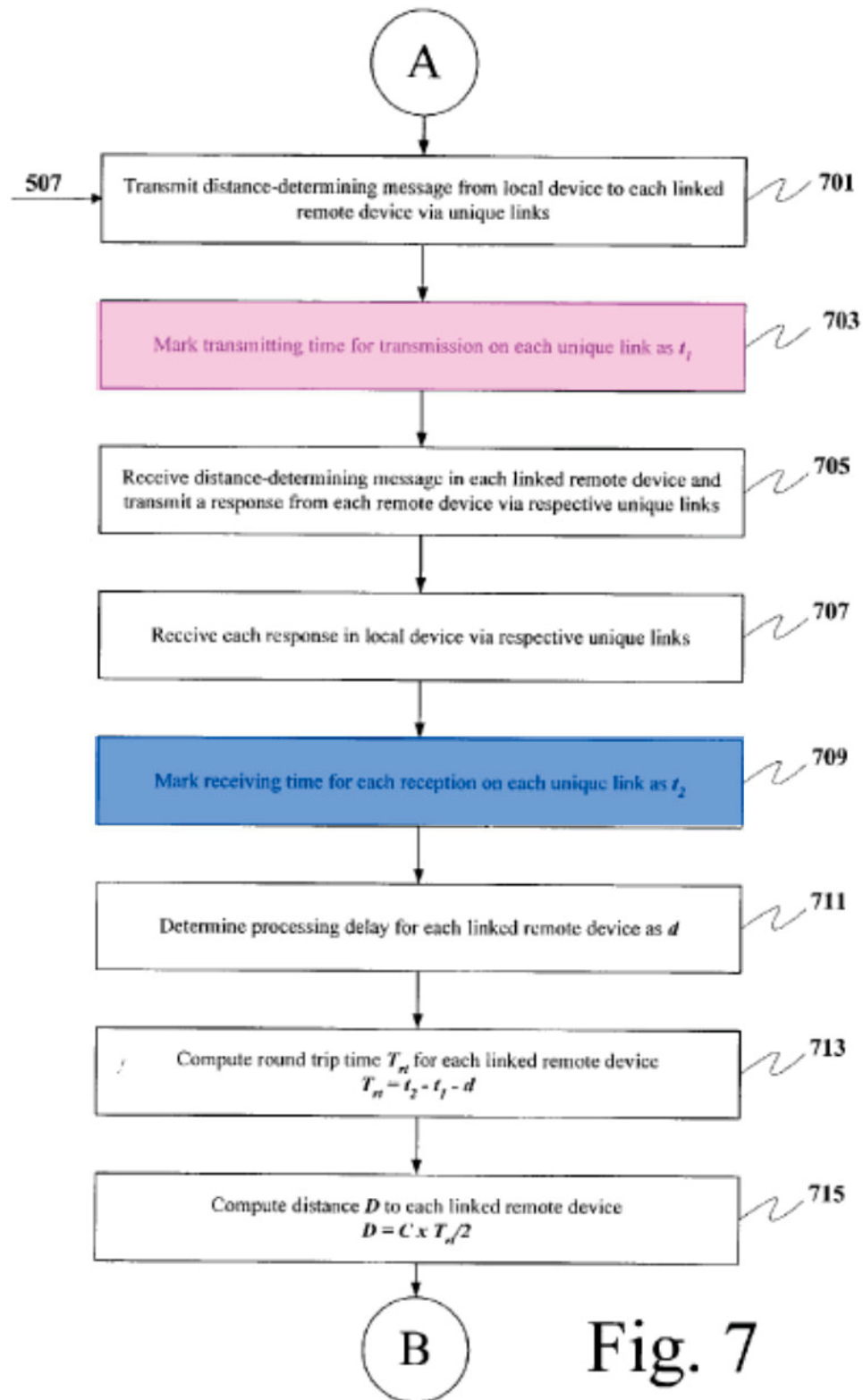
Fig. 7

Thus, *McCorkle* discloses, or at least renders obvious, *said controller of said wireless device locator* (e.g., processing unit 301 of local device 405) *also for cooperating with said transceiver* (e.g., UWB transceiver of local device 405) *for receiving the reply signals* (e.g., responses).

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

McCorkle discloses, or at least renders obvious, [1.7]. As discussed for [1.4], processor unit 301 of local device 405 includes software for performing the processing performed in implementing *McCorkle's* distance measuring system using UWB transmission. *Id.*, [0080]. This processing also includes the local device 405 performing the following determinations based on obtained data. *Id.*, [0120]-[0127], Fig. 7. As discussed for [1.5] and [1.6], *McCorkle* discloses sending a distance-determining message from local device 405 to remote device 410₁ and receiving a response back from remote device 410₁. When local device 405 transmits the distance-determining message, the transmit time t_1 is obtained by a system clock in processing unit 301 of local device 405 and is stored in main memory 307 of local device 405, as shown step 703 (highlighted in pink) in Figure 7 below. EX1003, [0120]. When local device 405 receives the response from remote device 410₁, local device 405 similarly obtains and stores the receive time t_2 , as shown in step 709

(highlighted in dark blue) in Figure 7 below. *Id.*, [0122].



Local device 405 receives information from remote device 410₁ providing the radio type of remote device 410₁. *Id.*, [0124]. This information may be included in the response or as part of a separate signal sent by remote device 410₁. *Id.* Once local device 405 knows the device type of remote device 410₁, local device 405 refers to the LUT table stored in memory 307 or ROM 309 of known processing delays for particular device types to determine the processing delay *d* for remote device 410₁, as shown in step 711 (highlighted in red) in Figure 7 below. *Id.*

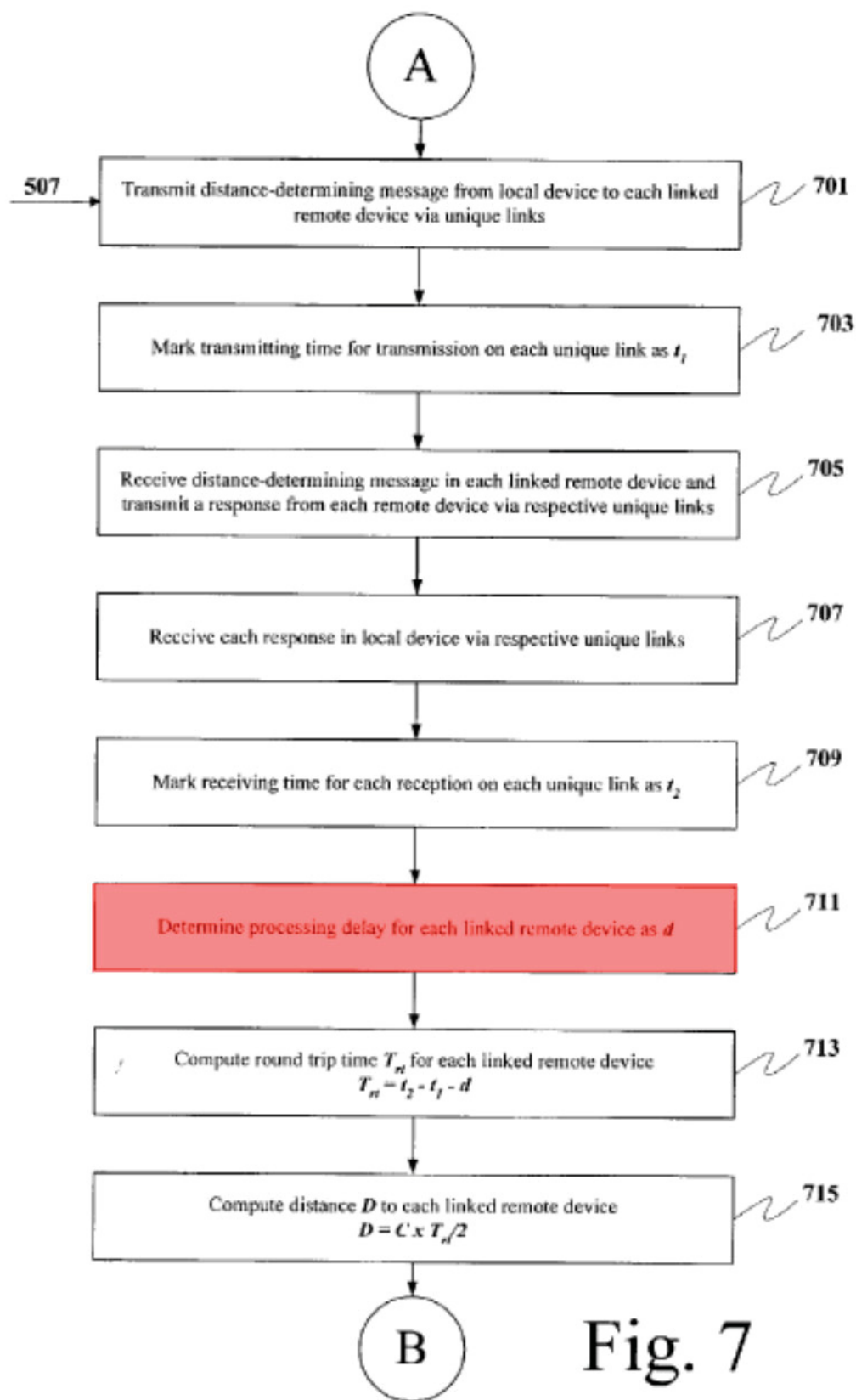


Fig. 7

Local device 405 uses the transmit time t_1 , receive time t_2 , and the processing delay d of remote device 410₁ to determine the round trip time T_{rt} of the signals to remote device 410₁ using the formula $T_{rt} = t_2 - t_1 - d$, as shown in step 713 (highlighted in dark green) in Figure 7 below. *Id.*, [0126].

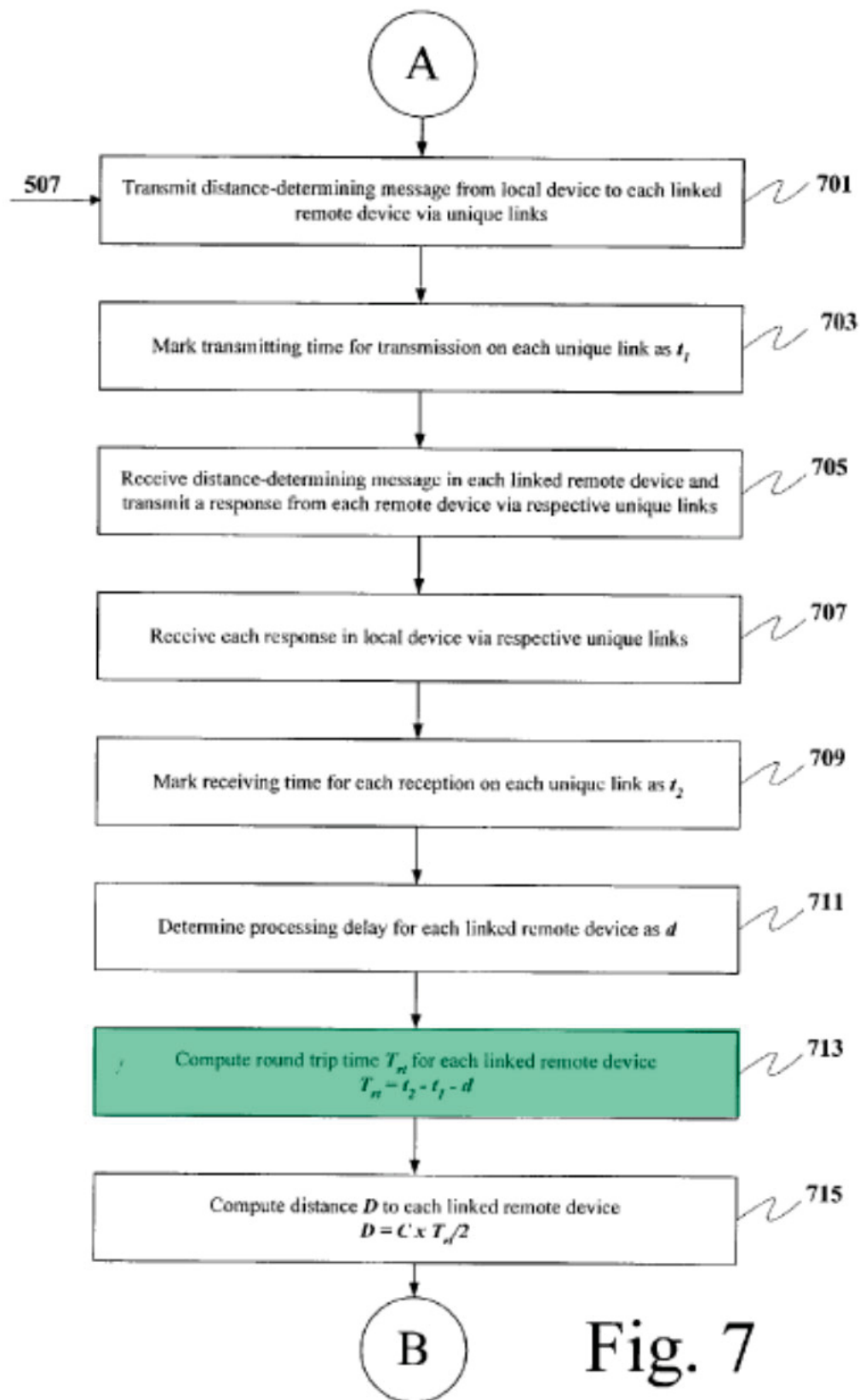


Fig. 7

This round trip time corresponds to the claimed *propagation delay*. For example, the '777 patent describes that the total propagation delay is: t_{PD1} (the time it takes for the location finding signal to travel from the wireless device locator 32 to the target device 34) + t_{PD2} (the time it takes for the reply signal 46 to travel from the target device 34 to the wireless device locator 32). EX1001, 6:60-7:36.

To the extent Speir argues that the claimed *propagation delay* corresponds to half the total propagation delay, *McCorkle* discloses dividing the round trip time, T_{rt} , in half to calculate the distance to the remote device using the formula $D = c \times T_{rt}/2$, as shown in step 715 (highlighted in blue) in Figure 7 below. EX1003, [0127].

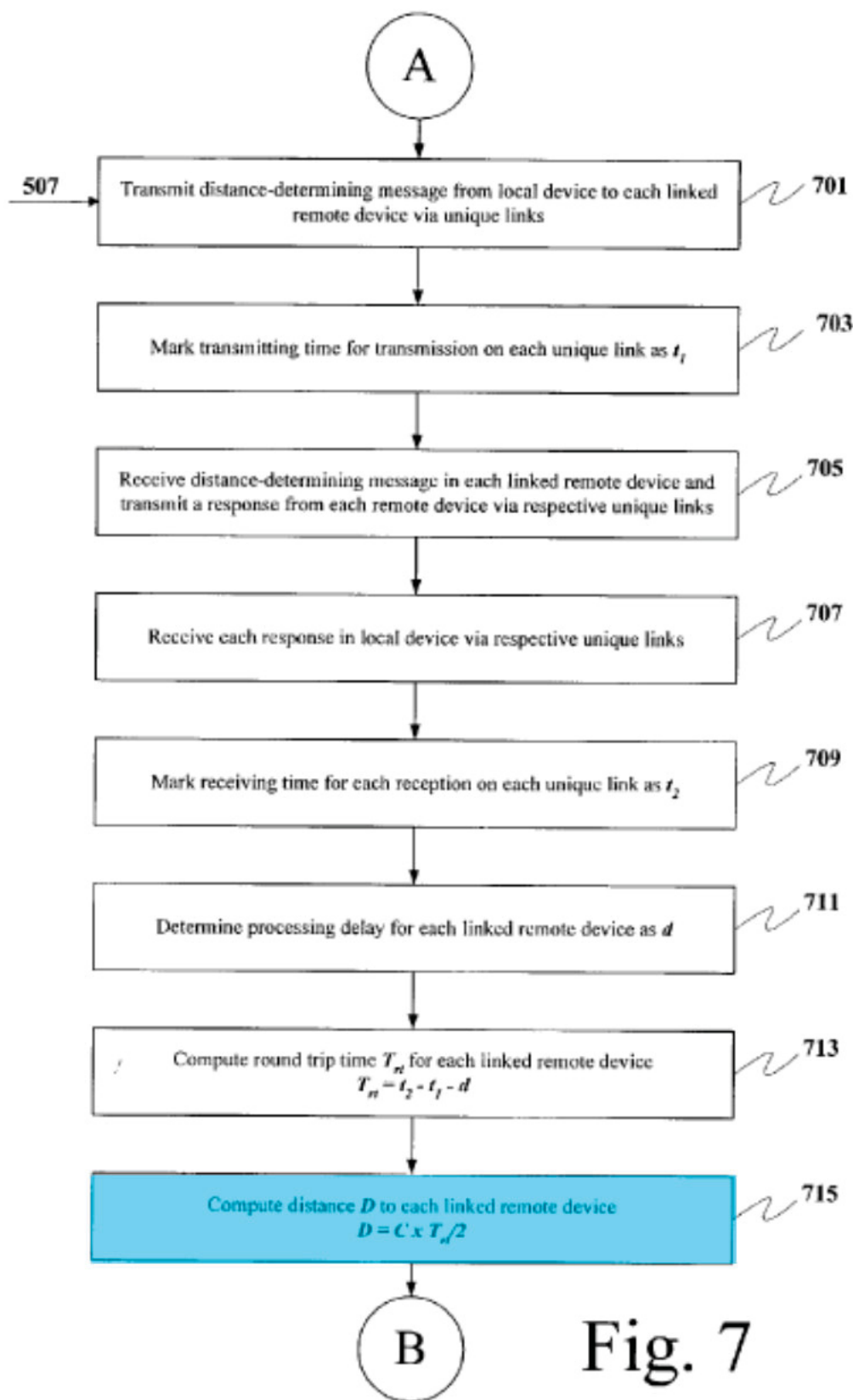


Fig. 7

This is similar to the disclosure of the '777 patent which describes “[d]ividing the total propagation delay by two (since both propagation delays may be considered equal or substantially equal for a stationary or relatively slow moving target 34) and multiplying this by the speed of light gives the estimated distance to the target 39, based upon a single propagation delay associated with the signal pair 45, 46.” EX1001, 7:21-36.

McCorkle discloses that multiple distance-determining messages are sent to each remote device at least so that the location of the remote device can be continually updated. *Id.*, [0145], [0152]. The process shown in Figure 7 is repeated as loop 507 such that the propagation delay is calculated for each distance-determining message transmitted and corresponding response received so that the distance can be continually calculated. *Id.*, [0110]-[0111], [0137], [0140], [0166], Figs. 5, 7.

Thus, *McCorkle* discloses, or at least renders obvious, that the *controller* (e.g. processing unit 301) *determin[es] a propagation delay* (e.g., T_{rt} or $T_{rt}/2$) *associated with the transmission of each location finding signal* (e.g., distance-determining messages) *and the respective reply signal* (e.g., respective response) *therefore based upon the known device latency of said target wireless communications device* (e.g., known processing delay d determined from LUT based on radio type of the remote device is used in the calculation to determine T_{rt} or $T_{rt}/2$).

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

McCorkle alone discloses, or at least renders obvious, [1.8], or, in the alternative, *McCorkle* in view of *Leeper* renders obvious [1.8]. As discussed for [1.4], processor unit 301 of local device 405 includes software for performing the processing performed in implementing *McCorkle*'s distance measuring system using UWB transmission. *Id.*, [0080]. This processing also includes the local device 405 performing the following determinations based on obtained data. *Id.*, [0120]-[0127], Fig. 7. As discussed for [1.7], *McCorkle* discloses determining a propagation delay for each of the distance-determining messages and corresponding responses sent between local device 405 and remote device 410₁. *McCorkle* further discloses using these propagation delays to calculate distances to remote device 410₁ from local device 405 using the formula $D = c \times T_{rt}/2$, as shown in step 715 (highlighted in blue) in Figure 7 below. EX1003, [0127].

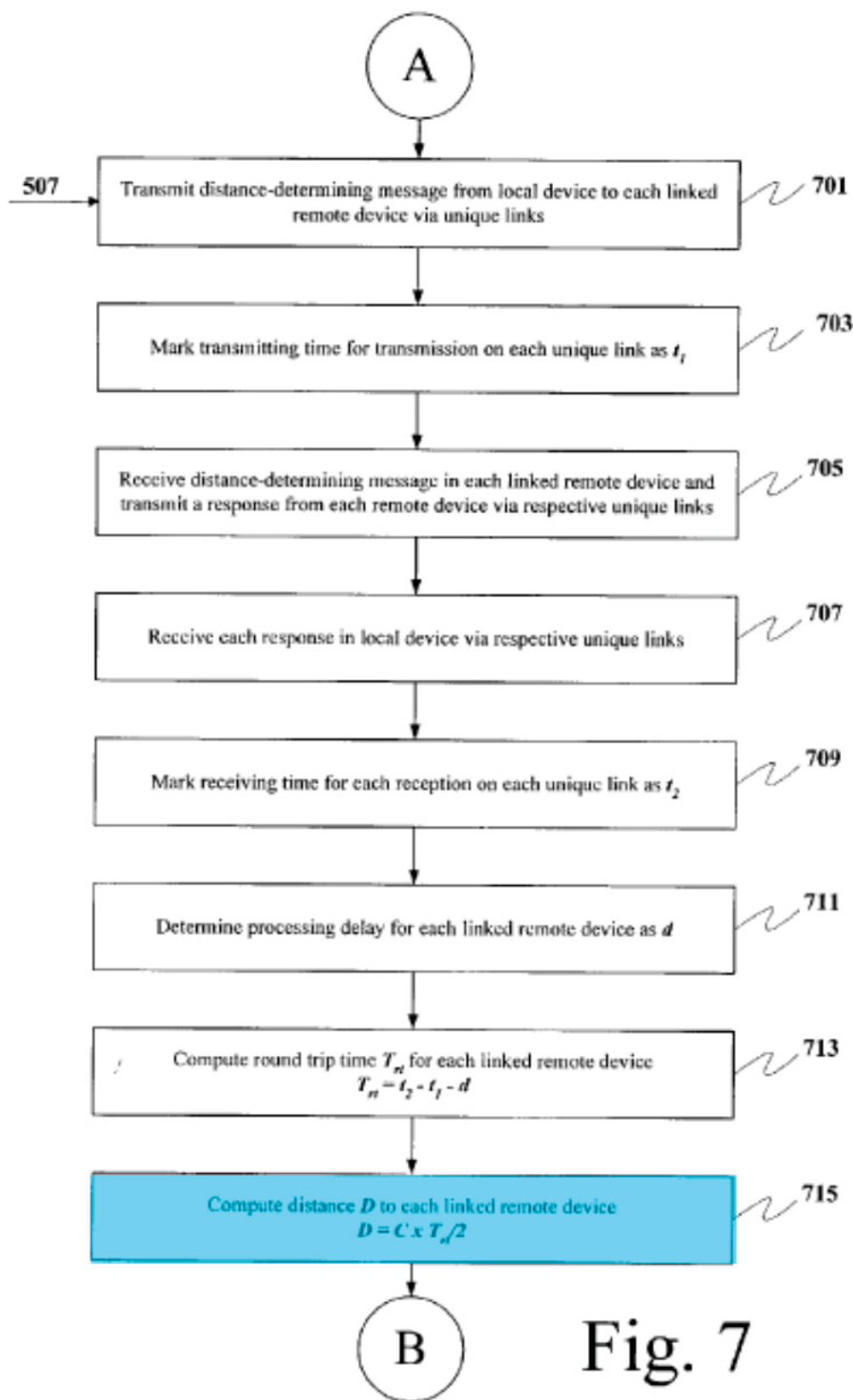


Fig. 7

Thus, *McCorkle* discloses, or at least renders obvious, that the *controller* (e.g., processing unit 301) *estimate[es] a range to the target wireless communications device* (e.g., distance to remote device 410₁) *based upon a plurality of determined propagation delays* (e.g., distance is calculated for each of the determined round trip times, T_{rt}).

To the extent Speir argues that the claimed *estimating* requires that a single range be determined based on multiple calculated propagation delay, this would have been rendered obvious over *McCorkle* as modified by *Leeper*. Like *McCorkle*, *Leeper* discloses determining a distance or range between two wireless communication devices by sending and receiving signals between the devices and determining a propagation delay of the signals. EX1004, 2:15-3:9 (describing computation of ranging agent), 4:22-64, (describing operation of ranging agent) 6:66-7:7 (describing ranging message), 7:35-59 (describing propagation delay calculation), Fig. 1. Furthermore, *Leeper* also discloses that “the process of exchanging messages between the devices may be repeated a number (N) of times and averaged” to reduce errors. *Id.*, 5:34-52.

A POSITA would have been motivated to combine the teachings of *McCorkle* with those of *Leeper* with a reasonable expectation of success. First, the references are analogous art to the '777 patent (and each other), as each discloses wireless communication systems in the same field of endeavor (location determination) and

are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1; EX1002, ¶¶46-47.

Second, combining the teachings of *McCorkle* with *Leeper* would have been no more than the combination of prior art elements according to known methods to yield predictable results. A POSITA reading *McCorkle* would have looked for known ways to make the distance determinations between its wireless devices more accurate. EX1002, ¶48. A POSITA would have understood that using *Leeper*'s averaging of multiple calculated propagation delays would have been a beneficial modification to *McCorkle*'s distance-determining system because *Leeper* describes that using the average of multiple calculated propagation delays reduces errors that may occur in the distance calculation. EX1004, 5:34-52; EX1002, ¶48. A POSITA would have understood that it would have been beneficial to send multiple distance-determining messages to calculate an averaged distance between the wireless communications devices based on the averaged propagation delay. EX1002, ¶48. This modification allows for an effective way of reducing errors that may occur from a single distance calculation that is inaccurate. *Id.* A POSITA would have been motivated to implement *Leeper*'s use of averaging with *McCorkle*'s distance-determining system to create a more accurate solution for distance determination between two wireless communications devices. *Id.*

Third, combining the teachings of *McCorkle* with *Leeper* would have been the use of a known technique to improve similar devices in the same way. The devices disclosed in *McCorkle* and *Leeper* are comparable systems. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1. A POSITA would have had a reasonable expectation of success at least because using averages in calculations was well known, and *Leeper* describes the process that would have been beneficial to repeat and average. EX1002, ¶49; EX1004, 5:34-52. *Leeper* describes to a POSITA how to implement averaging in a distance-determining system like *McCorkle*'s. EX1002, ¶49. Both *McCorkle* and *Leeper* disclose calculating propagation delays of signals sent between electronic devices to determine a distance between those devices. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1004, Abstract, 2:15-3:9, 4:22-64, 6:66-7:7, 7:35-59, Fig. 1.

To the extent *Leeper* is interpreted as disclosing averaging the calculated distances instead of the calculated propagation delays that is a difference from the claim, but both in the claim and specification of the '777 patent as well as in *Leeper* the end result is that an average distance is calculated. EX1001, 7:47-65, 11:9-14; EX1003; EX1002, ¶¶50-52. A POSITA would have understood that both calculations (i.e., (1) calculating multiple distances based on the calculated propagation delays and then averaging the calculated distances and (2) averaging the

calculated propagation delays and then calculating the average distance based on the averaged propagation delays) would obtain the same end result (i.e., an average distance). EX1002, ¶¶50-52. Because there are limited options to try to average in the equation, it would have at least been obvious to try averaging the calculated propagation delays before calculating the distance with a reasonable expectation of success. *Id.*; *KSR Int'l. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007). Here, *Leeper*'s disclosure at least renders obvious averaging the calculated propagation delays because mathematically a POSITA would have recognized that one equation is equivalent to the other and there are a finite number of ways to calculate an average distance. EX1002, ¶¶50-52. The Supreme Court has held that a patent claiming a process having a step completed at a particular time during the process is rendered invalid by prior art that completes that same step at a different time during the process. *Miller v. Foree*, 116 U.S. 22, 27-28 (1885). The Federal Circuit has similarly held claims invalid when the prior art does steps in a different order, but results in the same product. *In re Aspen Aerogels, Inc.*, 835 Fed. Appx. 587, 589 (Fed. Cir. 2020).

Thus, *McCorkle*'s system as modified by *Leeper* to include taking an average of multiple propagation delay determinations to estimate the distance renders obvious that the *controller* (e.g., processing unit 301) *estimat[es] a range to the target wireless communications device* (e.g., average distance to remote device 410₁)

based upon a plurality of determined propagation delays (e.g., multiple determined round trip times T_{rt} from repeated message exchanges between local device 405 and remote device 410₁).

b. Claim 2

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* in view of *Leeper* renders obvious the additional elements of [2.0], for the reasons discussed for [1.8] where it was demonstrated that *McCorkle* system as modified by *Leeper* to include taking an average of multiple propagation delay determinations to estimate the distance renders obvious that the controller (e.g., processing unit 301) estimates the range (e.g., average distance to remote device 410₁) based upon an average of the propagation delays (e.g., an average of multiple determined round trip times T_{rt} from repeated message exchanges between local device 405 and remote device 410₁).

c. Claim 3

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional elements of [3.0]. *McCorkle* discloses that antenna 105 may include

separate transmitting and receiving antennas (e.g., *a plurality of antennas*). EX1003, [0045], [0052]. In addition, it would have been obvious to a POSITA that antenna 105 may include multiple antennas for determining a distance and a direction from local device 405 to remote device 410₁. EX1002, ¶53; EX1003, [0002], [0153]-[0157], Fig. 11; EX1005, 31:19-47, Fig. 9. *McCorkle* discloses determining both a direction and a distance to remote device 410₁, as shown in Figure 11 below. EX1003, [0002], [0153]-[0157], Fig. 11. Local device 405 corresponds to the X indicating device 1101 and remote devices 410₁ to 410_N correspond to the remaining Xs indicating devices shown in Figure 11. *Id.*, [0153]-[0157], Fig. 11.

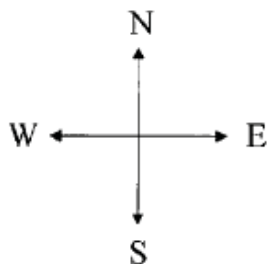
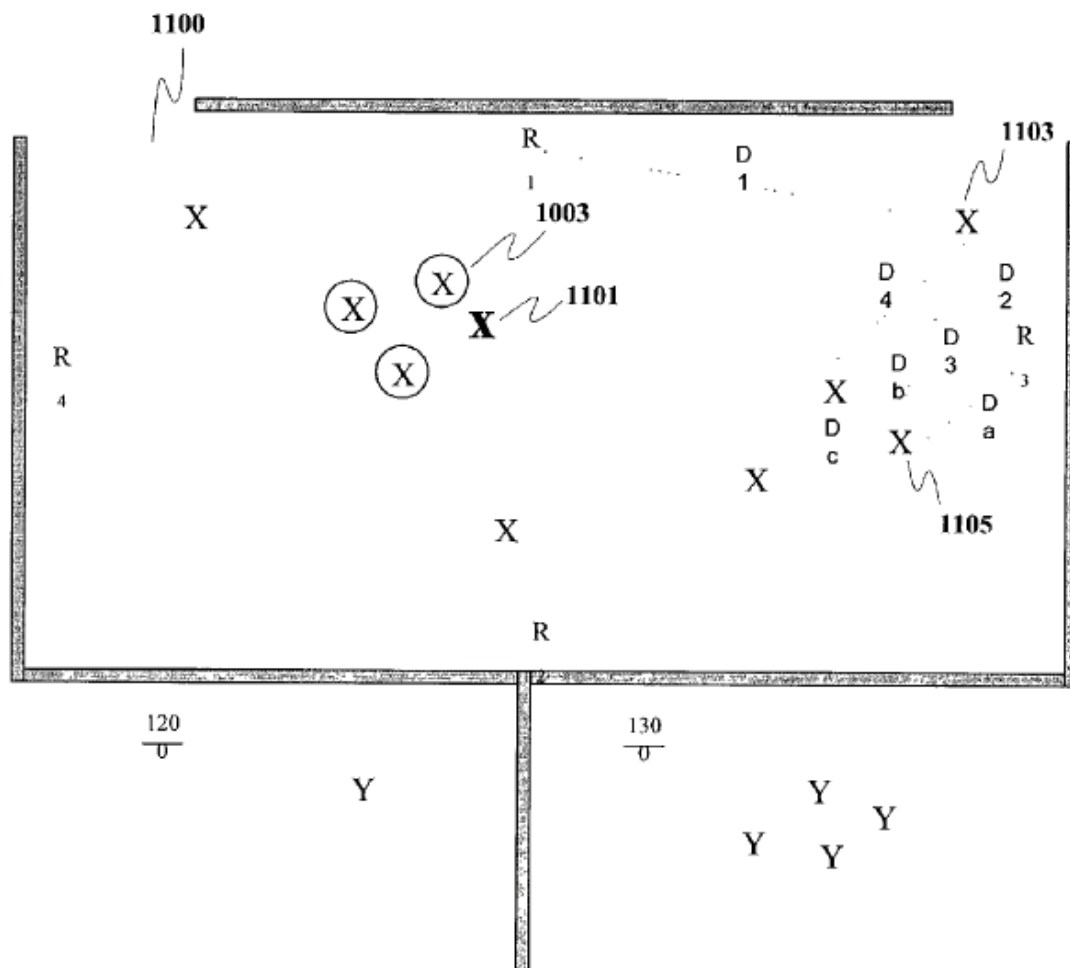


Fig. 11



It would have been obvious for a POSITA to look to related patents to *McCorkle* for determining what type and number of antennas to use for determining the distance and direction to the remote device. EX1002, ¶¶54-55. For example, it would have been obvious for a POSITA to look to U.S. Patent 7,058,414

(“*Rofheart*”) which is a parent to *McCorkle* and includes Figure 9 that corresponds to Figure 11 of *McCorkle*. Compare EX1005, Fig. 9 with EX1003, Fig. 11. *Rofheart* is also incorporated by reference into *McCorkle*. EX1003, [0001]. *Rofheart* describes multiple antennas on the local device that may be used to provide the relevant special information and resolve the distance. EX1005, 31:19-47, Fig. 9. For example, *Rofheart* discloses that this may be accomplished by using multiple antennas to receive the reply signal that produce a directional antenna pattern. *Id.* Thus, it would have been obvious to a POSITA to use multiple directional antennas to determine the distance and direction of remote devices from a local device as shown in Figure 11 of *McCorkle*.

Thus, *McCorkle* renders obvious that *said at least one antenna* (e.g., antennas 105) *comprises a plurality of antennas* (e.g., multiple directional antennas).

To the extent Speir argues that *McCorkle* alone does not disclose or render obvious that *said at least one antenna comprises a plurality of antennas*, it would have been obvious to modify *McCorkle*’s local device 405 to include a plurality of antennas based on the teachings of *Tajima*. EX1002, ¶¶56-57. Like *McCorkle*, *Tajima* discloses determining a distance and direction to a remote wireless device. EX1003, Abstract, 5:5-17, Figs. 1, 3, 4. *Tajima* also discloses that its local device includes both a non-directional antenna and a directional antenna for determining the direction to the remote device. *Id.*, 5:28-34, 6:35-39, 7:15-38, 10:37-55, Fig. 4.

A POSITA would have been motivated to combine the teachings of *McCorkle* with those of *Tajima* with a reasonable expectation of success. First, the references are analogous art to the '777 patent (and each other), as each discloses wireless communication systems in the same field of endeavor (location determination) and are pertinent to the problem of how to locate a remote wireless device. EX1001, Abstract; EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1006, Abstract, 5:5-17, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4; EX1002, ¶58.

Second, combining the teachings of *McCorkle* with *Tajima* would have been no more than the combination of prior art elements according to known methods to yield predictable results. A POSITA reading *McCorkle* would have looked for known ways to determine the direction that a signal is coming from. EX1002, ¶59. A POSITA would have understood that using *Tajima*'s non-directional antenna and directional antenna would have been a beneficial modification to *McCorkle*'s distance-determining system because *Tajima* describes how to use the antennas for determining the direction of the signal in addition to the distance to the remote device. EX1006, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4; EX1002, ¶59. A POSITA would have understood that it would have been beneficial to use both a non-directional antenna and a directional antenna for determining the direction to remote device. EX1002, ¶59. This modification allows for an effective way of determining a direction to the remote device. *Id.* A POSITA would have been

motivated to implement *Tajima*'s use of both a non-directional antenna and a directional antenna with *McCorkle*'s distance-determining system to determine the direction to the remote device. *Id.*

Third, combining the teachings of *McCorkle* with *Tajima* would have been the use of a known technique to improve similar devices in the same way. The devices disclosed in *McCorkle* and *Tajima* are comparable systems. EX1003, Abstract, [0098]-[0105], [0118]-[0128], Figs. 4, 7; EX1006, Abstract, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4. A POSITA would have had a reasonable expectation of success at least because *McCorkle* discloses that local device 405 may use "any known UWB antenna." EX1003, [0102]. A POSITA would have understood that UWB uses radio signals for transmitting information. EX1002, ¶¶60-61; EX1003, [0002], [0067]-[0068], [0124]. *Tajima* describes to a POSITA how to implement using radio antennas to determine a distance and direction to a remote device. EX1006, 5:28-68, 6:35-39, 7:15-38, 10:37-55, Figs. 1, 3, 4.

Thus, *McCorkle*'s system as modified by *Tajima* to include to include a non-directional antenna and a directional antenna renders obvious that *said at least one antenna* (e.g., antennas 105) *comprises a plurality of antennas* (e.g., a non-directional antenna and a directional antenna).

[3.1] 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.

McCorkle alone, or in view of *Tajima*, renders obvious, [3.1]. As discussed for [3.0], a POSITA would have found it obvious to use multiple directional antennas to determine a direction to remote device. EX1002, ¶¶53-61; [0153]-[0157], Fig. 11; EX1005, 31:19-47, Fig. 9.

The processor unit 301 is connected to a communication interface 313 including the UWB transceiver and antennas 105. EX1003, [0069], [0086], [0101]. Processor unit 301 includes software for performing the processing performed in implementing *McCorkle*'s distance measuring system using UWB transmission. *Id.*, [0080]. *McCorkle* discloses that the local device processes reply signals received from each of the linked remote devices 410₁-410_N using its UWB transceiver and antennas to determine both the distance and direction to each of the linked remote devices 410₁-410_N. *Id.*, [0101], [0126]-[0128], Figs. 7, 11.

As discussed for [3.0], *Rofheart*, a parent of *McCorkle*, was incorporated by reference in *McCorkle*, and a POSITA would have looked to *Rofheart* to further understand the well-known routine details regarding the type of antennas (e.g., directional antennas) and how a multiple antenna system would work when utilizing multiple directional antennas. EX1002, ¶54. Similar to *McCorkle*, *Rofheart*'s processing system 201 also includes a communication interface 219 for receiving

wireless communications from remote devices. EX1005, 15:22-63, 31:19-38, Figs. 2-3. Processor system 201 includes software for performing the processing performed in implementing *Rofheart's* distance measuring system using UWB transmission. *Id.*, 14:14-41. *Rofheart* describes multiple antennas on the local device that may be used to provide the relevant special information and resolve the distance to the remote devices. EX1005, 31:19-47, Fig. 9. In particular, *Rofheart* discloses that the local device processes reply signals received from each of the linked remote devices using its UWB transceiver and directional antennas to determine both the distance and direction to each of the linked remote devices. *Id.*, 23:59-25:31, 27:46-28:38, 31:19-38, Figs. 7, 9.

Thus, *McCorkle* renders obvious that *said controller* (e.g., processor unit 301) *cooperates with said plurality of antennas* (e.g., receives signal information from antennas 105) *to determine a bearing* (e.g., direction) *to said target wireless communications device* (e.g., remote device 410₁) *based upon at least one of the received reply signals* (e.g., reply signal sent from remote device 410₁ to local device 405).

To the extent *Speir* argues that *McCorkle* alone does not disclose or render obvious that *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*, *McCorkle's* local device 405 as modified above by the

teachings of *Tajima* to include a non-directional antenna and a directional antenna for determining a direction to the remote device renders this element obvious. EX1002, ¶¶56-61.

McCorkle's processor unit 301 is connected to a communication interface 313 including the UWB transceiver and antennas 105. EX1003, [0069], [0086], [0101]. Processor unit 301 includes software for performing the processing performed in implementing *McCorkle*'s distance measuring system using UWB transmission. *Id.*, [0080]. *McCorkle* discloses that the local device processes reply signals received from each of the linked remote devices 410₁-410_N using its UWB transceiver and antennas to determine both the distance and direction to each of the linked remote devices 410₁-410_N. *Id.*, [0101], [0126]-[0128], Fig. 11. Similarly, the reply signals in *Tajima* are used to determine the distance and direction to the remote device. EX1006, 5:18-34, 7:15-38. Thus, a POSITA would have understood that *McCorkle*'s processor unit 301 would similarly use the reply signals obtained through the non-directional and directional antennas to determine the distance and direction to the remote device. EX1002, ¶57.

Thus, *McCorkle*'s local device 405 as modified by the teachings of *Tajima* to include both a non-directional antenna and a directional antenna renders obvious that *said controller* (e.g., processor unit 301) *cooperates with said plurality of antennas* (e.g., non-directional antenna and directional antenna) *to determine a bearing* (e.g.,

direction) *to said target wireless communications device* (e.g., remote device 410₁) *based upon at least one of the received reply signals* (e.g., determination of direction is made based on the signal received by local device 405 from remote device 410₁).

d. Claim 5

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional elements of [5.0] for the reasons discussed for [3.0] and [3.1]. In particular, as discussed for [3.0], *McCorkle* renders obvious that antennas 105 may include multiple directional antennas. EX1002, ¶¶53-55.

To the extent Speir argues that *McCorkle* alone does not disclose or render obvious that said at least one antenna comprises at least one directional antenna, *McCorkle*'s local device 405 as modified above by the teachings of *Tajima* to include a non-directional antenna and a directional antenna for determining a direction to the remote device (see discussion for [3.0] and [3.1]) renders this element obvious. *Id.*, ¶¶56-61.

e. Claim 6

[6.0] 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.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* discloses, or at least renders obvious the additional elements of [6.0]. As discussed for [1.3] and [1.4], *McCorkle* discloses that local device 405 (*wireless device locator*) includes an antenna, a transceiver, and a controller. *McCorkle* further discloses that local device may be a mobile device such as a mobile telephone, a laptop computer, or a personal digital assistant (PDA) which a POSITA would have understood has a *portable housing* because by 2004, it was common for these devices to have a housing having a size and weight that allows the device to be handheld by a person. EX1003, [0100]; EX1002, ¶62 (citing EX1017, Abstract, 7:21-22, Figs. 1, 3).

Thus, *McCorkle* discloses, or at least renders obvious, *wherein said wireless device locator* (e.g., local device 405) *further comprises a portable housing* (e.g., external portable housing of a mobile telephone, laptop computer, or PDA) *carrying said at least one antenna* (antenna 105), *said transceiver* (e.g., UWB transceiver), *and said controller* (e.g., processing unit 301).

f. Claim 7

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* alone discloses, or at least renders obvious, the

additional elements of [7.0]. As discussed for [1.1], remote devices 410₁-410_N correspond to the claimed *wireless communications devices*. *McCorkle* further discloses that remote devices 410₁-410_N communicate on wireless network 400 which may with a wireless local area network (WLAN). EX1003, [0098]. Thus, remote devices 410₁-410_N include *wireless local area network (WLAN) devices*.

g. Claim 8

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* alone discloses, or at least renders obvious, the additional elements of [8.0]. As discussed for [1.1], remote devices 410₁-410_N correspond to the claimed *wireless communications devices*. *McCorkle* further discloses that remote devices 410₁-410_N communicate on wireless network 400 which may be a wireless network in which the wireless devices make point-to-point connections or point-to-multipoint connections on the shared channel of a piconet. EX1003, [0098]. A POSITA would have understood that this type of network corresponds to a mobile ad-hoc network (MANET). EX1002, ¶63 (citing EX1007, 5; [US8625481], 2:36-48). In a MANET, “the user’s mobile devices are the network, and they must cooperatively provide the functionality usually provided by the network infrastructure (e.g., routers, switches, servers).” EX1007, 5; *see also*

EX1002, ¶63 (citing EX1016, 2:36-48). The devices may communicate with each other via various well known wireless data transfer protocols. *See, e.g.*, EX1007, Abstract, 8-11; EX1002, ¶63 (citing EX1016, 2:40-45). For example, similar to the network disclosed in *McCorkle*, one type of MANET occurs when wireless devices communication with one another via the Bluetooth protocol known as a piconet. EX1007, 10-11; EX1002, ¶63 (citing EX1016, 2:45-48). Thus, remote devices 410₁-410_N include *mobile ad-hoc network (MANET) devices*.

h. Claim 9

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

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 1. *McCorkle* alone discloses, or at least renders obvious, the additional elements of [9.0]. *McCorkle* discloses that remote devices 410₁-410_N (*wireless communications devices*) may be mobile devices such as mobile telephones, which is a *cellular communications device*. EX1003, [0100].

i. Claim 10

[10.0] A wireless communications system comprising:

To the extent limiting, *McCorkle* discloses, or at least renders obvious, the preamble for the same reasons discussed for [1.0].

[10.1] a plurality of wireless local area network (WLAN) devices each having a device type associated therewith from among a plurality of different device types, and each device type having a known device latency associated therewith; and

McCorkle discloses, or at least renders obvious, [10.1] for the same reasons discussed for [1.1] and [7.0].

[10.2] a wireless device locator comprising

McCorkle discloses, or at least renders obvious, [10.2] for the same reasons discussed for [1.2].

[10.3] at least one antenna and a transceiver connected thereto, and

McCorkle discloses, or at least renders obvious, [10.3] for the same reasons discussed for [1.3].

[10.4] a controller for cooperating with said transceiver for transmitting a plurality of location finding signals to a target WLAN device from among a plurality of WLAN devices;

McCorkle discloses, or at least renders obvious, [10.4] for the same reasons discussed for [1.4] and [7.0].

[10.5] said target WLAN device transmitting a respective reply signal for each of said location finding signals;

McCorkle discloses, or at least renders obvious, [10.5] for the same reasons discussed for [1.5] and [7.0].

[10.6] said controller of said wireless device locator also for cooperating with said transceiver for receiving the reply signals,

McCorkle discloses, or at least renders obvious, [10.6] for the same reasons discussed for [1.6].

[10.7] 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

McCorkle discloses, or at least renders obvious, [10.7] for the same reasons discussed for [1.7] and [7.0].

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

McCorkle in view of *Leeper* renders obvious [10.8] for the same reasons discussed for [1.8], [2.0], and [7.0].

j. Claim 11

[11.0] The wireless communications system of claim 10 wherein said at least one antenna comprises a plurality of antennas;

McCorkle in view of *Leeper* renders obvious the elements of claim 10. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional elements as discussed for [3.0].

[11.1] and 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.

McCorkle alone, or in view of *Tajima*, renders obvious [11.1] for the same reasons discussed for [3.1] and [7.0].

k. Claim 12

[12.0] A wireless device locator for locating a target wireless communications device comprising:

McCorkle discloses, or at least renders obvious, [12.0] for the same reasons discussed for [1.2]-[1.8].

[12.1] at least one antenna and a transceiver connected thereto, and

McCorkle discloses, or at least renders obvious, [12.1] for the same reasons discussed for [1.3].

[12.2] a controller for cooperating with said transceiver for transmitting a plurality of location finding signals to the target wireless communications device and receiving a respective signal therefrom for each of said location finding signals,

McCorkle discloses, or at least renders obvious, [12.2] for the same reasons discussed for [1.4] and [1.6].

[12.3] 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

McCorkle discloses, or at least renders obvious, [12.3] for the same reasons discussed for [1.1] and [1.7].

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

McCorkle alone discloses, or at least renders obvious, [12.4], or, in the alternative, *McCorkle* in view of *Leeper* renders obvious [12.4] for the same reasons discussed for [1.8].

l. Claim 13

[13.0] The wireless device locator of claim 12 wherein said controller estimates the range based upon an average of the propagation delays.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* in view of *Leeper* renders obvious the additional elements of [13.0] for the same reasons discussed for [2.0].

m. Claim 14

[14.0] The wireless device locator of claim 12 wherein said at least one antenna comprises a plurality of antennas; and

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the limitations of claim 12. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional limitations of [14.0] for the reasons discussed for [3.0].

[14.1] 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.

McCorkle alone, or in view of *Tajima*, renders obvious, [14.1] for the same reasons discussed for [3.1].

n. Claim 15

[15.0] The wireless device locator of claim 12 wherein said at least one antenna comprises at least one directional antenna.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional limitations of [15.0] for the reasons discussed for [5.0].

o. Claim 16

[16.0] 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.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* alone discloses, or at least renders obvious, the additional elements of [16.0], for the reasons discussed for [6.0].

p. Claim 17

[17.0] The wireless device locator of claim 12 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* alone discloses, or at least renders obvious, the additional elements of [17.0] for the reasons discussed for [7.0].

q. Claim 18

[18.0] The wireless device locator of claim 12 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* alone discloses, or at least renders obvious the additional elements of [18.0] for the reasons discussed for [8.0].

r. Claim 19

[19.0] The wireless device locator of claim 12 wherein the target wireless communications device comprises a cellular communications device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 12. *McCorkle* alone discloses, or at least renders obvious, [19.0] for the reasons discussed for [9.0].

s. Claim 20

[20.0] 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, and each device type having a known device latency associated therewith, the method comprising:

To the extent limiting, *McCorkle* discloses, or at least renders obvious, the preamble for the same reasons discussed for [1.0]-[1.8].

[20.1] using a controller for cooperating with a transceiver for transmitting a plurality of location finding signals to the target wireless communications, and receiving a respective reply signal for each of the location finding signals therefrom;

McCorkle discloses, or at least renders obvious, [20.1] for the same reasons discussed for [1.2]-[1.6].

[20.2] using the controller for 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

McCorkle discloses, or at least renders obvious, [20.2] for the same reasons discussed for [1.7].

[20.3] further using the controller for estimating a range to the target wireless communications device based upon a plurality of determined propagation delays.

McCorkle alone discloses, or at least renders obvious, [20.3], or, in the alternative, *McCorkle* in view of *Leeper* renders obvious [20.3] for the same reasons discussed for [1.8].

t. Claim 21

[21.0] The method of claim 12 wherein the controller estimates the range based upon an average of the propagation delays.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 20. *McCorkle* in view of *Leeper* renders obvious the additional elements of [21.0] for the same reasons discussed for [2.0].

u. Claim 22

[22.0] The method of claim 20 further comprising determining a bearing to the target wireless communications device based upon at least one of the received reply signals.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 20. *McCorkle* alone, or in view of *Tajima*, renders obvious the additional elements of [22.0] for the same reasons discussed for [3.1].

v. Claim 23

[23.0] The method of claim 20 wherein the target wireless communications device comprises a wireless local area network (WLAN) device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 20. *McCorkle* alone discloses, or at least renders obvious, the additional elements of [23.0] for the reasons discussed for [7.0].

w. Claim 24

[24.0] The method of claim 20 wherein the target wireless communications device comprises a mobile ad-hoc network (MANET) device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 20. *McCorkle* alone discloses, or at least renders obvious the additional elements of [24.0] for the reasons discussed for [8.0].

x. Claim 25

[25.0] The method of claim 20 wherein the target wireless communications device comprises a cellular

communications device.

McCorkle alone, or in view of *Leeper*, discloses or renders obvious the elements of claim 20. *McCorkle* alone discloses, or at least renders obvious, [25.0] for the reasons discussed for [9.0].