

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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DECLARATION OF DR. MICHAEL S. BRAASCH

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I, Dr. Michael S. Braasch, of Guysville, OH, declare that:

I. ASSIGNMENT

1. I have been retained as a technical expert by counsel on behalf of General Motors LLC (“GM” or “Petitioner”). I understand that Petitioner is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute *inter partes* review (“IPR”) proceedings of U.S. Patent No. 10,444,028 (“the ’028 patent”) (GM-1001).

2. I have been asked to provide my independent analysis of the ’028 patent in view of the prior art publications cited below.

3. I am not, and never have been, an employee of GM. However, I was retained by GM to teach a one-day short course on GPS antennas in the late 1990s. I taught this course on behalf of NavtechGPS (a navigation seminar company). To the best of my recollection, I have had no relationship with GM before or since this one day course. I received no compensation for this Declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’028 patent, the prior art publications cited below, and the issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’028 patent.

II. QUALIFICATIONS

4. I am currently the Thomas Professor of Engineering at Ohio University, Athens, Ohio. My qualifications for formulating my analysis on this

matter are summarized here and are addressed more fully in my curriculum vitae, which is attached hereto as Appendix A.

5. 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 aircraft navigation systems with an emphasis in GPS.

6. From 1989 to 1993, I was a research engineer in the Avionics Engineering Center at Ohio University. I became an adjunct assistant professor in the Department of Electrical and Computer Engineering at Ohio University in 1993 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 and real-time positioning including courses specifically on the use of GPS.

7. 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.

8. 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.

9. 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*, which is attached as Appendix A to this Declaration.

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

11. In addition to gaining expertise via my academic training, professional experiences, and research accomplishments described above, I have kept abreast of the field of navigation systems 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.

III. LEGAL PRINCIPLES

12. In forming my analysis and conclusions expressed in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Anticipation

13. I have been informed that a patent claim is invalid as anticipated under 35 U.S.C. § 102 if each and every element of a claim, as properly construed, is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or includes the claimed elements, it anticipates.

14. I have been informed that a claim is invalid under 35 U.S.C. § 102(a) if the claimed invention was known or used by others in the U.S., or was patented or published anywhere, before the Applicant's invention. I further have been informed that a claim is invalid under 35 U.S.C. § 102(b) if the invention was patented or published anywhere, or was in public use, on sale, or offered for sale in this country, more than one year prior to the filing date of the patent application (critical date). And a claim is invalid, as I have been informed, under 35 U.S.C. § 102(e), if an invention described by that claim was described in a U.S. patent granted on an application for a patent by another that was filed in the U.S. before the date of invention for such a claim.

B. Obviousness

15. I have been informed that a patent claim is invalid as "obvious" under 35 U.S.C. § 103 in light of one or more prior art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention ("POSITA"), taking into account (1) the scope and content of the prior art, (2) the

differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness, which include: (i) “long felt need” for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others. For purposes of my analysis here, I have applied a date of February 5, 2004, as the date of the alleged invention in my obviousness analyses, although in many cases the same analysis would hold true even if the date of the alleged invention occurred earlier than February 2004 (especially given the earlier publication or filing dates of the prior art in Exhibits GM-1004, GM-1005, GM-1006, GM-1007, GM-1008, GM-1009, and GM-1010 as described below).

16. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify the single prior art reference, or combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole.

I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

C. Claim Construction

17. I have been informed by counsel that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and custom meaning, the words of a claim are first given their plain meaning that those words would have had to a POSITA. I understand that the structure of the claims, the specification, and the file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a POSITA to a claim term at the time of filing. I have followed this approach in my analysis.

18. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time the alleged invention was made (not today). Because I do not know at what date the alleged invention as claimed was made, I have used the filing date of the earliest provisional application to which the '028 patent claims priority (Application No. 60/541,9904) as the point

in time for claim interpretation purposes, which was February 5, 2004. However, the interpretations that I provide below would have also been correct if the date of alleged invention was anywhere within the early 2000s. Additionally, I have not conducted any analysis as to whether or not the claims of the '028 patent are supported by the disclosures of the 60/541,990 provisional application.

IV. PERSON OF ORDINARY SKILL IN THE ART

19. Based on my knowledge and experience in the field and my review of the '028 patent and file history, I believe that a POSITA would have had a combination of experience and education in electrical engineering and navigation systems. This typically would consist of a minimum of a bachelor degree in electrical engineering, computer engineering, computer science, or a related engineering field plus 2-5 years of work and/or research experience in the field of electrical engineering and its subfield of navigation systems. My analysis and conclusions as expressed herein are thus based on the perspective of a person of ordinary skill in the art having this level of knowledge and skill at the time of the '028 patent. The same experience can be obtained through research and study in a graduate program or through comparable exposure to research literature through industry employment working in the field of navigation systems.

20. Because I do not know at what date the alleged invention as claimed was made, I have used the filing date of the earliest provisional application to

which the '028 patent claims priority (Application No. 60/541,9904) as the point in time from which my analysis from the perspective of one of ordinary skill in the art is based. Again, as previously explained, that date was February 5, 2004.

However, my analysis of the prior art and the conclusion herein would also apply even if the date of the alleged invention as claimed was anywhere within the early 2000s.

V. MATERIALS CONSIDERED

21. My analyses set forth in this Declaration are informed by my experience in the field of electrical engineering and navigation systems. Based on my above-described experience in the field of electrical engineering and navigation systems, I believe that I am considered to be an expert in the field. Also, based on my experiences, I understand and know of the capabilities of persons of ordinary skill in this field during early 2000s, and specifically during the time before the February 2004 priority date for the '028 patent (described in detail above in ¶¶4-11), and I taught, participated in organizations, and worked closely with many persons of such skill level in the field during that time frame.

22. As part of my independent analysis for this Declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this field during the time before the priority date for the '028 patent; my own knowledge and experiences gained

from my work experience in the fields of navigation technology and electrical engineering generally; my experience in teaching and advising others in those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed the following publications and materials:

- The disclosure and claims of U.S. Patent No. 10,444,028 (“the ’028 patent”; GM-1001);
- The prosecution history of the ’028 patent (GM-1002);
- U.S. Patent Pub. No. 2003/0055542 to Knockeart et al. (“Knockeart”; GM-1004);
- U.S. Patent Pub. No. 2002/0026278 to Feldman et al. (“Feldman”; GM-1005);
- U.S. Patent Pub. No. 2005/0096840 to Simske (“Simske”; GM-1006);
- U.S. Patent No. 7,203,598 to Whitsell (“Whitsell”; GM-1007);
- U.S. Patent No. 6,615,133 to Boies et al. (“Boies”; GM-1008);
- U.S. Patent No. 5,845,227 to Peterson (“Peterson”; GM-1009);
- U.S. Patent No. 7,027,915 to Craine (“Craine”; GM-1010)
- “Bearing Straight,” *Forbes* (May 4, 1998) (Located at <https://www.forbes.com/forbes-life-magazine/1998/0504/096.html?sh=7d25a7166b54>) (GM-1011);

- J. Hightower and G. Borriello, “Location systems for ubiquitous computing,” in *Computer*, vol. 34, no. 8, pp. 57-66, Aug. 2001, doi: 10.1109/2.940014 (GM-1012)
- U.S. Patent Pub. No. 2003/0009277 to Fan et al. (“Fan”; GM-1013)
- U.S. Patent No. 6,377,810 to Geiger et al. (“Geiger”; GM-1014)
- U.S. Patent No. 6,456,854 to Chern et al. (“Chern”; GM-1015)
- U.S. Patent Pub. No. 2004/0192299 to Wilson et al. (“Wilson”; GM-1016)
- U.S. Patent Pub. No. 2004/0224702 to Chaskar (“Chaskar”; GM-1017)

23. Although this Declaration refers to selected portions of the cited references for the sake of brevity, it should be understood that these are examples, and that one of ordinary skill in the art would have viewed the references cited herein in their entirety and in combination with other references cited herein or cited within the references themselves. The references used in this Declaration, therefore, should be viewed as being incorporated herein in their entireties.

VI. BACKGROUND OF THE '028 PATENT

A. Subject Matter Overview

24. The technology in the '028 patent at issue generally relates to a system for determining the optimal route between an origin and a destination using travel time information obtained from vehicles traveling in a network of roads.

The '028 patent describes “providing route, navigation, traffic, and or direction information to a traveler.” GM-1001, 1:51-54. Providing directions can include “locating a portable or mobile communication facility (e.g. locating a cell phone of a traveler through triangulation, or through gps), determining a destination and providing information relating to a route, including directions.” *Id.*, 1:54-59. The system is “adapted to calculate travel time estimates, best route suggestions, shortest route suggestions, alternate route suggestions, typical route suggestions, travel conditions, route conditions, directions, navigation or other route information.” *Id.*, 2:11-16. A monitoring facility can monitor and transmit “information relating to traffic conditions.” *Id.*, 2:39-44; *see also id.*, 2:35-38. “For example, a tracking facility may track traffic patterns and locate an abnormal traffic condition (e.g. an accident, construction, traffic congestion, or vehicles traveling [at] significantly slower rates than a speed limit or predicted speed) and a warning facility may be used to warn vehicles in close proximity to the abnormal traffic condition.” *Id.*, 27:23-28.

25. The '028 patent goes on to describe using probe devices located in traveling vehicles to estimate travel times for various road segments. These probe devices can take the form of cellular telephones located in traveling vehicles. For example, the '028 patent describes “estimating the travel time on a road portion through a plurality of cell phone locations.” GM-1001, 5:51-53. The '028 patent

describes that the positions of “mobile phones, or other transmitters” are used to determine traffic conditions. *See id.*, 19:61-20:10. The locations of these probe devices “may be used to estimate roadway congestion and or travel speed.” *Id.*, 19:67-20:2.

For example, cell phones in an area may be located and mapped against a known roadway map to determine roadway congestion levels. In another example, the position of the cell phone locations over a period of time may be tracked to estimate route speed. In an embodiment, cell phone locations are tracked while the cell phone is otherwise in normal use. In another embodiment, cell phones in an area are requested to transmit so their positions can be determined.

Id., 20:2-10.

26. The '028 patent further describes that the users of these probe devices can elect to have their location information shared for the purpose of determining traffic conditions. The '028 patent states that users may select a link “to enable, disable, or otherwise control the access of the mobile communication facilities location.” GM-1001, 45:31-33. The '028 patent describes that this selective sharing of location data can be achieved through the use of buddy lists. The '028 patent describes that “a user may have a ‘buddy list’ where known people or entities are known[.]” *Id.*, 45:35-37. The user can then “enable or disable this group’s access to information in the mobile communication facility (e.g. location information).” *Id.*, 45:37-39. Such lists of “buddies” or contacts can include “work, colleagues, home, family, navigation facilities, direction facilities, traffic

facilities, friends, agents, travel agent, lawyer, or other groups, entities, and or individuals.” *Id.*, 45:39-43. The device may also inform the user when another entity is attempting to access location data for the device and “the user may then have the ability to enable or disable the access.” *Id.*, 45:45-51. The user may also grant everyone access or certain predetermined groups access to location information. *Id.*, 45:51-57.

27. The system can calculate a route to a user specified destination based on the starting point of the user. GM-1001, 23:26-32. This can include presenting “a map with a route 2902 and an alternate route based on traffic condition information 2904.” *Id.*, 24:5-7.

B. File History of the '028 Patent

28. As part of my preparation of this Declaration, I reviewed select portions of the file history of the '028 patent (GM-1002), including the two Office Actions mailed during prosecution, Applicant’s responses to the Office Actions, and the Notice of Allowability that followed thereafter. I understand that the application that the '028 patent claims priority to U.S. Provisional Application No. 60/541,990 which was filed on February 5, 2004, and that this date is also the earliest possible effective filing date of the patent. The '028 patent eventually issued on October 15, 2019. *See* GM-1001 at Cover.

29. On December 16, 2015, Applicant filed the application that matured into the '028 patent. GM-1002, 5-165. The original application included a single independent claim (claim 1), with 31 total claims. *Id.*, 160-164.

30. On July 12, 2018, the USPTO mailed the first office action. GM-1002, 246-253. In that office action, the examiner rejected several of the claims as being indefinite under 35 USC § 112 and rejected all of the pending claims as being or as obvious over Fan et al (US 2003/0009277) in view of Nishimura et al (US 5,638,280). *Id.* In rejecting claim 1, the examiner identified paragraphs [0036]-[0037] of Fan as disclosing the claim feature of “wherein each of the plurality of cell phones further has a user initiated permission set to permit a requester to obtain its location[.]” *Id.*, 249. Specifically, the examiner identified the functionality in Fan of the user registering with the system as permission to permit a requester to obtain its location. *Id.* The cited section of Fan describes “exemplary table **28** which is indexed by mobile units and used by processing unit **30** to maintain the location and velocity data.” GM-1013, [0036]. The system collects information from each user “during the initial registration process.” *Id.* This includes information about the user, the user’s vehicle, and the user’s mobile unit. *Id.* The table records “the most recent locations received from vehicles 10-1 through 10-*n*.” *Id.*, [0037]. This vehicle location information is used to calculate travel times for various road segments. *Id.* The examiner considered

this registration process as the user providing permission to permit the navigation system to obtain the user device location. GM-1002, 249.

31. On November 12, 2018, Applicant submitted a response to the non-final office action that included amendments to independent claim 1. GM-1002, 274-287. The amendments to independent claim 1 in the November 12 response included amending the claim to recite “wherein each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that permit access to user cellphone location data.” *Id.*, 283.

1. (Currently Amended) A computer program product that, when executing on one or more computers, performs the steps of:
 - automatically receiving a current location; and
 - presenting a roadway map of an area proximate the current location, wherein the map includes at least one route from the current location to a destination based at least in part on a traffic condition, wherein the traffic condition is at least in part based on a plurality of cell phone speeds ~~on the route, each of the plurality of cell phone speeds~~ estimated through an assessment of multiple locations of each of the plurality of cell phones, ~~as determined through electronic triangulation,~~ wherein each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that [[to]] permit a requestor to obtain its location access to user cellphone location data.

Id.

32. On February 14, 2019, the USPTO mailed the second office action. GM-1002, 288-297. In that office action, the examiner once again rejected the claims as obvious over Fan in view of Nishimura, citing to the same paragraphs ([0036]-[0037]) of Fan for the amended limitation regarding “access to user

cellphone location data” while additionally citing to table 28 in FIG. 4 of Fan. *Id.*, 291-292. In addressing the claim amendments, the examiner stated that “[f]urthermore, it is noted that the features ‘permission set’ and ‘list of authorizations’ are not specifically defined therefore information contained in table 28 is considered as ‘permission set’ and ‘list of authorizations’ as claimed. Nishimura does not explicitly teach the permission set. However, Fan teaches the claimed limitation.” *Id.*, 295-296.

33. On April 15, 2019, the Applicant responded to the second office action by further amending claim 1 to recite “a user initiated permission set comprised of a list of authorizations that permit a user to selectively enable or disable access to user cellphone location data.” GM-1002, 304 (emphasis original).

1. (Currently Amended) A computer program product that, when executing on one or more computers performs the steps of:
automatically receiving a current location; and
presenting a roadway map of an area proximate the current location, wherein the map includes at least one route from the current location to a destination based at least in part on a traffic condition, wherein the traffic condition is at least in part based on a plurality of cell phone speeds estimated through an assessment of multiple locations of each of ~~[[the]]~~ a plurality of cell phones, wherein each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that permit a user to selectively enable or disable access to user cellphone location data.

Id.

34. Along with the amendment, the Applicant stated that “Fan does not disclose any permission set at all, and certainly none that includes a list of

authorizations that permit a user to selectively enable or disable access to the cellphone location information received from a user. Fan merely describes registering users within a system that collects data. Such registration is not a permission set that can be selectively enabled or disabled.” GM-1002, 309; *see also id.*, 310.

35. On June 14, 2019, the UPSTO issued a Notice of Allowability. GM-1002, 330-336. That document included a “Reasons for Allowance” section that identified this last claim amendment and the corresponding applicant arguments as the reason for allowance. *Id.*, 335. However, as demonstrated in my below analysis of the known art prior to the earliest priority date of the ’028 patent, user initiated authorization to “permit *a user to selectively enable or disable* access to user cellphone location data,” was known in the prior art.¹

VII. INTERPRETATIONS OF THE ’028 PATENT CLAIMS AT ISSUE

36. I understand that claim terms, in the absence of an express definition or disclaimer, are given their ordinary and customary meaning, as would have been understood by a POSITA at the time of the alleged invention.

37. In considering the meaning of the claims, however, I understand that one must consider the language of the claims in light of the remainder of the

¹ All emphasis added unless otherwise noted.

specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.

38. I have applied these principles in interpreting the Challenged Claims for purposes of my analysis in this Declaration. At this point in time, I do not believe that any claim terms require specific construction.

VIII. LOCATION SHARING AND PRIVACY IN PRIOR ART SYSTEMS

39. As discussed above, the earliest possible priority date for the '028 patent is February 5, 2004. Data and information privacy had been a concern in both mobile and non-mobile devices long before 2004. Device and system designers recognized that data security and privacy was of the utmost concern to prevent sensitive information from falling into the wrong hands and to ensure consumer confidence that their information was secure, thus providing customers with reassurance that such systems were safe to use. This was specifically true when it came to sharing of location information for mobile devices and obtaining express permission to obtain, utilize, and share such location information. Contrary to what was indicated during prosecution of the '028 patent, it was well-known in the prior art to provide a user interface to allow users of mobile devices to expressly enable or disable access to user cellphone location data.

40. As one example, in U.S. Patent No. 6,377,810 to Geiger et al. ("Geiger"), which was filed in June 1999 and issued on April 23, 2002, the

inventors describe a system in which “[l]ocation information is generated for a mobile device using a global positioning system (GPS) receiver (17) or by other means. A request for receipt of location information is received at the mobile device, over a wireless communications channel from a requesting entity (25), and a confirmation of *permission to receive location information is sent to the requesting entity*, over the wireless communication channel.” GM-1014, Abstract. Geiger describes “a requesting entity 25 that wishes to know the location of the mobile device 15[.]” *Id.*, 3:51-54. The particular mobile device “receives the location and permission request[.]” *Id.*, 4:7-10. If the user consents to share location information “the user enters an input at the user input 16, which causes the mobile device 15 to generate a location access permission attribute certificate granting permission to the requestor.” *Id.*, 4:13-17. Geiger describes methods to ensure that this location information is only shared with verified entities. *Id.*, 4:7-39.

41. In another example, in U.S. Patent No. 6,456,854 to Chern et al. (“Chern”), which was filed in May of 2000 and issued on September 24, 2002, the inventors describe “[a] system and method for locating mobile telephone devices via the Web.” GM-1015, Abstract. Chern goes on to describe providing a user interface on the user’s device that allows the user to selectively enable or disable access to the user cellphone location data:

FIG. 6 is a flowchart of a process for automatically sending location information from a mobile telephone device to a Web server. In step 240, *the user of the mobile telephone device navigates through the mobile unit's browser and selects an option for automatically publishing its location*. In one implementation, the user may choose to have Web server 136 periodically query the mobile unit for updated location information. Alternatively, *the user may choose to have the mobile unit 100 periodically send its location to Web server 136*, as previously described above with reference to step 228. In step 242, Web server 136 sends a request for GPS information to the mobile telephone device.

Id., 7:42-56. In another example, Chern describes a user interface having a selector 260 that “allows the user to choose to send GPS information to Web server 136.” *Id.*, 8:14-16; *see also id.*, 8:11-14.

42. In yet another example of requiring a user of a mobile device to expressly enable or disable location sharing, in U.S. Patent Pub. No. 2004/0192299 to Wilson et al. (“Wilson”), which was filed on December 20, 2002, the inventors describe a method of sharing location information with friends or buddies, similar to that described in the later filed '028 patent. For example, Wilson describes that “the user receives a confirmation screen (block 3104) that requires the user to *confirm that the user wishes to permit the friend to access the user's location* and mobile number.” GM-1016, [0138]. Wilson goes on to describe that “[i]f the user wishes to *deny location information to the requesting friend*, then the user receives a deny confirmation screen (block 3110) that indicates that the selected

friend will not have access to the user's location.” *Id.*, [0139]. Wilson describes that “the system provides options to protect user's privacy” that includes an interface that allows “users [to] quickly and easily turn on/off the location feature (‘go invisible’) at any time.” *Id.*, [0176].

43. In yet another example, in U.S. Patent Pub. No. 2004/0224702 to Chaskar (“Chaskar”), filed on May 9, 2003, the inventor describes a system and method “for access controlled delivery of location information.” GM-1017, Abstract. Chaskar describes that “[t]he mobile station is capable of receiving consent, such as from a user, to deliver location information regarding the mobile station.” *Id.*, [0007]. This consent to share location information can occur in response to “a request for a location-based service, which can trigger a prompt.” *Id.* Chaskar goes on to describe that it was known in prior art systems that the entity “requesting the location of a mobile station must have consent from the mobile station 10, or more particularly the user of the mobile station, before [the requesting entity] may receive the location information.” *Id.*, [0039]. The requesting entity “can prompt the mobile station for consent to deliver the location information[.]” *Id.*, [0040]; *see also* [0044] (“the software program prompts the user for consent to deliver the location information...If the user does not consent to delivery of the location information, the [requesting entity] cannot receive the location information[.]”).

44. As I discuss in greater detail below, this well-known functionality for requiring user permission to access location information by allowing the user to selectively enable or disable access to the user cellphone location data is also disclosed by Knockeart (U.S. Patent Pub. No. 2003/0055542) which describes two modes of data collection for collecting probe vehicle location and speed information and further describes that “[t]he operator of the vehicle has the option of enabling or disabling either mode of data collection through the user interface of the in-vehicle system.” GM-1004, [324]; *see also id.*, [0319]. The Feldman reference described below also discusses requiring “the knowledge and consent of the[] drivers” before “[t]racking vehicles.” GM-1005, [0064].

45. The above described examples and other examples in the prior art would have been well within the knowledge of a POSITA that, to help protect sensitive personal information of mobile device users, including location information of the mobile device, users of such devices were prompted to expressly grant or deny access to such location information by remote systems and entities.

IX. OVERVIEW OF CONCLUSIONS FORMED

46. This Declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1-7, 9-10, 12-21, 25-26, 29, and 31 of the '028 patent are rendered obvious in light of Knockeart in view of Feldman.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 7-8 of the '028 patent are rendered obvious in light of Knockeart in view of Feldman and Simske.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 10-11 and 30 of the '028 patent are rendered obvious in light of Knockeart in view of Feldman and Whitsell.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 14 and 22-24 of the '028 patent are rendered obvious in light of Knockeart in view of Feldman and Boies.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claim 14 of the '028 patent is rendered obvious in light of Knockeart in view of Feldman, Boies, and Peterson.

- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 27-28 of the '028 patent are rendered obvious in light of Knockeart in view of Feldman and Peterson.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claim 31 of the '028 patent is rendered obvious in light of Knockeart in view of Feldman and Craine.

X. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN WITH RESPECT TO CLAIMS 1-7, 9-10, 12-21, 25-26, 29, AND 31 (GROUND 1)

47. For the reasons articulated in detail below, and based on my review of the '028 patent and file history and the prior art references, I am confident that a POSITA would have readily understood that the combination of Knockeart and Feldman plainly provides all elements of claims 1-7, 9-10, 12-21, 25-26, 29, and 31 of the '028 patent. Feldman describes use of cellular telephones as probe devices for determining the locations and speeds of multiple vehicles traveling over road segments in a geographic area which would have readily applied to the navigation system of Knockeart and by the relatively late time frame leading up to February 2004, there were a number of conventional reasons that would have prompted a POSITA to predictably apply Feldman's suggested option to Knockeart's system (as described in detail below).

A. Overview of Knockeart

48. Knockeart describes a navigation system in which the locations of car based navigation terminals are tracked to identify travel speeds for various road segments. These determined travel speeds for the road segments are then used to identify the fastest travel routes from an origin to a destination. A user can specify a destination for a travel route using an in-vehicle terminal and the remote system will use the specified destination, the current location of the vehicle, and the travel time information obtained from numerous probe vehicles to determine a fastest route from the vehicle's current location to the specified destination. The remote system then provides information to the in-vehicle terminal which allows the in-vehicle terminal to display a map of the route along with turn-by-turn instructions for navigating to the destination.

49. Knockeart describes that “[t]he in-vehicle system communicates with the server system using a wireless communication link 110, such as over a cellular telephone system. A position system, such as a set of GPS satellites 140, provides positioning signals that are used by the in-vehicle systems, and optionally by the centralized server system to increase the accuracy of position estimates.” GM-1004, Abstract. “The server system computes a route to the destination and transmits the computed route to the in-vehicle system. The in-vehicle system guides the operator along the route.” *Id.*

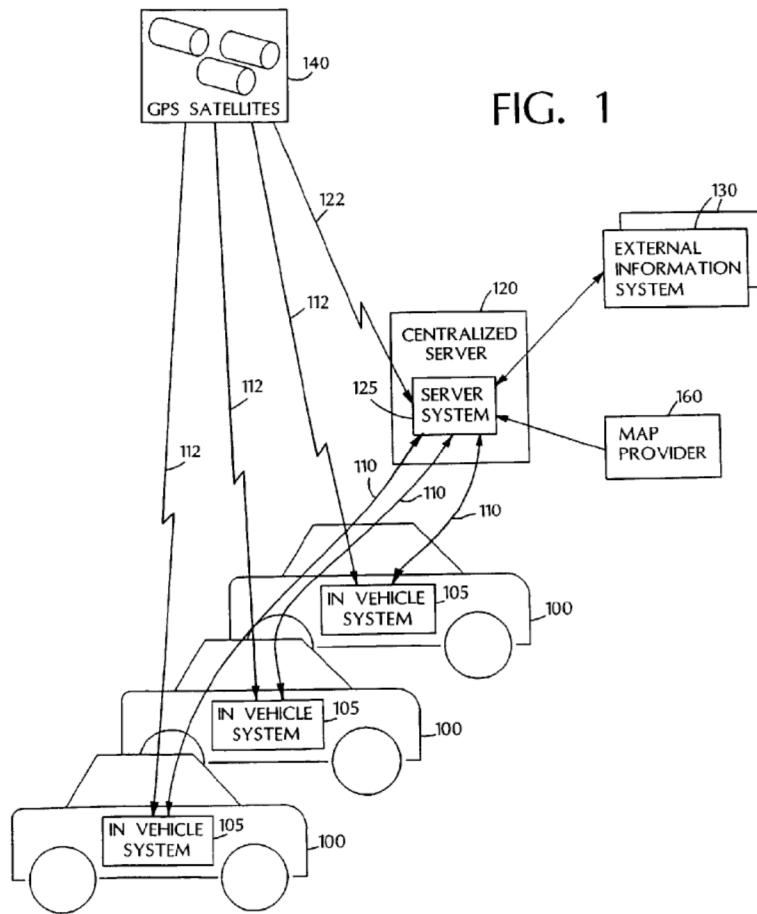


FIG. 1

GM-1004, FIG. 1.

50. Knockeart describes that the in-vehicle system “uses a displayed map on which the planned route and the vehicle’s location are dynamically displayed.” *Id.*, [0006]. The in-vehicle system determines the current location of the vehicle using GPS, which involves “multiple satellites emit[ting] signals that allow an in-vehicle GPS receiver to estimate its absolute location.” *Id.*, [0007]. Knockeart describes that the in-vehicle system “receiv[es] from the server a specification of a planned route through the road network to the destination” and “transmits a specification of the route to the vehicle.” *Id.*, [0010]. The in-vehicle system further

“receiv[es] from the server a specification of a planned route through the road network to the destination as well as receiving from the server a map that includes a specification of the road network in the vicinity of the planned route” such as “a ‘corridor’ around the planned route[.]” *Id.* The in-vehicle system also “display[s] the received map in conjunction with a representation of the planned route[.]” *Id.*

51. Knockeart goes on to describe “a method for collecting traffic information” that includes “tracking the location of a vehicle, including detecting when the vehicle traverses each of a plurality of segments of a road network, where “[f]or each detected segment, the method includes logging traffic-related data, including logging data related to the vehicle’s speed on the detected segment.” GM-1004, [0027]. In another example, Knockeart describes “tracking the location of a vehicle, including detecting when the vehicle traverses each of a set of segments of a road network” where “[f]or each detected segment, the method features comparing the vehicle’s speed on the segment to a stored speed for that segment, and if the vehicle’s speed on the segment deviates from the stored speed, transmitting a traffic notification identifying that segment to a server.” *Id.*, [0029]. The server system “makes use of some or all vehicles 100 as ‘probes’ for collecting traffic information” which is fed into the traffic database. *Id.*, [0318]. The server system can also “send[] updated traffic information to the external information system,” so that the “vehicle navigation system can be a source of

traffic information in addition to, or instead of, being a consumer of traffic information from external information system 130.” *Id.* When a vehicle requests a route from an origin (such as the vehicle’s current location) to a destination, the system “plan[s] a route through the road network from a starting to a destination location using the speed information associated with the road segments.” *Id.*, [0030]. This includes “enabling a subset of an available set of probe vehicles to provide the traffic related data[.]” *Id.*, [0031].

52. Knockeart describes that the in-vehicle system includes “an onboard computer, including storage for a map database, a wireless communication system for passing data between the onboard computer and a remote server, an input/output device for providing a user interface between the onboard computer and an operator of the vehicle, and a vehicle sensor for providing motion-related signals to the onboard computer,” where “[t]he onboard computer is programmed to perform the functions of accepting a planned route from the server over the wireless communication system, maintaining a first location estimate of the vehicle using the motion-related signals from the vehicle sensor, and, using the planned route and the first location estimate, providing guidance instructions to the operator through the input/output device.” GM-1004, [0038].

53. Knockeart describes that “traffic-related information [] is used by server system 125 to determine a fastest route from a starting to a destination

location.” GM-1004, [0077]. “The route is typically planned to provide a shortest distance or to try to *provide the shortest travel time*.” *Id.*, [0004]. Knockeart discloses that “[t]wo modes of data collection are used” for collecting probe vehicle location/speed data. *Id.*, [0319]. Furthermore, “[t]he operator of the vehicle has the option of enabling or disabling either mode of data collection through the user interface of the in-vehicle system.” *Id.*, [0324].

B. Overview of Feldman

54. Feldman describes a navigation system that is highly similar to that of Knockeart. Feldman includes additional details on using mobile navigation devices as probes to determine traffic flow rates for road segments in an area. This includes using cellular telephones in the possession of drivers as probes for determining traffic flow rates. Specifically, Feldman describes a navigation system for “finding optimal routes between given points, estimating travel times and initiating alerts and route alterations when unexpected traffic events change the vehicular traffic situation picture.” GM-1005, [0099]; *see also id.*, [0100]. These optimal routes are based on traffic information obtained using cellular telephones as probes.

55. Feldman describes “acquiring a variety of the vehicular traffic data and information associated with the oriented road section network, from a variety of sources[.]” GM-1005, Abstract. The system then “calculate[es] a mean

normalized travel time (NTT) value for each oriented road section of said oriented road section network using the prioritized, filtered, and controlled, vehicular traffic data and information associated with each source, for forming a partial current vehicular traffic situation picture associated with each source[.]” *Id.*; *see also id.*, [0018]. The system can then “generat[e] a single complete current vehicular traffic situation picture associated with entire oriented road section network” and “predict[] a future complete vehicular traffic situation picture associated with the entire oriented road section network[.]” *Id.*; *see also id.*, [0018].

56. Feldman describes that it was known “[i]n the prior art” to “protect[] the privacy of individuals associated with or hosting the sources... of vehicular traffic data and information which are acquired, collected, or gathered” including “cellular telephone types of mobile wireless communications networks or systems.” GM-1005, [0015]. Feldman goes on to specify that best routes are determined “using vehicular traffic data and information acquired from mobile sensors of a **cellular phone** mobile communication network[.]” *Id.*, [0024]. Feldman uses cellular phone probe information for “calculating velocities of vehicles, for example, by acquiring series of exact locations of the vehicles located along roads in known time intervals[.]” *Id.*, [0005].

57. Feldman goes on to describe identifying which cell phones, from a candidate set of cell phones, are likely to be traveling in vehicles. “In cellular

telephone networks, this is done by identifying phones whose cell-handover rates indicate a relatively fast movement.” GM-1005, [0059]. “Those cellular phones that are suspected as being ‘vehicle-carried’ are immediately tracked for their locations using the handovers themselves as ‘footprints’ or ‘footsetps’[sic], and/or other locating capability of the cellular phone network.” *Id.*, [0061]. “The tracking of the ‘moving’ phones is done by polling their locations in known time intervals.” *Id.*, [0062].

C. Combination of Knockeart with Feldman

58. Based on my review of the intrinsic record of the ’028 patent, Knockeart and Feldman, and my knowledge and experience in the field, I am confident that a POSITA would have readily recognized that all the elements of claims 1-7, 9-10, 12-21, 25-26, 29, and 31 are disclosed or suggested by the teachings of Knockeart in view of Feldman. Based on the multiple reasons articulated below, a POSITA would have been prompted to modify Knockeart’s navigation system to provide the conventional features suggested by Feldman as a matter of predictable and routine engineering design, especially by the relatively late time frame leading up to February 2004.

59. Multiple reasons would have prompted a POSITA to modify Knockeart’s navigation system to include the common prior art practice of using cellular telephones traveling in vehicles to determine traffic information for

various road segments, including the speed of travel of the cellular telephones along the road segments (as suggested by Feldman). As a first reason, a POSITA would have understood that cellular telephones were already in wide use by February of 2004, with many, if not most drivers carrying cellular telephones along with them in their vehicles, and therefore cellular telephones would have provided a large number of devices from which to collect traffic information, thus improving the accuracy of such information due to the large sample size. Feldman recognizes this knowledge of a POSITA, explaining that “currently, there is a significantly larger potential number of vehicles associated with cellular telephone types of a mobile wireless communication network or system compared to the potential number of vehicles associated with GPS types of a mobile wireless communication network or system.” GM-1005, [0009]. Knockeart’s main embodiment utilizes dedicated in-vehicle navigation systems that include “an onboard computer” which performs functions including determining and relaying vehicle location information. *See, e.g.*, GM-1004, [0007]-[0009], [0038], [0112]-[0114], [0122].

60. A POSITA would have recognized that cellular telephones were in much wider use than dedicated, system specific in-vehicle navigation systems. Feldman acknowledges this fact that there were far fewer of such system-specific in-vehicle systems than vehicle-carried cell phones at the time of Feldman’s priority date of August 28, 2000. GM-1005, [0009]. By February 2004, a POSITA

would have recognized that cell phone usage was even more wide spread.

Therefore, a POSITA would have recognized that it would have been beneficial to replace, enhance, or supplement at least some of the in-vehicle location tracking systems described by Knockeart with cell phone based location tracking (as taught by Feldman) because, as Feldman expressly recognizes, “there is a significantly larger potential number of vehicles associated with cellular telephone types of a mobile wireless communication network or system” therefore providing a greater number of potential probes for assessing traffic. GM-1005, [0009]. A POSITA would have recognized that having a larger pool of probes for use in collecting traffic data would have led to higher accuracy in travel time determinations for road segments. In addition to increasing the accuracy of measured traffic data, using cellular phones for at least some of the probes in the combined Knockeart-Feldman system would have allowed traffic information to be collected for a larger geographic area (larger number of roads) due to the ability to collect traffic information for roads that experience lower than average vehicle traffic.

61. As a second reason, a POSITA would have understood that by 2004, not only were cellular phones in widespread use, including among people driving in vehicles, but smart phones were also obtaining more and more functionality. As Feldman describes “[a] growing number of mobile wireless communication devices are increasingly being installed or carried in vehicles[.]” GM-1005, [0053].

Feldman discloses that its teachings are intended to “provide[] a variety of vehicular traffic related service applications to end users, *on the basis of existing infrastructure* of vehicular traffic data and information acquisition and collection, such as by using a cellular phone mobile communication network[.]” *Id.*, [0102]. A POSITA would have recognized that use of already existing cell phones in the possession of many if not most drivers, and the existing cellular phone infrastructure, to collect traffic data would have eliminated the need for users of the system to have both a cell phone (for communication and other non-traffic/navigation related purposes) and a dedicated in-vehicle navigation/location system. A POSITA would have recognized that implementing Knockeart’s in-vehicle system as already existing cellular phones already in the possession of drivers would have eliminated the need for users of Knockeart’s navigation system to purchase multiple pieces of potentially expensive computing equipment by implementing multiple functions in a single device (cell phones already in the possession of users). A POSITA would have recognized that the resulting combination would have reduced the costs of using such a system for users by eliminating the need to purchase specialized, vehicle specific equipment. The resulting combination also would have increased convenience of implementing Knockeart’s navigation system which would have both increased the total customer base and the number of available traffic probe devices, leading to greater

revenues for the resulting system while also improving the accuracy of traffic information measured using the cell phones as probes.

62. As a third reason, a POSITA would have understood that such a modification would have allowed the resulting system to acquire traffic data from “an ‘arbitrary’, non-pre-determined or non-designated, population or group of vehicles...therefore, resulting in a potentially large number of mobile sensors or electronic devices providing dynamic vehicle location and velocity data and information to the computerized central traffic data and information handling system” rather than only from devices of subscribers to the specific service. GM-1005, [0013], [0035]. “Hence, acquiring the vehicular traffic data and information from the data providing network does not depend at all on a specific group of mobile sensor device carrying end users.” GM-1005, [0102]. As discussed above, having a larger number of potential probes to use for collecting traffic information would have increased the accuracy of travel time estimates for road segments and allowed for collection of traffic data over a greater geographic area, including less frequently travelled road segments.

63. As a fourth reason, Feldman expressly teaches that an “important benefit” of its cellular phone based traffic data collection techniques are that they are “generally applicable and complementary to various different ‘upstream’ prior art techniques of gathering, collecting, or acquiring, vehicular traffic data and

information, and, generally applicable and complementary to various different ‘downstream’ prior art techniques of electronically communicating, sending, or distributing, the analyzed, modeled, and processed, vehicular traffic data and information in vehicular traffic related service applications to end users.” GM-1005, [0019]. Specifically, “[t]he present invention is implemented for acquiring, modeling, and processing vehicular traffic data and information, *in order to be compatible with a wide variety of end user types of traffic related service applications.*” *Id.*, [0102]. A POSITA would have recognized that compatibility with a wide variety of existing systems would have allowed for easier introduction and adoption by users of such a navigation system, thus increasing the overall user base of the system. Feldman’s teachings are intentionally contemplated as being compatible with and beneficial to other navigation systems, such as that disclosed by Knockeart, and therefore a POSITA would have recognized that Feldman’s teachings are readily applicable to the navigation system of Knockeart to improve the overall system.

64. As a fifth reason, Feldman expressly describes that its “sequence of generating dynamic three-dimensional vehicular traffic situation pictures *serves as a highly accurate and precise data base for vehicular traffic related service applications.*” GM-1005, [0103]. In another example, Feldman describes providing a “highly accurate and precise, yet, practicable and implementable

techniques for analyzing, modeling, and processing, the acquired, collected, or gathered, vehicular traffic data and information[.]” *Id.*, [0011]. Knockart expressly describes using various traffic information database sources. For example, Knockart’s server connects to “external information systems” including “an external information system [that] can provide traffic-related information that is used by server system 125 to determine a fastest route from a starting to a destination location.” GM-1004, [0077]. A POSITA would have recognized that utilizing a “highly accurate and precise data base for vehicular traffic” as one of the external sources of traffic information would have improved the accuracy and performance of Knockart’s navigation system.

65. As a sixth reason, Knockart already describes that the in-vehicle navigation systems communicate with the server using a cellular telephone system and therefore implementing Knockart’s system to use cellular telephones as at least some of the in-vehicle probes would have required minimum alterations to the original system of Knockart. As Knockart describes, the in-vehicle system communicates wirelessly with the server “over a standard analog cellular telephone system” or “digital cellular telephone links.” GM-1004, [0074], [0078], [0086]. Using cellular telephones already configured to communicate over the cellular telephone system as some or all of the probes in Knockart’s navigation system would have been an obvious implementation of Knockart’s system.

66. As a seventh reason, a POSITA would have been prompted to implement Knokeart's system to utilize standalone mobile cellular telephone handsets as in-vehicle probes for collecting traffic information (as suggested by Feldman) because doing so would be merely the application of a known technique (as suggested by Feldman) to a known system (e.g., Knokeart's traffic information collection and route guidance system) ready for improvement to yield predictable results. Here, Feldman provides straightforward evidence of a known technique of using a cellular telephone handset as an in-vehicle probe for collecting traffic data, including speed of travel along road segments, in navigation systems, and Knokeart's teaching provides a known system that would have been improved by application of Feldman's suggested technique for at least the reasons described above (§§58-65). A POSITA would have further recognized that Feldman's teachings would have been beneficially applied to Knokeart's system in one or more predictable manners. For example, a POSITA would have predictably applied the teachings of Feldman to Knokeart to use Feldman's traffic data collected from vehicle-carried cellular phones to provide at least part of the vehicle traffic information used by Knokeart's system. For example, a POSITA would have predictably applied the teachings of Feldman to Knokeart to implement all or a portion of Knokeart's in-vehicle systems as cellular phones for the purpose of collecting probe vehicle traffic data. In some such implementations,

some vehicles would have utilized the specialized in-vehicle systems described by Knockeart while other vehicles used vehicle mounted cellular phones or user carried cellular phones as the in-vehicle systems in the resulting combination. In some implementations, all of the in-vehicle systems described by Knockeart would have been implemented as vehicle mounted or user carried cellular phones. In the alternative or in addition to such a modification to Knockeart's system based on Feldman, a POSITA would have been prompted to implement Knockeart's system to utilize Feldman's vehicular traffic data collected by tracking "vehicle-carried" cellular telephones as one of the external traffic information sources expressly described in Knockeart. GM-1005, [0007]-[0009], [0036], [0038], [0053], [0058]-[0062]; GM-1004, [0077], ("an external information system 130 can provide traffic-related information that is used by server system 125 to determine a fastest route from a starting to a destination location"), [0170], [0317]-[0318], [0351]. In any of these implementations (or any combination of these implementations), cellular phones would have served as probes for determining traffic information, including travel times along road segments, as expressly taught by Feldman.

67. Based upon my knowledge and experience in this field and my review of Knockeart and Feldman, I am confident a POSITA would have recognized that such a modification would have yielded predictable results, and these modifications would have been within the predictable and ordinary level of skill of

a POSITA (certainly by a time frame as late as February 2004). Thus, a POSITA would have had a reasonable expectation of success in implementing such a combined system based on applying Feldman’s teachings to Knockeart’s system. Knockeart even contemplates “[o]ther embodiments” not expressly described and a POSITA would have recognized that Feldman’s cell phone based traffic data collection technique provides just such an embodiment that would have been readily applicable to the system of Knockeart. GM-1004, [0420]. Indeed, as would have been known to a POSITA, it was well-known in the art prior to 2004 to utilize cell phones as probes to collect traffic data for road segments. *See e.g.*, GM-1006, [0012]-[0013]; GM-1007, 1:42-54, 2:56-3:2; GM-1010, 7:51-54.

D. Application of the Combination of Knockeart and Feldman to the Challenged Claims

[1.P] A computer program product that, when executing on one or more computers performs the steps of:

68. Even if the preamble here was considered to be a limiting element of claim 1, the teachings of Knockeart describe a computer program product that, when executing on one or more computers performs the below described steps. For example, Knockeart’s system utilizes “a vehicle navigation system...includ[ing] an onboard computer[.]” GM-1004, [0038]. Figure 2 of Knockeart shows the onboard computer as part of the in-vehicle system:

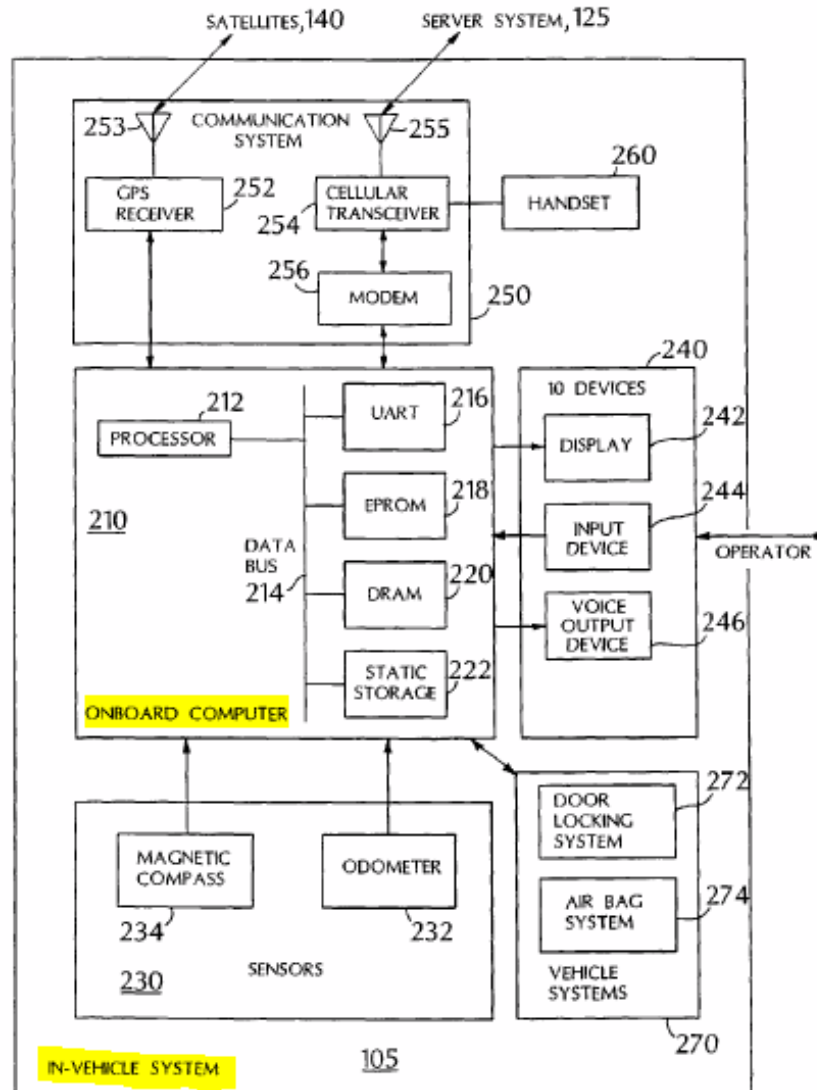


FIG. 2

Id., FIG. 2 (annotated).

69. Knockeart describes that the in-vehicle system includes “a wireless communication system for passing data between the onboard computer and a remote server, an input/output device for providing a user interface between the onboard computer and an operator of the vehicle, and a vehicle sensor for providing motion-related signals to the onboard computer.” GM-1004, [0038].

Furthermore, “[t]he *onboard computer is programmed* to perform the functions of accepting a planned route from the server over the wireless communication system, maintaining a first location estimate of the vehicle using the motion-related signals from the vehicle sensor, and, using the planned route and the first location estimate, providing guidance instructions to the operator through the input/output device.” *Id.* A POSITA would have understood that in the Knockeart-Feldman combination, this programming would have included programming to perform all of the functions conducted by the resulting system. Knockeart goes on to describe that “[o]nboard computer 210 has limited storage and processing capabilities” and that “[i]n this version of the in vehicle system, onboard computer 210 includes a processor 212 coupled to other components of the onboard computer over a data bus 214.” GM-1004, [0114]; *see also id.*, [0113]. The onboard computer executes “software components of in-vehicle system 105[.]” *Id.*, [0146]; *see also* [0145]-[0147], [0166]-[0168], [0356]-[0357], [0403], claim 35.

[1.1] automatically receiving a current location; and

70. Knockeart discloses that the in-vehicle system automatically receives a current location. Specifically, the in-vehicle system of Knockeart “track[s] the location of the vehicle.” GM-1004, [0010]; *see also id.*, [0011]-[0014]. This can include “receiving a reference signal from a positioning system, for example receiving signals from GPS satellites, and computing position data related to the

location of the vehicle using the received reference signal,” and further, “[f]or example, the position data can be latitude and longitude estimates, or can be GPS pseudorange measurements.” *Id.*, [0012]. The in-vehicle system can then transmit this location received location information to a server. *Id.* In another example, Knockeart describes that “[t]he vehicle information system also includes a positioning system that provides a reference for estimating the locations of vehicles 100 in absolute terms (i.e., in terms of their latitudes and longitudes). In particular, Global Positioning System (GPS) satellites 140 ***provide signals that when received at the vehicles enable the in-vehicle systems to estimate their locations.***” *Id.*, [0071]; *see also* [0075] (“In- vehicle systems 105 receive signals from GPS satellites 140 over radio frequency communication paths 112.”), [0086]-[0088]. In yet another example, Knockeart describes that the onboard computer receives “location-related information” from the GPS receiver 252. *Id.*, [0122].

[1.2] presenting a roadway map of an area proximate the current location;

71. Knockeart discloses presenting a roadway map of an area proximate the current location. Knockeart describes that the in-vehicle system “uses a displayed map on which the planned route and the vehicle’s location are dynamically displayed.” GM-1004, [0006]. Specifically, Knockeart describes that the in-vehicle system “receiv[es] from the server a specification of a planned route through the road network to the destination as well as receiving from the server a

map that includes a specification of the road network in the vicinity of the planned route” such as “a ‘corridor’ around the planned route[.]” *Id.*, [0010]. The in-vehicle system also “display[s] the received map in conjunction with a representation of the planned route[.]” *Id.* In another example, Knockeart describes that “[t]he planned route is shown in conjunction with the spot map, as is the vehicle’s DGPS based location.” *Id.*, [0282].

[1.3] wherein the map includes at least one route from the current location to a destination based at least in part on a traffic condition,

72. Knockeart discloses that the map includes at least one route from the current location to a destination based at least in part on a traffic condition.

Knockeart goes on to describe “a method for collecting traffic information” that includes “tracking the location of a vehicle, including detecting when the vehicle traverses each of a plurality of segments of a road network” and “[f]or each detected segment, the method includes logging traffic-related data, including logging data related to the *vehicle’s speed on the detected segment.*” GM-1004, [0027]. A POSITA would have recognized that this collected vehicle speed data for each road segment represents traffic conditions on each road segment.

73. When a particular in-vehicle system requests a route from an origin (such as the vehicle’s current location) to a destination, the system “*plan[s] a route* through the road network from a starting to a destination location using the *speed information associated with the road segments.*” GM-1004, [0030]. This includes

“enabling a subset of an available set of probe vehicles to provide the traffic related data[.]” *Id.*, [0031]. Specifically, Knockart describes that “**traffic-related information** [] is used by server system 125 to **determine a fastest route** from a starting to a destination location.” *Id.*, [0077]. “The route is typically planned to provide a shortest distance or to try to **provide the shortest travel time.**” *Id.*, [0004]. In another example, Knockart describes that the “server system 125 makes use of a traffic database 524 when planning routes that are based on expected travel time.” *Id.*, [0317]; *see also id.*, [0315]-[0319], [0170], [0089], [0254]-[0255], [0351]. Knockart also discloses that, in at least some embodiments, the starting location is the current location of the vehicle. For example, in FIG. 15A, Knockart discloses that the route planning process includes determining a current location of the vehicle (1503) and sending the destination and current location data to the server (1505) which then calculates a route that is returned to the in-vehicle system. GM-1004, FIG. 15A; *see also* [0174]-[0176]. In another example, Knockart describes that “[t]he in-vehicle system also sends information to the server system that allows the server system to determine **the vehicle’s starting location**[.]” *Id.*, [0086]. This can include “the in-vehicle system send[ing] the estimated latitude and longitude output obtained from a GPS receiver in the vehicle, or send[ing] other raw output from its GPS receiver.” *Id.*

74. As previously discussed, this route is displayed on the map. Specifically, Knockeart describes that the in-vehicle system “receiv[es] from the server *a specification of a planned route* through the road network to the destination as well as receiving from the server *a map that includes a specification of the road network* in the vicinity of the planned route” such as “a ‘corridor’ around the planned route[.]” GM-1004, [0010]. The in-vehicle system also “*display[s] the received map in conjunction with a representation of the planned route[.]*” *Id.*

75. In further examples, Knockeart describes using information from a “link speeds database 1910, which includes expected travel speeds for all the links in main roads network 100” when planning fastest routes from the current location of the vehicle to a destination. GM-1004, [0330]. Probe vehicles can report exception messages to the server when “a traffic exception has occurred” such as “a travel speed along a link is substantially slower or faster than expected[.]” *Id.*, [0337]; *see also id.*, [0338]-[0342]. The server “updates traffic database 524, which it uses to plan routes, based on the exception messages it receives from the probe vehicles.” *Id.*, [0340]. The server uses traffic exception data to “reset[] its expected speeds for the links on which exceptions have been reported[.]” *Id.*, [0341]. These link speeds reflecting exceptional traffic conditions make up the traffic data described above that is used for route planning. *Id.*, [0170], [0316]-

[0319], [0351]. For example, Knockeart describes that “the server system may know that certain links are congested with slower than expected speeds for their road classes” and “[t]he route planning algorithm would then tend to avoid such a congested link if there are alternative routes that can be taken.” *Id.*, [0254]; *see also id.*, [0255].

[1.4] wherein the traffic condition is at least in part based on a plurality of cell phone speeds estimated through an assessment of multiple locations of each of a plurality of cell phones,

76. Knockeart discloses that the traffic condition is at least in part based on a plurality of probe vehicle speeds estimated through an assessment of multiple locations of each of a plurality of probe vehicles while Feldman discloses determining traffic conditions at least in part based on a plurality of cell phone speeds estimated through an assessment of multiple locations of each of a plurality of cell phones. As I discussed in paragraphs 58-67, above, a POSITA would have found it obvious and beneficial to apply Feldman’s suggestions to the navigation system of Knockeart to include the common prior art practice of using cellular telephones traveling in vehicles to determine traffic information for various road segments, including the speed of travel of the cellular telephones along the road segments (as suggested by Feldman). A POSITA would have further recognized that Feldman’s teachings would have been beneficially applied to Knockeart’s system in one or more predictable manners. For example, a POSITA would have

predictably applied the teachings of Feldman to Knockart to use Feldman's traffic data collected from vehicle-carried cellular phones to provide at least part of the vehicle traffic information used by Knockart's system. For example, a POSITA would have predictably applied the teachings of Feldman to Knockart to implement all or a portion of Knockart's in-vehicle systems as cellular phones for the purpose of collecting probe vehicle traffic data. In some such implementations, some vehicles would have utilized the specialized in-vehicle systems described by Knockart while other vehicles used vehicle mounted cellular phones or user carried cellular phones as the in-vehicle systems in the resulting combination. In some implementations, all of the in-vehicle systems described by Knockart would have been implemented as vehicle mounted or user carried cellular phones. In the alternative or in addition to such a modification to Knockart's system based on Feldman, a POSITA would have been prompted to implement Knockart's system to utilize Feldman's vehicular traffic data collected by tracking "vehicle-carried" cellular telephones as one of the external traffic information sources expressly described in Knockart. GM-1005, [0007]-[0009], [0036], [0038], [0053], [0058]-[0062]; GM-1004, [0077], ("an external information system 130 can provide traffic-related information that is used by server system 125 to determine a fastest route from a starting to a destination location"), [0170], [0317]-[0318], [0351]. In any of these implementations (or any combination of these implementations),

cellular phones would have served as probes for determining traffic information, including travel times along road segments, as expressly taught by Feldman.

77. Turning first to the teachings of Knockeart, Knockeart describes “a method for collecting traffic information” that includes “*tracking the location of a vehicle*, including detecting when the vehicle traverses each of a plurality of segments of a road network” and noting that “[f]or each detected segment, the method includes logging traffic-related data, including *logging data related to the vehicle’s speed on the detected segment.*” GM-1004, [0027]. In another example, Knockeart describes “tracking the location of a vehicle, including detecting when the vehicle traverses each of a set of segments of a road network” where “[f]or each detected segment, the method features comparing the vehicle’s speed on the segment to a stored speed for that segment, and if the vehicle’s speed on the segment deviates from the stored speed, transmitting a traffic notification identifying that segment to a server.” *Id.*, [0029]. The server system “makes use of some or all vehicles 100 as ‘probes’ for collecting traffic information” which is fed into the traffic database. *Id.*, [0318].

78. Knockeart is clear that it collects information from a plurality of probe vehicles traveling a plurality of road segments, “[a]t the server system, navigation application 512 receives the logged speed information from a number of probe vehicles” and “[u]sing this collected information, the navigation application

updates traffic database 524.” GM-1004, [0325]. In another example, Knockart teaches that “the in-vehicle system *tracks the vehicle’s location* on main roads network 1000 that is stored in in-vehicle database 432.” *Id.*, [0322]. The in-vehicle system uses, for example, “GPS location estimates” to determine vehicle locations. *Id.* Using this vehicle location information, “[t]he in-vehicle system records the time the vehicle takes to travel from one end to the other of the link and stores a reference to the link, the time of day, and the speed traveled along the link in the link speed log.” *Id.*; *see also id.*, [0321]. Knockart discloses that the in-vehicle systems communicate using cellular phone systems, disclosing that link speed information is provided to the server, such as “over a cellular telephone connection with the server system.” *Id.*, [0323]. The server system can also “send[] updated traffic information to the external information system,” so that the “vehicle navigation system can be a source of traffic information in addition to, or instead of, being a consumer of traffic information from external information system 130.” *Id.*, [0318]; *see also* [0319].

79. When a vehicle requests a route from an origin (such as the vehicle’s current location) to a destination, the system “plan[s] a route through the road network from a starting to a destination location using the speed information associated with the road segments.” GM-1004, [0030]. This includes “enabling a subset of an available set of probe vehicles to provide the traffic related data[.]”

Id., [0031]. Knockeart thus teaches using the in-vehicle systems as probes to estimate speeds of the probe vehicles through an assessment of multiple locations of each of a plurality of in-vehicle systems to identify traffic conditions.

80. As discussed above, Feldman discloses that in the predictable combination of Knockeart with Feldman, at least some of the probes used for collecting traffic information, including estimated speeds for a plurality of road segments, are cell phones traveling in vehicles. Feldman describes “acquiring a variety of the vehicular traffic data and information associated with the oriented road section network, from a variety of sources” including cellular telephones traveling in vehicles along the road sections. GM-1005, Abstract. Feldman discloses that it was known in the art to collect traffic data using “mobile sensors or electronic devices physically located in or attached to vehicles[.]” GM-1005, [0007]. The primary example of such a mobile sensor described in Feldman is “mobile wireless devices such as *cellular telephones*” that were used to collect and report “dynamic *vehicle location and velocity data* and information[.]” *Id.*, [0008]; *see also id.*, [0009], [0035]-[0036], [0038], [0053].

81. As disclosed in the background section of Feldman (indicating knowledge of a POSITA in the relevant area of navigation systems prior to the filing date of Feldman), in the predictable combination of Knockeart with Feldman, cellular phone probe information is used for “*calculating velocities of*

vehicles, for example, by *acquiring series of exact locations* of the vehicles located along roads in known time intervals[.]” GM-1005, [0005]. In another example of using cellular phones as probes for electing traffic information, Feldman describes that “[t]hose cellular phones that are suspected as being ‘vehicle-carried’ are immediately *tracked for their locations*[.]” *Id.*, [0061].

Feldman goes on to describe that “[t]he tracking of the ‘moving’ phones is done by *polling their locations in known time intervals*.” *Id.*, [0062]. This cell phone location data is then used to calculate “a mean normalized travel time (NTT) value for each oriented road section[.]” *Id.*, [0066]. A POSITA would have recognized that such road link travel times would have been used to determine probe vehicle speeds in the combined system, as discussed above as “speed” is a comparison of time to distance. Specifically, “normalized travel time refers to a travel time normalized with respect to *a pre-determined distance*” which a POSITA would have recognized as providing, or at least rendering obvious, an estimated speed for the cell phone. *Id.*, [0055]. For example, Feldman describes calculating “the velocity of a given vehicle on the different road sections of the identified path[.]” GM-1005, [0055]. “A statistical processing of the velocities of all mobile sensors 62 that traveled on a specific oriented road section during the time period of an assessment cycle yields a normalized travel time (NTT) value...on that specific oriented road section[.]” *Id.* As I discussed above, Knockeart also

discloses that in the predictable combination, the in-vehicle probes (vehicle carried cellular phones) are used to “log[] data related to *the vehicle’s speed* on the detected segment.” GM-1004, [0027].

[1.5] wherein each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that permit a user to selectively enable or disable access to user cellphone location data.

82. As I discussed in paragraphs 39-45, above, protection of a user’s private information, including location information, was a known concern well before 2004 and a POSITA would have been aware of many prior art references disclosing user interfaces that allowed users of mobile devices to selectively enable or disable access to user cellphone location data. GM-1014, Abstract, 3:51-54, 4:7-39; GM-1015, Abstract, 7:42-56, 8:11-16, FIG. 6; GM-1016, [0138]-[0139], [0176]; GM-1017, Abstract, [0007], [0039]-[0040], [0044]. Knockart includes disclosures of just such an interface and thus demonstrates that the combination of Knockart and Feldman provides that each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that permit a user to selectively enable or disable access to user cellphone location data.

83. Knockart describes two modes of data collection for collecting location information from the in-vehicle systems. GM-1004, [0319], [0324]. The first mode of location data collection described includes “ongoing traffic ‘profile’ data [that] is collected by the in-vehicle systems in probe vehicles” and

occasionally uploaded to the server. *Id.*, [0319]. In the second mode of location information data collection, “the in-vehicle systems in the probe vehicles detect when the vehicle’s speed is significantly slower than would be expected based on the class of road being traveled, on or based on traffic related data that is stored in the vehicle and which relates the expected speed to the road segment being traveled on.” *Id.* In such instances, the in-vehicle system “immediately reports the exception to the server system so that the server system can update its traffic database 524 to reflects[sic] unexpected traffic conditions.” *Id.*

84. Relevant to this claim element, Knockeart is express that “[t]he operator of the vehicle has the option of enabling or disabling either mode of data collection through the user interface of the in-vehicle system.” GM-1004, [0324]. A POSITA would have recognized that this selective enabling or disabling of access to the in-vehicle systems location data would have been applied to the cellular phone probes described by Feldman in the resulting combination. Thus a POSITA would have recognized that the Knockeart-Feldman combination provides that each of the plurality of cell phones further has a user initiated permission set comprised of a list of authorizations that permit a user to selectively enable or disable access to user cellphone location data. Specifically, a POSITA would have recognized that a user interface that presents options for “enabling or disabling” multiple modes of location data collection provides the claimed “list of

authorizations” for selectively enabling or disabling access to user cellphone location data. This is confirmed by Feldman, which discloses that “[t]racking vehicles” should only be performed with “the knowledge and consent of their drivers” in order to preserve the user’s privacy. GM-1005, [0064].

85. A POSITA also would have recognized that in the predictable combination of Knockart with Feldman, the option to selectively enable or disable access to user cellphone location data would have been presented as a list of authorizations. For example, Knockart describes a physical user interface that “includes multiple push buttons associated with display 242.” GM-1004, [0118]. A POSITA would have recognized that in the resulting combination, the cellular phones used as in-vehicle probes for providing traffic data would have had a similar user interface for receiving user input, such as the multiple push buttons described by Knockart to allow for the user to interact with the device and make selections. Knockart goes on to describe that the “multiple push buttons” allow the user “to *select alternatives* shown on display 242, or to scroll the *list* of displayed alternatives” when selecting between multiple available options. *Id.* In another example, Knockart describes that the user can interact with the in-vehicle user device (implemented as a cellular phone in the predictable combination) by “accepting a selection from the *list* of categories[.]” *Id.*, [0032]. There are several

other disclosers of “scrolling lists” and “selecting from a displayed list of choices” throughout Knockeart. *Id.*, [0211], [0219], [0230].

86. A POSITA therefore would have recognized that, in the resulting combination of Knockeart with Feldman, the multiple available options for “enabling or disabling” probe location data collection described by Knockeart would have been provided as a “list of displayed alternatives” displayed on a user interface of the resulting in-vehicle cellular phone probe to allow the driver to scroll the available options to select one of the available options (e.g., enable or disable location tracking). GM-1004, [0324], [0118]. Knockeart discloses that the user interface for the probe devices allow drivers to select from alternatives by scrolling through a list of alternatives and the options to enable or disable location tracking are just one example of the many user interactions conducted through the user interface described in Knockeart.

87. Alternatively, a POSITA would have recognized that it would have been obvious to provide the options for enabling or disabling tracking of location data (in either of the two modes of data collection) as a list of selectable options presented via Knockeart’s user interface based on Knockeart’s express description of allowing users to scroll lists of available options presented by the user interface. Implementing the resulting in-vehicle cellular phone probes in such a manner would have been beneficial because it already uses a user interface technique

expressly described by Knockeart for presenting lists for allowing users to make selections and therefore implementing the “enabling or disabling” options using such lists would have eliminated the need for developing another method of allowing such user selection.

88. For at least the above discussed reasons, I am confident a POSITA would have recognized that the teachings of Knockeart in view of Feldman provide all elements of claim 1 of the '028 patent.

[2] The computer program product of claim 1, wherein each of the plurality of cell phones communicates its respective locations through a cellular network infrastructure to a server for calculation of the traffic condition.

89. Knockeart in view of Feldman provides that each of the plurality of cell phones communicates its respective locations through a cellular network infrastructure to a server for calculation of the traffic condition. As I described in paragraphs 58-67, above, in the predictable combination of Knockeart with Feldman, at least some of the in-vehicle probes used to collect traffic information would have been implemented as cellular phones. Feldman discloses that “mobile sensors or electronic devices provid[e] dynamic ***vehicle location*** and velocity data and information ***to the computerized central traffic data and information handling system.***” GM-1005, [0035]. In another example, Feldman discloses that “mobile wireless communication devices are increasingly being installed or carried in vehicles, and are capable of transmitting vehicular locations to a computerized

central data and information receiving and processing system.” *Id.*, [0053]; *see also id.*, [0071]. As discussed above, at least some of the mobile devices in the predictable combination are “cellular phones.” *Id.*, [0053].

90. Feldman further discloses that “[d]ata acquisition from cellular phones is controlled by a server connected to a particular ***cellular phone network***” and therefore Feldman discloses that in the predictable combination the cellular phone location information is provided to the server through a cellular network infrastructure. GM-1005, [0060]; *see also id.*, [0061]. As Feldman describes, “cellular phones that are suspected as being ‘vehicle-carried’ are immediately tracked for their locations.” *Id.*, [0061]. Knockeart provides numerous other examples of in-vehicle probe location data and other information being communicated to the server over a cellular phone network. *See e.g.* GM-1004, [0074], [0078], [0086] (communication between in-vehicle system and the server over a cellular network infrastructure). Turning back to Feldman, Feldman also discloses that “processing steps” for “calculating a mean normalized travel time (NTT) value for each oriented road section” “take[s] place in a server” using the obtained cell phone location data. GM-1005, [0065]-[0066].

91. In addition to or alternative to the above discussed disclosures of Feldman, Knockeart also discloses that the in-vehicle system for each probe vehicle (implemented in whole or in part as vehicle carried cellular phones in the

predictable Knockeart-Feldman system) communicates through a cellular network infrastructure to a server for calculation of the traffic condition. For example, Knockeart describes that each in-vehicle system “*tracks the vehicle’s location* on main roads network” using “GPS location estimates it receives from its GPS receiver[.]” GM-1004, [0322]. Knockeart describes that the in-vehicle system uses this location information to determine “the time the vehicle takes to travel” each link and records “a reference to the link, the time of day, and the speed traveled along the link in the link speed log.” *Id.* While this embodiment describes the travel time and speed calculations as being performed by the in-vehicle system, a POSITA would have recognized that it would have been obvious to transmit the raw location data to the server to allow the server to calculate the travel times and speeds on each link for each vehicle. Such an implementation would have been recognized by a POSITA as beneficial as it would have allowed for processing needs to be shifted to the server, thereby reducing the amount of processing and memory capacity required for the in-vehicle system. This would have been especially beneficial in the Knockeart-Feldman combination in which the in-vehicle systems for probe vehicles are implemented as cellular phones. Additionally, the server system is one of only two predictable options for where such calculations would be performed in the resulting system (the other option being the cellular phone probes). For example, Knockeart describes an

embodiment in which “the in-vehicle *system provides the vehicle’s location to the server system*[.]” GM-1004, [0390].

92. Knockart further discloses that each in-vehicle system communicates wirelessly with the server “over a standard analog cellular telephone system” or “digital cellular telephone links.” GM-1004, [0074], [0078], [0086]. Therefore, a POSITA would have recognized that the plurality of vehicle-carried cell phones in the Knockart-Feldman combination would have communicated their respective locations through a cellular network infrastructure to the server for calculation of the traffic condition.

[3] The computer program product of claim 1, wherein each of the plurality of cell phones communicates its respective speed through a cellular network infrastructure to a server for calculation of the traffic condition.

93. As I described above with respect to claim 2, the predictable combination of Knockart with Feldman discloses that each of the plurality of cell phones communicates its respective locations *and speed* through a cellular network infrastructure to a server for calculation of the traffic condition. Feldman discloses that in the predictable combination “mobile sensors or electronic devices provid[e] dynamic vehicle location and *velocity data* and information *to the computerized central traffic data and information handling system*.” GM-1005, [0035]. As discussed above, at least some of the mobile devices in the predictable combination are “cellular phones.” *Id.*, [0008]-[0009], [0034]-[0036], [0038], [0053].

94. Feldman further discloses that “[d]ata acquisition from cellular phones is controlled by a server connected to a particular *cellular phone network*” and therefore Feldman discloses that in the predictable combination the in-vehicle cellular phone speed information is provided to the server through a cellular network infrastructure. GM-1005, [0060]. As Feldman describes, “cellular phones that are suspected as being ‘vehicle-carried’ are immediately tracked for their locations[.]” *Id.*, [0061]. Knockart provides numerous other examples of in-vehicle probe speed data and other information being communicated to the server over a cellular phone network. *See e.g.* GM-1004 [0074], [0078], [0086]. For example, Knockart describes that each in-vehicle probe (which is a cellular phone in the predictable combination) sends “a reference to the link, the time of day, and the *speed traveled* along the link in the link speed log” for each link traversed and “sends the logged profile information it has stored in link speed log 1920 *to the server system...over a cellular telephone connection* with the server system.” GM-1004, [0322]-[0323]. Knockart goes on to describe that “[a]t the server system, navigation application 512 *receives the logged speed information* from a number of probe vehicles.” *Id.*, [0325]. In another example, Knockart further describes the in-vehicle system transmitting data “identifying the link and the *travel speed, to the server system*” to identify “traffic exception[s].” *Id.*, [0338]; *see also id.*, [0336]-[0338], [0347]-[0348]. Turning back to Feldman, Feldman

also discloses that “processing steps” for “calculating a mean normalized travel time (NTT) value for each oriented road section” “take[s] place in a server” using the obtained cell phone speed data. GM-1005, [0065]-[0066].

95. In addition to or alternative to the above discussed disclosures of Feldman, Knockeart also discloses that the in-vehicle system for each probe vehicle (implemented in whole or in part as vehicle carried cellular phones in the predictable Knockeart-Feldman system) communicates through a cellular network infrastructure to a server for calculation of the traffic condition. For example, Knockeart describes that the in-vehicle system uses this location information to determine “the time the vehicle takes to travel” each link (i.e., speed) and records “a reference to the link, the time of day, and the *speed traveled* along the link in the link speed log.” GM-1004, [0322]. While this embodiment describes the travel time and speed calculations as being performed by the in-vehicle system, a POSITA would have recognized that it would have been obvious to transmit the raw location data to the server to allow the server to calculate the travel times and speeds on each link for each vehicle. Such an implementation would have been recognized by a POSITA as beneficial as it would have allowed for processing needs to be shifted to the server, thereby reducing the amount of processing and memory capacity required for the in-vehicle system. This would have been especially beneficial in the Knockeart-Feldman combination in which the in-

vehicle systems for probe vehicles are implemented as cellular phones.

Additionally, the server system is one of only two predictable options for where such calculations would be performed in the resulting system (the other option being the cellular phone probes). For example, Knockeart describes an embodiment in which “the in-vehicle *system provides the vehicle’s location to the server system*[.]” GM-1004, [0390].

96. Knockeart further discloses that each in-vehicle system communicates wirelessly with the server “over a standard analog cellular telephone system” or “digital cellular telephone links[.]” GM-1004, [0074], [0078], [0086]. Therefore, a POSITA would have recognized that the plurality of vehicle-carried cell phones in the Knockeart-Feldman combination would have communicated their respective locations through a cellular network infrastructure to the server for calculation of the traffic condition.

[4] The computer program product of claim 1, wherein access to user cellphone location data is granted following a confirmation of at least one entry on the list of authorizations.

97. The combination of Knockeart with Feldman provides that access to user cellphone location data is granted following a confirmation of at least one entry on the list of authorizations. As I discussed above with respect to Element 1.5, Knockeart is express that “[t]he operator of the vehicle has the option of enabling or disabling either mode of data collection through the user interface of

the in-vehicle system.” GM-1004, [0324]. A POSITA would have recognized that this selective enabling or disabling of access to the in-vehicle systems location data would have been applied to the cellular phone probes described by Feldman in the resulting combination. Additionally, a POSITA would have recognized that requiring the vehicle operator to either enable or disable collection of location data would have required a confirmation of at least one entry on the list of authorizations to allow access to the probe cellular phone location data. Thus, a POSITA would have recognized that the Knockeart-Feldman combination provides that access to user cellphone location data is granted following a confirmation of at least one entry on the list of authorizations. Specifically, a POSITA would have recognized that a user interface that presents options for “enabling or disabling” multiple modes of location data collection provides the claimed “list of authorizations” from which the driver could selectively enable or disable access to user cellphone location data. This is confirmed by Feldman, which discloses that “[t]racking vehicles” should only be performed with “the knowledge and consent of their drivers” in order to preserve the user’s privacy. GM-1005, [0064].

98. This is confirmed by further disclosures of Knockeart which disclose a user interface that allows the user to “scroll the list of displayed alternatives” and “*select alternatives*” when navigating menus to make selections. GM-1004,

[0118], [0032], [0211], [0219], [0230]. From these combined disclosures of Knockeart and Feldman, a POSITA would have recognized that in the predictable combination, selecting the alternative to enable collection of location data provides confirmation of at least one entry on the list of authorizations and that such a selection would have granted access to user cellphone location data in the Knockeart-Feldman combination in which at least some of the probe devices are vehicle-carried cell phones.

[5] The computer program product of claim 1, wherein the user initiated permission set is accessed through a user interface presented on a user device.

99. Knockeart discloses that the user-initiated permission set is accessed through a user interface presented on a user device. As I discussed with respect to Element 1.5, above, “[t]he operator of the vehicle has the option of ***enabling or disabling*** either mode of data collection ***through the user interface of the in-vehicle system.***” GM-1004, [0324]. As previously discussed, in the predictable combination of Knockeart with Feldman, at least some of the in-vehicle systems are implemented as cellular phones and therefore in the resulting combination, the user interface for selectively enabling or disabling access to device location information would be presented on a user interface of the vehicle carried cellular phone. GM-1005, [0005]-[0008], [0053], [0055], [0061]-[0062], [0066]. I note that claim 5 does not require the recited “user device” to be different from one of

the “cell phones” recited by claim 1. Therefore, the Knockeart-Feldman combination provides claim 5 by disclosing, collectively, that in the resulting combination the user interface for selectively enabling or disabling collection of location information would be presented on vehicle carried cellular phones.

100. However, I have also been asked to assess claim 5 in the event that it is read narrowly to require that the user device is distinct from the cell phone from which the location data is collected. While I disagree with this interpretation of claim 5, based on my knowledge and experience in the relevant field and my review of the cited prior art references, I believe that a POSITA would have recognized such functionality would have been obvious based on the teachings of Knockeart in view of Feldman combination. Specifically, Knockeart’s teachings regarding allowing a user to create a profile on a personal computing device that is distinct from the in-vehicle device and store preferences as part of that profile renders obvious that the user initiated permission set is accessed through a user interface presented on a user device even if this claim is interpreted narrowly as discussed above.

101. Regarding user profiles, Knockeart discloses “individual operators can have stored profiles that are stored in the vehicle and may have corresponding storage on the server system.” GM-1004, [0237]. The server system “includes a remote configuration system” that the user can access over the Internet to

“modify their records in user profiles 2232 that are stored at the server system.”

Id., [0405]. A POSITA would have recognized from this disclosure that the user would have been able to access the profile from any internet connected device, such as a cell phone, PDA, tablet, or personal computer distinct from the location information collecting cellular phone, to “modify” the user profile. For example, Knockeart describes that “[t]he user can access the remote configuration system in a variety of ways, including over the Internet[.]” *Id.*, [0408]. Knockeart therefore discloses that the personal profile, which stores user preferences such as whether to selectively enable or disable collection of location data, can be edited by a different computer by accessing the remote configuration system over the Internet, such as through a web browser.

102. Alternatively, it would have been obvious to allow the user to modify the profile from computing devices other than the location information collecting cellular phone of the Knockeart-Feldman combination to increase user convenience. For example, as would have been recognized by a POSITA, such access would have allowed for modification of the profile with a keyboard and mouse-enabled device, to make modifications to the profile quicker and easier. As Knockeart describes, “[a] user’s profile is downloaded by the server system to the in-vehicle system in that user’s vehicle, or can alternatively be stored on the server system.” GM-1004, [0405]. To the extent Knockeart does not expressly disclose

that the user selected options for enabling or disabling location tracking are stored as part of the user profile, it would have been obvious to store such information in the user profile. For example, Knockeart describes that “[i]nformation in the user profiles can include *various types of information*[.]” *Id.* A POSITA would have recognized that it would have been beneficial to include the user’s preference for enabling or disabling location tracking in the user profile so that the user did not need to enter such a selection every time the user enters a new destination or every time the user engages with the navigation application executing on the vehicle carried cellular phone. Additionally, the user profile data structure already exists and therefore a POSITA would have recognized that such an implementation would have eliminated the need to create a new, additional data structure for storing such user selection information.

[6] The computer program product of claim 1, further comprising receiving a navigation request to assist a driver in navigating to the destination.

103. Knockeart describes receiving a navigation request to assist a driver in navigating to the destination. Specifically, Knockeart describes that the in-vehicle system can receive a request from the driver, which causes the in-vehicle system to send a request to the server to “plan[] a route through the road network from a starting to a destination location using the speed information associated with the road segments.” GM-1004, [0030]; *see also id.*, [0031]. Specifically, Knockeart

describes that its implementation includes “a navigation system for accepting ***route planning request*** from the vehicles[.]” *Id.*, [0041]. In one specific example of Knockeart, “the user provides a destination specification to the remote configuration system and the server system downloads a planned route to the destination” as part of a “route planning request[.]” *Id.*, [0408]. In another example, Knockeart describes that its navigation system “enable[s] an operator of a vehicle to specify a desired destination, and then to be guided by the system to that destination while driving the vehicle,” where the “[i]n-vehicle system 105 tracks (i.e., repeatedly estimates) the position of the vehicle as it travels to the desired destination, and provides instructions to the operator to guide the operator to the desired destination.” *Id.*, [0072]. This section of Knockeart goes on to describe that “a route planning function is performed by server system 125 at the request of in-vehicle system 105 while route guidance functions are performed by in-vehicle system 105.” *Id.*, [0073]. As part of this navigation request “a starting location (or other location-related data), speed and heading, and a desired destination are uploaded from the in-vehicle system to the server system and then a planned route is downloaded from the server system to the in-vehicle system.” *Id.*, [0074]; *see also id.*, [0084]-[0090].

[7] The computer program product of claim 1, wherein the plurality of cell phones is selected from a candidate set of cell phones in an area proximate the route.

104. The Knockeart-Feldman combination provides that the plurality of cell phones is selected from a candidate set of cell phones in an area proximate the route. Specifically, Feldman describes that the plurality of cell phones are selected from a candidate set of cell phones by identifying cell phones in a particular area near the starting point and destination that are identified as likely traveling within vehicles.

105. Knockeart describes “*enabling a subset of an available set of probe vehicles* to provide the traffic related data[.]” GM-1004, [0031]. Feldman provides additional details on how to select a plurality of probe cell phones from a candidate set of cell phones in an area proximate the route in the predictable combination that a POSITA would have beneficially applied to Knockeart to ensure that only relevant location data from candidate devices is used in determining the best/fastest route to the destination.

106. Specifically, Feldman describes selecting a “sample population” of cell phones from a “huge” number of available probe cell phones. GM-1005, [0058]. “The choice of sample units is done by making sure that they are in high probability moving-vehicle-carried” to create an “initial choice of sensor population[.]” *Id.*, [0059]. Subsequently, “[t]hose cellular phones that are suspected as being ‘vehicle-carried’ are immediately tracked for their locations.” *Id.*, [0061]. The system then selects a subset of this subset of available cellular

phones by “filter[ing] out cellular phones that are recognized as ‘noise’” such as by removing “cellular phones that stopped moving.” *Id.*, [0062]. “Once the ‘moving’ sensors are identified, method/system 10 *includes them in the sample population*[.]” *Id.*, [0063]. Feldman additionally discloses that the estimated link travel times derived from probe vehicle information is used in “finding optimal routes between given points,” and therefore a POSITA would have recognized that the subset of probe cell phones would be cell phones located in an area proximate the route as this link speed information is the information that is relevant to planning the route. *Id.*, [0099]; *see also id.*, [0100]-[0101]; GM-1004, [0030], [0077], [0170], [0315]-[0319];

[9] The computer program product of claim 1, wherein the destination is received from a source that is remote from a device on which the roadway map is presented.

107. Knockeart discloses that the destination is received from a source that is remote from a device on which the roadway map is presented. Specifically, Knockeart gives several examples in which the destination is received from the remote server, which is remote from the in-vehicle system (implemented as a cellular phone in at least some vehicles in the Knockeart-Feldman combination), on which the roadway map is presented. As I previously discussed, Knockeart discloses that the roadway map is displayed on the in-vehicle system. For example, the in-vehicle system “uses a displayed map on which the planned route and the vehicle’s location are dynamically displayed.” GM-1004, [0006]. The in-

vehicle system “receiv[es] from the server a specification of a planned route through the road network to the destination as well as receiving from the server a map that includes a specification of the road network in the vicinity of the planned route” such as “a ‘corridor’ around the planned route[.]” *Id.*, [0010]. The in-vehicle system also “display[s] the received map in conjunction with a representation of the planned route[.]” *Id.*

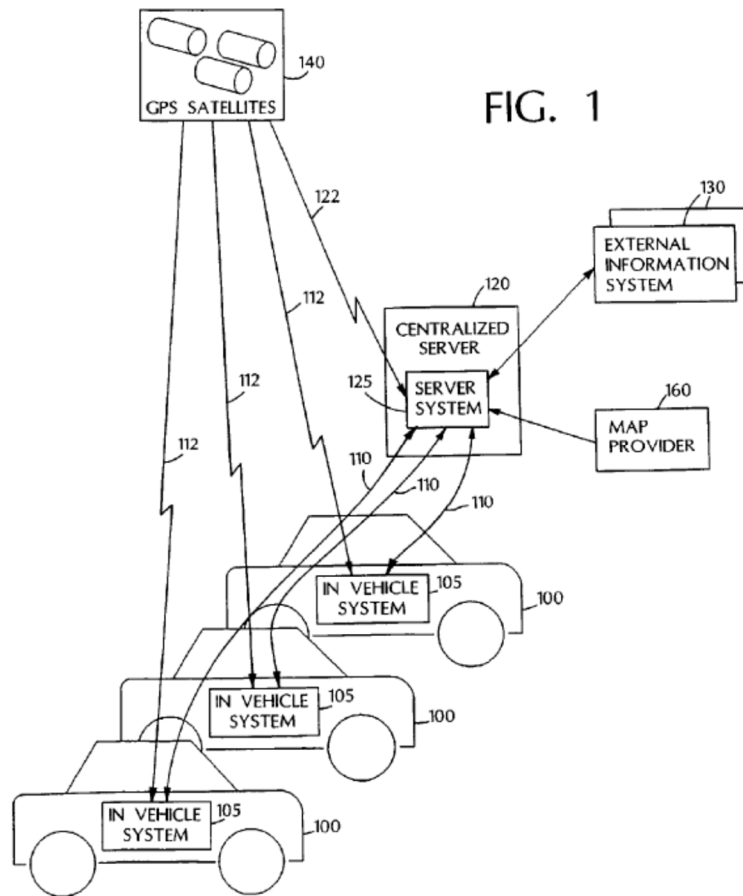
108. Knockeart’s server system further “includes a **remote** configuration system” accessible over the Internet that the user/driver can access to “modify their records in user profiles 2232 that are stored at the server system.” GM-1004, [0405]. This information can include “a list of frequent destinations [specified] over the Internet[.]” *Id.* “A user’s profile is **downloaded** by the server system **to the in-vehicle system** in that user’s vehicle, or can alternatively be stored on the server system.” *Id.*, [0405]. The user can “later in the vehicle choose a particular destination in that list by selecting from a display of the list by the in-vehicle system.” *Id.*; *see also* [0408]. A POSITA would have understood from these disclosures of Knockeart that the destination is received (as part of the user profile) from a remote source (the remote configuration system).

109. As another example, of the in-vehicle system receiving the destination from a system that is remote from the in-vehicle system, Knockeart describes that the user specifies a point of interest (“yellow pages”) category and “the server

downloads the specific listings in the selected yellow pages category to the in-vehicle system” and [t]he operator then selects from the downloaded list.” GM-1004, [0231]; *see also id.*, [0230], [0181]. A POSITA would have recognized that this disclosure of receiving potential destinations from a remote source based on a category of interest provides that the destination is received from a source that is remote from a device on which the roadway map is presented.

[10] The computer program product of claim 1, further including a triangulation system.

110. Knockeart discloses that the predictable Knockeart-Feldman combination includes a triangulation system. Knockeart describes that “the location of the vehicle can be estimated using the Global Positioning System (GPS)” where “[i]n GPS, ***multiple satellites*** emit signals that allow an in-vehicle GPS receiver to ***estimate its absolute location.***” GM-1004, [0007]; *see also id.*, [0012]-[0014], [0071], [0075], [0086]. A POSITA would have recognized that estimating an absolute location from signals received from multiple satellites is a form of triangulation and thus the predictable combination of Knockeart with Feldman provides that the system further includes a triangulation system.



GM-1004, FIG. 1.

111. For example, a POSITA would have recognized that a system that estimates its absolute location based on positioning signals emitted from multiple satellites is a triangulation system. This is confirmed, for example, by a 1998 article titled “Bearing Straight” which describes “GPS (Global Positioning System)” as “a creation of the Defense Department” which provides “a precise, worldwide navigational system[.]” GM-1011, 2. This article goes on to describe that “[a] receiver that picks up three (four is better) [GPS satellite] signals can then determine a precise location on the surface of the earth through the technique

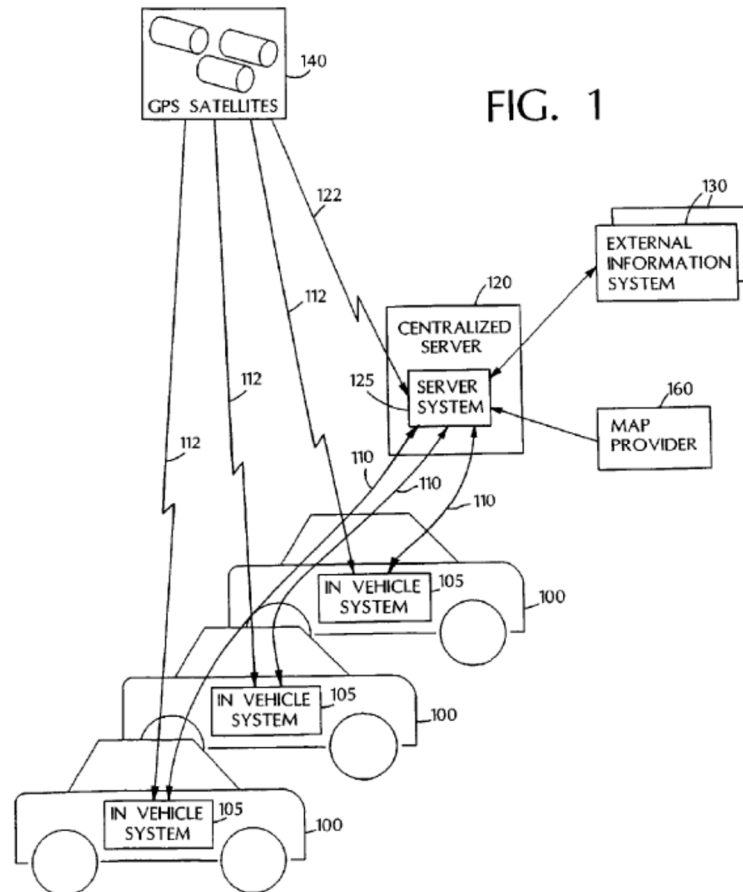
known as “triangulation.”” *Id.* This understanding of a POSITA is further confirmed by an IEEE article from 2001 which describes that “[w]hen attempting to determine a given location...[t]riangulation can be done *via lateration*, which uses multiple distance measurements between known points, or via angulation, which measures angle or bearing relative to points with known separation.” GM-1012, 1. The article goes on to describe that “Global Positioning System is perhaps the most widely publicized location-sensing system” of this type, describing that “*GPS provides an excellent lateration framework* for determining geographic positions.” *Id.* Knockeart’s disclosure of determining the location of the vehicle using “*multiple satellites* emit[ting] signals that allow an in-vehicle GPS receiver to *estimate its absolute location*” thus provides this claim. GM-1004, [0007]

[12] The computer program product of claim 10, wherein the triangulation system includes global positioning system (GPS) triangulation.

112. Knockeart discloses that the predictable Knockeart-Feldman combination provides that the triangulation system includes global positioning system (GPS) triangulation. Knockeart describes that “the location of the vehicle can be estimated using the Global Positioning System (GPS)” and “*[i]n GPS, multiple satellites* emit signals that allow an in-vehicle GPS receiver to *estimate its absolute location*.” GM-1004, [0007]; *see also id.*, [0012]-[0014], [0071], [0075], [0086].

A POSITA would have recognized that estimating an absolute location from

signals received from multiple GPS satellites is a form of triangulation and thus the predictable combination of Knockeart with Feldman provides the triangulation system includes global positing system (GPS) triangulation.



GM-1004, FIG. 1.

113. For example, a POSITA would have recognized that a system that estimates its absolute location based on positioning signals emitted from multiple GPS satellites is a GPS triangulation system. This is confirmed, for example, by a 1998 article titled “Bearing Straight” which describes “GPS (Global Positioning System)” as “a creation of the Defense Department” which provides “a precise,

worldwide navigational system[.]” GM-1011, 2. This article goes on to describe that “[a] receiver that picks up three (four is better) [GPS satellite] signals can then determine a precise location on the surface of the earth through the technique known as ‘triangulation.’” *Id.* This understanding of a POSITA is further confirmed by an IEEE article from 2001 which describes that “[w]hen attempting to determine a given location...[t]riangulation can be done *via lateration*, which uses multiple distance measurements between known points, or via angulation, which measures angle or bearing relative to points with known separation.” GM-1012, 1. The article goes on to describe that “Global Positioning System is perhaps the most widely publicized location-sensing system” of this type, describing that “*GPS provides an excellent lateration framework* for determining geographic positions.” *Id.* Knockeart’s disclosure of determining the location of the vehicle using “*multiple satellites* emit[ting] signals that allow an in-vehicle GPS receiver to *estimate its absolute location*” thus provides this claim. GM-1004, [0007]

[13] The computer program product of claim 1, wherein the map includes a visual indication of traffic on the route.

114. Knockeart discloses that the map includes a visual indication of traffic on the route:

The server system uses its traffic database, which include current link speeds on segments of the road network, to ***determine the current traffic conditions on the operator’s trips.*** Various alternative

presentations of the traffic conditions can be used. In this version of the system, *the traffic conditions are categorized* into a small number of categories, such as normal, congested, and severely congested, and *each category is displayed graphically to the operator using a different icon.*

GM-1004, [0394]. A POSITA would have recognized that displaying traffic data on the links “on the operator’s trips” provides a visual indication of traffic on the route, because the route is displayed as part of the map. *Id.*, [0394]; *see also id.*, [0006], [0010]-[0011], [0074].

[14] The computer program product of claim 1, further comprising providing an estimation of how much time is predicted to travel through the traffic condition.

115. Knockeart discloses providing an estimation of how much time is predicted to travel through the traffic condition. Specifically, Knockeart discloses identifying link travel times for each link in the route and provides the estimated travel time to the system for presentation to the user. Knockeart’s server system “plan[s] a *route* through the road network from a starting to a destination location *using the speed information associated with the road segments.*” GM-1004, [0030]; *see also id.*, [0077], [0089], [0254], [0315]-[0319], [0337]-[0342]. The “link speeds database...includes expected travel speeds for all the links in main roads network 100.” *Id.*, [0330]. The system can plan routes based on one or more criteria such as “based on *lowest expected travel time*” along the route. *Id.*, [0254]. A POSITA would have recognized that the combined expected travel speeds/times

for each link along the planned route is one of numerous examples in Knockeart that provide the claimed “traffic condition.”

116. Knockeart goes on to describe a scenario in which “the server system plans and downloads several routes, for instance planned according to different criteria, such as shortest time, shortest distance, etc.” and then “[t]he in-vehicle system displays characteristics of the alternatives (e.g., time, distance) and the operator selects one.” GM-1004, [0413], *see also id.*, claim 24 (“notifying the user according to an estimated travel time to the destination”). A POSITA would have recognized that displaying the characteristic of “time” for each route (for which travel times for each link have been determined) provides, or at least renders obvious, providing an estimation of how much time is predicted to travel through the traffic condition.

[15] The computer program product of claim 1, wherein the traffic condition is a historical traffic condition.

117. Both Knockeart and Feldman discloses that in the predictable combination of Knockeart with Feldman, in at least some cases the traffic condition is a historical traffic condition. Turning first to Knockeart, Knockeart describes that each probe vehicle system “collects on an ongoing basis ***a history*** (a profile) ***of the speed that the vehicle travels*** on links of the main roads network[.]” GM-1004, [0321]; *see also id.*, [0243]. This historic speed data is stored along with a “time of day” that the link was traversed. *Id.*, [0321]-[0322]. Knockeart

further describes that the system stores the “expected” link travel speed according to “time of day.” *Id.*, [0337]. In a further example, Knockeart discloses that “[m]ultiple travel times are stored for each link, for instance, to account for the variations due to ***morning and evening busy periods***.” *Id.*, [0330]; *see also id.*, [0331]-[0336] (describing storing start and end times of “busy period[s]” and “[e]xpected speed” during such times for each link). This aligns precisely with the specification of the ’028 patent, which expressly identifies travel time at a particular “time of day” as an example of the claimed “historical traffic condition.” *See* GM-1001, 6:60-7:3, 18:23-27.

118. Feldman expands on this disclosure from Knockeart, describing that the resulting system collects “***historical and/or event related vehicular traffic data and information***.” GM-1005, [0014]; *see also id.*, [0036], [0053], [0084]-[0085], [0090]-[0093], [0100]. The link travel time prediction tools “are products of the analysis of ***historical*** vehicular traffic data and information.” *Id.*, [0092]. Feldman uses this “historical vehicular traffic data and information” to, among other things, identify “correlation and interrelation of the vehicular traffic situation picture between different oriented road sections as a function of time.” *Id.*, [0093]. This information is also used to identify historic “behavior pattern[s]” of each road section “as a function of time, for example, during minute and hourly progression of a day.” *Id.*, [0092]. The system can thereby identify a traffic “behavior pattern”

for each road segment “in different circumstances, such as different days of the week, holidays, special events, weather conditions, and so on.” *Id.*

119. A POSITA would have recognized that each of these examples of historic travel information categorized by: (i) time of day, (ii) day of the week, (iii) holidays, (iv) special events, and (v) weather conditions provide examples of the claimed historical traffic condition. A POSITA would have been prompted to beneficially apply this suggestion of Feldman to the resulting system of Knockeart in view of Feldman (and would have had a reasonable expectation of success in doing so) to account for each of the historic events described by Feldman when determining link travel speeds/times (in addition to Knockeart’s expressly discussed “morning and evening busy periods”) because doing so would have increased the functionality of the resulting system by allowing predicted travel speeds/times to account for a wider array of historical events, thereby improving the accuracy of travel speed/time predictions. GM-1004, [0330]-[0335]; GM-1005, [0092]. Furthermore, a POSITA would have recognized that such a modification would have provided additional useful information to both the system and drivers when selecting a route to the destination, thereby increasing the likelihood that the best route to the destination is taken. Such a modification is also merely the application of a known technique to a known system ready for improvement to yield predictable results. Knockeart expressly states that “other types of intervals”

other than busy periods of the day “can be used to store the speed information” and Feldman provides several different examples of such intervals for historically categorizing speed and other traffic related information. GM-1004, [0336]; GM-1005, [0092].

[16] The computer program product of claim 15, wherein the historical traffic condition includes traffic information based at least in part on an event recorded at a time of the historical traffic condition, and wherein the at least one route from the current location to the destination is further based at least in part on a comparison of the event recorded at the time of the historical traffic condition and a currently occurring event.

120. Both Knockeart and Feldman discloses that in the predictable combination of Knockeart with Feldman, in at least some cases, the historical traffic condition includes traffic information based at least in part on an event recorded at a time of the historical traffic condition, and wherein the at least one route from the current location to the destination is further based at least in part on a comparison of the event recorded at the time of the historical traffic condition and a currently occurring event.

121. Before addressing the relevant teachings of Knockeart and Feldman on this point, I first turn to the relevant descriptions within the '028 patent itself to give light as to some examples that a POSITA would have recognized as falling within the scope of this claim. The '028 patent identifies various examples of events recorded at a time of the historical traffic condition, including “time of year, time of day, type of day, holiday information, weekend information, construction

information, school vacation information, and accident information” GM-1001, 6:60-65; *see also id.*, 6:65-7:3, 18:23-27 (“time of day, week, and or year.”).

122. As I discussed above with respect to claim 15, the predictable combination of Knockcart with Feldman tracks historical traffic conditions, including road segment travel time/speed, for these same events, including time of day “different days of the week, holidays, special events, weather conditions, and so on.” GM-1005, [0092]; GM-1004, [0321]-[0322], [0330]-[0337] (describing determining an “[e]xpected speed” for road segments at various times of day).

123. Knockcart also discloses comparing the event recorded at the time of the historical traffic condition and a currently occurring event to identify exceptional traffic conditions. For example, Knockcart’s system records historic travel times according to time of day events (morning and evening “busy period[s]”) and then the system “detects that a traffic exception has occurred if a travel speed along a link is *substantially slower or faster than expected* (e.g. 75% of the expected speed or slower) for that link *at that time of day.*” GM-1004, [0330], [0337]; *see also id.*, [0331]-[0336]. A POSITA would have recognized that this disclosure indicates that the system performs a comparison of the current travel time (currently occurring event) to the historic travel time for that time of day (event recorded at a time of the historical traffic condition) to identify the traffic exception.

124. Knockeart goes on to describe that in the predictable combination, when the in-vehicle system (implemented as cellular phones in at least some cases in the combination) identifies such a traffic exception, it reports the exception to the server system. GM-1004, [0338]-[0340]. The server system uses this traffic exception information and “updates traffic database 524, *which it uses to plan routes[.]*” *Id.*, [0340]. A POSITA would have recognized that because the traffic exception detected based on a comparison of the currently occurring event and the event recorded at the time of the historical traffic condition is used to update travel times used to plan routes for vehicles, this provides the claim recitation of: wherein the at least one route from the current location to the destination is further based at least in part on a comparison of the event recorded at the time of the historical traffic condition and a currently occurring event. The predictable combination of Knockeart with Feldman therefore provides this claim. Knockeart’s “server system resets its expected speeds for the links on which exceptions have been reported after a period of time when no more exceptions are reported by probe vehicles for those links.” GM-1004, [0341]; *see also id.*, [0342].

125. Feldman provides similar disclosure to that of Knockeart regarding accounting for historical traffic conditions. For example, Feldman describes:

A behavior pattern of a specific oriented road section describes the regular changing of the associated NTT values as a function of time, for example, during minute and hourly progression of a day. Every

oriented road section has its own behavior pattern, and different behavior patterns describe the behavior in different circumstances, such as different days of the week, holidays, special events, weather conditions, and so on.

GM-1005, [0092].

126. Similar to the disclosure of Knockeart, Feldman describes that “while regular situations are handled with these tools, unexpected vehicular traffic developments are identified from the current vehicular traffic situation pictures by *comparing them to regular vehicular traffic behavior patterns.*” GM-1005, [0095]. Feldman continues with this example by describing that the most “recently calculated NTT values on each oriented road section is compared to the [historical] pattern that describes the behavior of this oriented road section.” *Id.* If there is a “significant discrepancy from the pattern [this] activates a respective correction of the NTT values” used to calculate fastest routes in the Knockeart-Feldman combination. *Id.* Feldman goes on to provide details on using such identified discrepancies (based on comparison of current and historic traffic conditions during similar events) to identify “a major event with prolonged influence” to correct NTT values used to identify fastest routes over a correction period. *Id.*, [0095]; *see also id.*, [0096]-[0098]. A POSITA would have applied these various teachings to the predictable Knockeart-Feldman combination for the reasons I discussed with respect to claim 15, above.

[17] The computer program product of claim 16, wherein the event is a weather condition.

127. The Knockeart-Feldman combination provides that the event is a weather condition. Specifically, Feldman discloses that the event can include “weather conditions.” GM-1005, [0092], [0095].

[18] The computer program product of claim 16, wherein the event is a time of day.

128. The Knockeart-Feldman combination provides that the event is a time of day. For example, Knockeart discloses that the events can include “a morning and an evening rush ‘hour’ (busy period).” GM-1004, [0326]; *see also id.*, [0330]-[0337]. In another example, Knockeart discloses that “[t]he navigation application stores ***the time of day*** and the speed traveled on each link in a link speed log 1920.” *Id.*, [0321]; *id.*, [0322] (“The in-vehicle system records the time the vehicle takes to travel from one end to the other of the link and stores a reference to the link, the time of day, and the speed traveled along the link in the link speed log.”); *see also id.*, [0323]-[0337]. Feldman similarly discloses that “[a] behavior pattern of a specific oriented road section describes the regular changing of the associated NTT values as ***a function of time, for example, during minute and hourly progression of a day.***” GM-1005, [0092]; *see also id.*, [0095].

[19] The computer program product of claim 16, wherein the event is a day of a week.

129. The Knockeart-Feldman combination provides that the event is a day of the week. Specifically, Feldman discloses that the event can include a “day[] of the week.” GM-1005, [0092]; *id.*, [0095].

[20] The computer program product of claim 16, wherein the event is a day of a year.

130. The Knockeart-Feldman combination provides that the event is a day of the year. Specifically, Feldman discloses that the events can include “holidays[.]” GM-1005, [0092]; *id.*, [0095]. A POSITA would have recognized that tracking traffic conditions on particular “holidays” provides, or at least renders obvious, that the event is a day of a year because holidays are generally understood as annually occurring days of the year and a POSITA would have recognized that such days of the year would likely have abnormal traffic patterns compared to typical traffic patterns. Therefore, it would have been useful to track the traffic patterns for specific days of the year identified as holidays as traffic is likely deviate from normal, non-holiday days, as indicated by Feldman’s disclosure that one of the events tracked includes holidays.

[21] The computer program product of claim 16, wherein the event is a holiday.

131. The Knockeart-Feldman combination provides that the event is a day of the week. Specifically, Feldman discloses that the events can include “holidays.” GM-1005, [0092]; *id.*, [0095].

[25] The computer program product of claim 1, wherein the traffic condition is a real time traffic condition that represents traffic on the route at a time when the roadway map is presented.

132. The Knockeart-Feldman combination provides that the traffic condition is a real time traffic condition that represents traffic on the route at a time when the roadway map is presented. Knockeart is express that in at least some cases, the routes are planned at least in part on “***current traffic information*** for the operator’s trips.” GM-1004, [0392]. Specifically, Knockeart describes that “[t]he server system uses its traffic database, which include ***current link speeds*** on segments of the road network, to determine the ***current traffic conditions*** on the operator’s trips.” *Id.*, [0394]. Such real time traffic conditions representing traffic on the route at a time when the roadway map is presented include “traffic exception[s]” reflecting that the current “travel speed along a link is substantially slower or faster than expected” as compared to historic travel data. *Id.*, [0337].

133. Feldman provides similar disclosure to that of Knockeart, explaining that the resulting system identifies “***current*** vehicular traffic situation pictures” using “several ***recently calculated*** NTT values on each oriented road section[.]” GM-1005, [0095]; *see also id.*, [0094]. In the Knockeart-Feldman combination, this “current vehicular traffic situation picture” is used to “provid[e] a variety of vehicular traffic related service applications to end users” including a fastest route to the destination. *Id.*, [0097], [0098]-[0099], [0100] (describing generating “[a]

recommendation based on the current vehicular traffic situation picture” for “route recommendation types of traffic related service applications”); *see also id.*, [0018], [0102], Abstract, Claim 1.

[26] The computer program product of claim 1, wherein the roadway map further comprises a second route to the destination such that a user can select the second route as an alternate route through a user interface.

134. Knockeart discloses that the roadway map further comprises a second route to the destination such that a user can select the second route as an alternate route through a user interface:

In another alternative version of the system, ***the server system plans and downloads several routes***, for instance planned according to different criteria, such as shortest time, shortest distance, etc. The in-vehicle system displays characteristics of the alternatives (e.g., time, distance) and ***the operator selects one***. If the server have not yet downloaded al[sic] the routes, only the selected route is continued to be downloaded.

GM-1004, [0413]. A POSITA would have recognized that “display[ing] characteristics of the alternatives” would have included displaying each route on the roadway map. As previously discussed, Knockeart expressly discloses displaying calculated routes on the roadway map. *Id.*, [0010], [0282]. A POSITA would have recognized that it would have been beneficial and obvious to display each of the alternative routes on the roadway map to give the driver more information when selecting a best route, such as by showing the driver what neighborhoods or what streets each route traverses to allow the user to make a

selection based on related criteria (such as selecting a more scenic route or a route with a gas station or grocery store along the way).

[29] The computer program product of claim 1, further comprising, presenting a user interface to save a future destination for future choosing, wherein the future choosing selects the saved future destination and forms the destination.

135. Knockeart discloses presenting a user interface to save a future destination for future choosing, wherein the future choosing selects the saved future destination and forms the destination. For example, Knockeart discloses that the vehicle operator can identify a “desired destination” for a current trip by selecting from “*a list of previously stored destinations* in a user’s ‘profile’” or “a list of recently specified destinations.” GM-1004, [0211], [217]-[0218]. Knockeart explains that “profiles that are stored in the vehicle” or “on the server system...can *hold typical destinations*, such as ‘work,’ ‘home,’ ‘airport,’ etc. for which *the operator has previously specified particular locations.*” *Id.*, [0237].

136. Knockeart’s system “includes a remote configuration system” accessible over the Internet that the user can access to “modify their records in user profiles 2232 that are stored at the server system.” GM-1004, [0405]. The profile can store previously entered destinations that the operator can select to set the destination for a current trip:

Information in the user profiles can include various types of information, including stored destinations that the user can select from when specifying a destination to the in-vehicle system. For instance, a

user can specify a list of frequent destinations over the Internet, and then later in the vehicle choose a particular destination in that list by selecting from a display of the list by the in-vehicle system.

GM-1004, [0405].

137. A POSITA would have recognized from these disclosures of Knockeart that the user specifies the list of frequent destinations over the Internet using a user interface including an input device such as “multiple push buttons,” “an alphanumeric keyboard,” or manual entry. GM-1004, [0118], [0223].

Alternatively, it would have been obvious to use a user interface to enter destinations for storage as part of the user profile because user interfaces were well-known (including being described throughout Knockeart) and would have provided a known and convenient way to enter the frequent destinations.

Additionally, a POSITA would have recognized that the above mentioned “recently specified destinations” would have been previously entered using a presented user interface described by Knockeart. GM-1004, [0210]-[0219] (describing a user interface including “scrolling lists from which the operator chooses” options for entering a destination), [0118] (describing the system user interface).

[31] The computer program product of claim 1, further comprising a warning system adapted to warn a driver traveling on the route of the traffic condition, wherein the warning is based on a proximity of the driver, as determined by the current location, to an adverse traffic condition.

138. The predictable Knockeart-Feldman combination provides a warning system adapted to warn a driver traveling on the route of the traffic condition, wherein the warning is based on a proximity of the driver, as determined by the current location, to an adverse traffic condition. Knockeart describes that its server system “provides current traffic information for the operator’s trips” to the in-vehicle system. GM-1004, [0392]. Knockeart further describes that “[i]f the received traffic data indicates an exceptional traffic condition on the specified path, ***the user is notified of the traffic condition.***” *Id.*, [0042]. The system can also “actively contact[] a user if an exceptional traffic condition occurs on one of the user’s previously specified trips” such as through a pager message, email, or telephone call. *Id.*, [0395]. Feldman describes providing “***alerts*** and route alterations when ***unexpected traffic events*** change the vehicular traffic situation picture.” GM-1005, [0099], [0101] (“...providing traffic alerts and alternative route recommendation types of traffic related service applications to end users”). Feldman describes that “an alert is sent to the driver” for an “‘unexpected’ traffic event” even if the event is “way off the recommended route” if it is within a close enough proximity to the driver to affect the route. *Id.*, [0101].

139. For at least the above reasons, I am confident a POSITA would have recognized that the teachings of Knockeart in view of Feldman provide all elements of claims 1-7, 9-10, 12-21, 25-26, 29, and 31 of the ’028 patent and that

there were multiple reasons that would have prompted a POSITA to apply the suggestions of Feldman to Knockeart's system.

XI. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN AND SIMSKE WITH RESPECT TO CLAIMS 7-8 (GROUND 2)

A. Overview of Simske

140. Simske describes “a navigation routing system” that includes similar functionality to the navigation systems described by Knockeart and Feldman. GM-1006, [0004]-[0005], [0012]. Simske describes that its navigation system identifies current traffic conditions “[b]ased on GPS tracking information obtained from other GPS-enabled devices along various available navigation routes” and uses this information along with information on “historical traffic flow patterns” to determine “a time-optimized navigation route” to one or more destinations. *Id.*, [0012]. Simske further discloses using cellular phones as probes to collect this traffic data for road segments. *Id.*, [0012]-[0013].

141. The navigation system of Simske “determines a travel time for each available route identified by route calculator 52 *using GPS-based tracking information for devices 14 traveling along the identified available routes*.” GM-1006, [0015]. The system is “configured to automatically monitor and acquire GPS information corresponding to each GPS-enabled device 14 within a particular operating region.” *Id.*, [0023]; *see also id.*, [0025]. The navigation system “access[es] position data 80 for each device 14” in the “operating region” and from

this set of probe devices “*identifies particular devices 14 traveling along available navigation routes* identified by route calculator 52” and determines traffic flow rates from the identified devices along the routes to identify the fastest route. *Id.*, [0026]; *id.*, [0027]-[0030].

B. Combination of Knockeart and Feldman with Simske

142. Multiple reasons would have prompted a POSITA to beneficially apply the teachings of Simske to the Knockeart-Feldman combination to select a plurality of cell phones from a candidate set of cell phones based at least in part on a comparison of a location of each of the plurality of cell phones to a location of the route. As discussed above, the navigation system described by Simske “access[es] position data 80 for each device 14” in the “operating region” and from this set of probe devices “*identifies particular devices 14 traveling along available navigation routes* identified by route calculator 52” and determines traffic flow rates from the identified devices along the routes to identify the fastest route. *Id.*, [0026]; *id.*, [0027]-[0030]. As a first reason, a POSITA would have recognized that implementing the system of Knockeart and Feldman to use only traffic flow data from devices located on or along available routes to the destination (rather than traffic flow data from all available probe devices) would have reduced the amount of traffic data that would need to be stored in volatile memory and processed to calculate a best route. Such an application of Simske’s teachings to

the Knockeart-Feldman combination therefore would have saved both memory and processing resources in the resulting system.

143. As a second reason, a POSITA would have recognized that such a modification based on the suggestions of Simske would have saved communication resources by reducing the amount of traffic flow data that would need to be transmitted between various devices and processors of the resulting system.

144. As a third reason, a POSITA would have been prompted to implement the system of Knockeart and Feldman to only collect traffic data from relevant vehicle carried cellular phones located on or around the available routes (as suggested by Simske) because doing so would be merely the application of a known technique (as suggested by Simske) to a known system (e.g., the traffic information collection and route guidance system of Knockeart and Feldman) ready for improvement to yield predictable results. Here, Simske provides straightforward evidence of a known technique of selecting a set of cellular phones as traffic information probes from a larger candidate set of cellular phones based on a comparison of a location of each of the cellular phones to a location of the route, and the combination of Knockeart and Feldman provides a known system that would have been improved by application of Simske's suggested technique for at least the reasons described above (¶¶142-143). Such a modification would have

been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such a modification. Knockeart even contemplates “[o]ther embodiments” not expressly described and a POSITA would have recognized that Simske’s suggestions for selecting a set of cellular phones for collecting traffic data based on proximity to the route provides just such an embodiment that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman). GM-1004, [0420]. Furthermore, a POSITA would have understood that using only relevant data when making such a determination would have been recognized as a best practice in designing such a system and therefore would have been well-within the scope of “other embodiments” contemplated by Knockeart.

C. Application of the Combination of Knockeart with Feldman and Simske to Claims 7-8

[7] The computer program product of claim 1, wherein the plurality of cell phones is selected from a candidate set of cell phones in an area proximate the route.

[8] The computer program product of claim 7, wherein the selection of the plurality of cell phones from the candidate set of cell phones is based at least in part on a comparison of a location of each of the plurality of cell phones to a location of the route.

145. I will address the application of the predictable Knockeart-Feldman-Simske combination to claims 7 and 8 together due to the overlap of these claims due to claim 8’s dependency from claim 7. Based on my knowledge and experience in the field and my review of Knockeart, Feldman, and Simske, it is my

opinion that the predictable combination of Knockeart, Feldman, and Simske renders obvious that the plurality of cell phones is selected from a candidate set of cell phones in an area proximate the route and that the selection of the plurality of cell phones from the candidate set of cell phones is based at least in part on a comparison of a location of each of the plurality of cell phones to a location of the route.

146. As discussed above, both Feldman and Simske disclose using cellular phones as probes for collecting traffic information including vehicle speeds along road segments. GM-1005, [0007]-[0010], [0035]-[0036], [0038], [0053], [0061]-[0062]; GM-1006, [0012]-[0013]. A POSITA would have recognized from the disclosures of Simske that the resulting navigation system of Knockeart, Feldman, and Simske identifies a set of cellular phones to use for collecting traffic data by starting with a set of candidate mobile sensor devices within “a particular geographic region” near the vehicle requesting navigation guidance and then selecting a set of “*particular devices 14 traveling along available navigation routes identified by route calculator*” from the candidate set of devices. GM-1006, [0016], [0026]; *id.*, [0023]-[0025]. Simske discloses that these identified routes are equivalent to the determined routes described in Knockeart (and Feldman), explaining that the “routes associated with the desired travel destinations” are calculated “from a current location” of the requesting vehicle. GM-1006, [0012];

id., [0015], [0020]. Therefore, based on these disclosures of Simske, a POSITA would have recognized that the plurality of probe cell phones from the candidate set is based at least in part on a comparison of the location of the cell phones (along the identified routes) to a location of the route (the current location and one or more destinations for the route). Similar to the disclosures of Knockeart and Feldman, Simske confirms that information from the identified probe devices is used “to determine flow rate data 84 for each available navigation route.” GM-1006, [0026].

XII. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN AND WHITSELL WITH RESPECT TO CLAIMS 10-11 AND 30 (GROUND 3)

A. Overview of Whitsell

147. Whitsell describes a “traffic information system” having “a traffic information server linked to a mobile terminal via a supporting wireless communications network.” GM-1007, Abstract. Whitsell describes that “[r]outes of travel are learned based on tracking the location of the mobile terminal while traveling a specific route, or over time to identify commonly traveled routes.” *Id.* Much like Feldman, Whitsell’s navigation system uses “cellular telephones” as vehicle-carried probes “to provide route- and location-specific traffic information.” *Id.*, 2:56-66. The cellular phone probes “are used to learn commonly traveled routes by periodically monitoring and recording location and, optionally, corresponding time-of-day information,” and “[t]hus, a mobile device associated

with a given motorist or vehicle can be used to develop a record of traveled routes, possibly with associated travel times and destination information, for that motorist.” *Id.*, 2:62-3:2; *see also id.*, 6:19-30. Each mobile device can “determine its own location based on *triangulating signals* received from geographically dispersed communication towers 12 associated with the *wireless communications network* 40.” *Id.* 7:39-43; *see also id.*, 7:43-49.

B. Combination of Knockeart and Feldman with Whitsell

148. A POSITA would have been prompted to modify the predictable combination of Knockeart with Feldman based on the additional teachings of Whitsell in at least two ways: to allow the vehicle-carried cellular phones of the resulting combination to determine their locations based on cell phone tower triangulation and to identify potential routes for a driver based on a prior recording of an actual route traveled from a location proximate the current location of the vehicle to a designated destination by a user represented by a device at the current location. A POSITA also would have a reasonable expectation of success in making such modifications as these were well-understood features of navigation systems during the relevant time frame.

149. As a first reason, a POSITA would have been prompted to apply the teachings of Whitsell to the Knockeart-Feldman combination to include functionality in the vehicle-carried cellular phones to determine location based on

cell phone tower triangulation because such a modification would have allowed the devices to determine their locations in areas in which GPS based location tracking is unavailable and/or unreliable or less-reliable. For example, a POSITA would have known that in dense urban environments or mountainous regions, buildings or natural features can block GPS signals, making GPS somewhat unreliable in such scenarios. Including cell phone tower triangulation as an additional method of identifying the location of each cellular phone would have allowed for more accurate location determination of the vehicle-carried cellular phone probes in such scenarios.

150. As a second reason, implementation of the vehicle-carried cellular phones used as probes to include cell tower triangulation based location determination would have provided a backup location determination method in the event of failure of the GPS system (either failure of the GPS unit of the cellular phone or failure of GPS satellites).

151. As a third reason, a POSITA would have further been prompted to apply the teachings of Whitsell to the Knockeart-Feldman combination to record previous trips of users in the system to use for suggesting future routes from the current location of the vehicle to the identified destination because such a modification would have beneficially allowed the resulting navigation system to gather travel time information for such routes. This would have facilitated

Knockeart's route planning functionality by providing a source of travel time information for routes frequently traveled by the user, thereby improving the overall travel time statistics for frequently traveled routes.

152. As a fourth reason, a POSITA would have recognized that implementing the system of Knockeart and Feldman to record such frequently traveled routes and using that information for future route determination (as suggested by Whitsell) would have improved the system by providing travel time information that includes the driver's particular driving tendencies and preferences, therefore making the historic travel time information for such routes specific to the user. Whitsell teaches that there are "dramatic benefits gained by providing route-specific information to a given motorist" and a POSITA would have recognized that this would have been directly applicable to the Knockeart-Feldman system. GM-1007, 8:39-43.

153. As a fifth reason, a POSITA would have been prompted to implement the system of Knockeart and Feldman to include the above described features suggested by Whitsell because doing so would be merely the application of known techniques (as suggested by Whitsell) to a known system (e.g., the traffic information collection and route guidance system of Knockeart and Feldman) ready for improvement to yield predictable results. Here, Whitsell provides straightforward evidence of known techniques for cell tower based triangulation

and recording of frequently traveled routes and the combination of Knockeart and Feldman provides a known system that would have been improved by application of Whitsell's suggested technique for at least the reasons described above (¶¶148-152). Such a modification would have been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such a modification. Knockeart even contemplates "[o]ther embodiments" not expressly described and a POSITA would have recognized that Whitsell's teachings provide just such embodiments that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman). GM-1004, [0420].

C. Application of the Combination of Knockeart with Feldman and Whitsell to claims 10-11 and 30

Claim [10] The computer program product of claim 1, further including a triangulation system.

Claim [11] The computer program product of claim 10, wherein the triangulation system includes cell phone tower triangulation.

154. Whitsell demonstrates that the predictable Knockeart-Feldman-Whitsell combination provides a triangulation system wherein the triangulation system includes cell phone tower triangulation. Specifically, Whitsell discloses that each probe cellular phone can "determine its own location based on triangulating signals received from geographically dispersed communication towers 12 associated with the wireless communications network 40." GM-1007, 7:39-43; *see also id.*, 7:43-49.

[30] The computer program product of claim 1, wherein the route is further based at least in part on a prior recording of an actual route traveled from a location proximate the current location to the destination by a user represented by a device at the current location.

155. Whitsell demonstrates that the predictable Knockeart-Feldman-Whitsell combination provides that the route is further based at least in part on a prior recording of an actual route traveled from a location proximate the current location to the destination by a user represented by a device at the current location. Specifically, Whitsell describes that in the navigation system of the predictable combination, “mobile devices are used to ***learn commonly traveled routes*** by periodically monitoring and ***recording*** location and, optionally, corresponding time-of-day information” and “[t]hus, a mobile device associated with a given motorist or vehicle can be used to ***develop a record of traveled routes, possibly with associated travel times*** and destination information, for that motorist.” GM-1007, 2:62-3:2. In another example of recording routes to identify commonly traveled routes to suggest for future routes of travel, Whitsell describes:

[O]perating software and supporting circuitry that ***enables the mobile terminal 50 to “learn” the routes traveled by the owner*** of a given mobile terminal 50. In the basic concept, the traffic information processor 60 records location information optionally with time information such that, over time, clear patterns of travel may emerge. Subsequently, when a given motorist is traveling in a vehicle with an associated mobile terminal 50, ***the traffic information processor 60 uses current location and/or time information to predict the most likely route of travel*** and, possibly, the most likely destination for the motorist.

GM-1007, 6:19-30, *see also id.*, 3:39-48, 3:61-4:11, 9:42-59, 10:9-39, 17:52-18:10.

Figure 7 of Whitsell shows an example method that includes recording an actual route from the current location to the destination for use in future route recommendations between the two points:

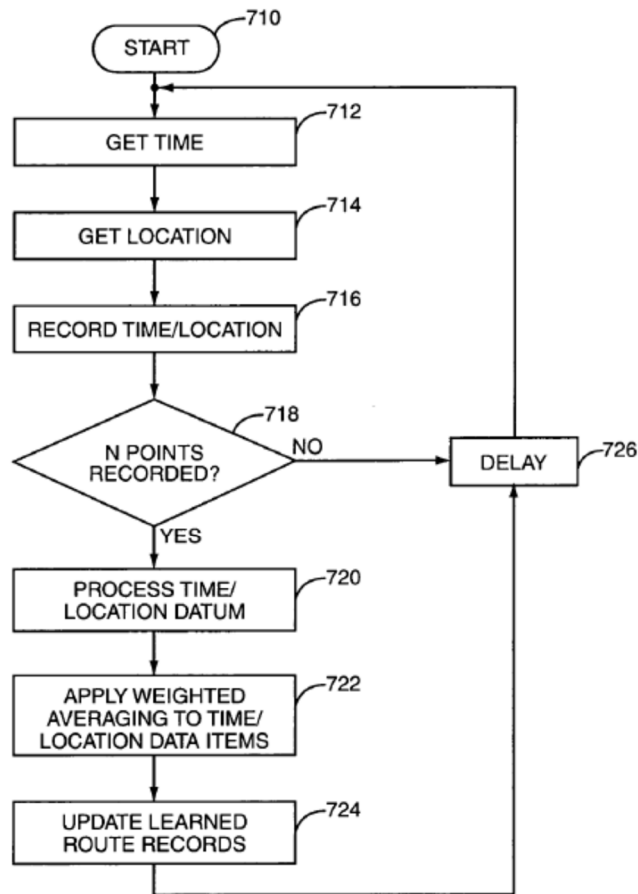


FIG. 7

GM-1007, FIG. 7.

XIII. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN AND BOIES WITH RESPECT TO CLAIMS 14 and 22-24 (GROUND 4)

A. Overview of Boies

156. Boies discloses a navigation system “for determining optimum routing of vehicles based on historical information as well as user preferences and current travel conditions.” GM-1008, Abstract. Boies teaches that the “[h]istorical data is compiled and statistically analyzed to determiner[sic] characteristics of each possible route between two points” and “[t]he characteristic information is then used along with user preference information and current travel condition information to determine an optimum route between the two points.” *Id.* Similar to the teachings of both Knockeart and Feldman, Boies teaches that “[t]he historical data used may include measured data obtained from other vehicles[.]” *Id.*, 1:49-53; *id.*, 41-56. Boies recognizes that specific historical conditions can affect traffic conditions, including travel times along road segments. Specifically, Boies teaches that “the occurrence of certain traffic situations, such as a road being blocked, an accident, road construction, and the like, influence the travel time.” *Id.*, 1:20-25. To ensure that such events that can influence travel time are accurately accounted for, Boies teaches collecting historical traffic data for such conditions:

The historical data may be any type of data that may affect the selection of optimum routes. For example, the historical data may include ***environmental condition information, weather condition information, traffic condition information***, road condition information, criminal activity information, traffic law enforcement information, accident information, and the like.

GM-1008, 2:60-66. Boies goes on to describe that, “estimated times of traversing a leg may be determined for various conditions.” *Id.*, 3:64-67; *see also id.*, 3:60-

4:8. Boies teaches using this historical event information to “estimate[] times of traversing a leg” of a route under “various conditions” in the course of calculating an “optimum route[].” *See id.*, 3:60-4:8, 2:60-66.

B. Combination of Knockeart and Feldman with Boies

157. A POSITA would have been prompted to apply the teachings of Boies to the combination of Knockeart and Feldman in at least two ways. First, a POSITA would have applied Boies to the Knockeart-Feldman combination to track historical traffic data for various road conditions including construction and accidents. Second, a POSITA would have been prompted to apply the teachings of Boies to the Knockeart-Feldman combination to provide an estimation of how much time is predicted to travel through these and other traffic conditions. As I discussed with respect to Gound 1, above, both Knockeart and Feldman reveal that the Knockeart-Feldman combination (and therefore the Knockeart-Feldman-Boies combination) tracks historical traffic conditions, including travel speeds on road segments, for several specific historical events. For example, Knockeart describes that each probe vehicle system “collects on an ongoing basis *a history* (a profile) *of the speed that the vehicle travels* on links of the main roads network[.]” GM-1004, [0321]; *id.*, [0243]. This historic speed data is stored along with a “time of day” that the link was traversed. *Id.*, [0321]-[0322]. Knockeart further describes that the system stores the “expected” link travel speed according to “time of day.”

Id., [0337]. In a further example, Knockeart discloses that “[m]ultiple travel times are stored for each link, for instance, to account for the variations due to ***morning and evening busy periods.***” *Id.*, [0330], [0331]-[0336]. Similarly, Feldman describes collecting “historical and/or event related vehicular traffic data and information” including for “different circumstances, such as different days of the week, holidays, special events, weather conditions, ***and so on.***” GM-1005, [0014], [0092]. As can be seen from this disclosure, Feldman expressly contemplates additional historical events that would affect traffic conditions. Boies compliments this teaching of Knockeart and Feldman, observing that “the occurrence of certain traffic situations, such as a road being blocked, an accident, road construction, and the like, influence the travel time” and expands on the examples of various historic traffic condition that affect travel time (including accidents and construction). GM-1008, 1:20-25.

158. A POSITA would have been prompted to apply the teachings of Boies to the Knockeart-Feldman combination as discussed above for several reasons and would have had a reasonable expectation of success in making such a modification. As a first reason, Feldman teaches that “[e]very oriented road section has its own behavior pattern” which “describe[s] the behavior in different circumstances[.]” GM-1005, [0092]. As I discussed above, Feldman gives several examples of specific historical events that would affect road segment travel times and ends this

list with an indication that additional such events are contemplated by stating “*and so on.*” *Id.* Boies provides just such additional examples of historical events that a POSITA would have recognized as affecting road segment travel times. Boies describes that traffic conditions such as abnormal weather and time of day affect traffic conditions while providing additional examples of such road conditions, including construction and accidents and therefore provides the additional examples that Feldman suggested a POSITA would have known. GM-1008, 3:60-4:8, 9:35-39; 3:20-23, 1:22-25; GM-1005, [0092].

159. As a second reason, Boies teaches that “the occurrence of certain traffic situations, such as a road being blocked, an accident, road construction, and the like, *influence the travel time*” and that systems that “do not take into consideration” these factors, which “may cause delays in traveling along the path,” will provide less than optimum routing recommendations. GM-1008, 1:20-38. A POSITA therefore would have been prompted to apply the relevant suggestions of Boies to the Knockeart-Feldman combination to improve the resulting system by taking these road conditions which “influence the travel time” into consideration when determining optimum routes to improve route determination accuracy. *Id.* Similarly, a POSITA would have applied Boies’ teaching to provide an estimation of how much time is predicted to traverse such traffic conditions to Knockeart-

Feldman to allow for such factors to be considered (either by the system and/or the user) when selecting a best route for avoiding such adverse conditions.

160. As a third reason, a POSITA would have been prompted to implement the system of Knockeart and Feldman to include the above described features suggested by Boies because doing so would be merely the application of known techniques (as suggested by Boies) to a known system (e.g., the traffic information collection and route guidance system of Knockeart and Feldman) ready for improvement to yield predictable results. Here, Boies provides straightforward evidence of known techniques for recording historical travel time information for specific event categories and also discloses providing an estimation of how much time is predicted to travel through such traffic conditions and the combination of Knockeart and Feldman provides a known system that would have been improved by application of Boies's suggested technique for at least the reasons described above (¶¶157-159). Such modifications would have been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such modifications. Knockeart even contemplates "[o]ther embodiments" not expressly described and a POSITA would have recognized that Boies's teachings provide just such embodiments that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman). GM-1004, [0420].

C. Application of the Combination of Knockeart with Feldman and Boies to Claims 14 and 22-24

Claim [14] The computer program product of claim 1, further comprising providing an estimation of how much time is predicted to travel through the traffic condition.

161. Boies demonstrates that the predictable combination of Knockeart with Feldman and Boies provides providing an estimation of how much time is predicted to travel through the traffic condition. Boies describes that each “route” or “travel path” includes several “legs,” each of which is subject to “certain traffic situations” which may “influence the travel time.” GM-1008, 1:20-56; *id.*, 2:59-3:16. Boies goes on to demonstrate that, in the predictable Knockeart-Feldman-Boies combination, the resulting navigation system collects historical traffic data for a variety of conditions, including “environmental condition information, weather condition information, traffic condition information, road condition information, criminal activity information, traffic law enforcement information, accident information, and the like.” *Id.*, 2:59-66. Boies goes on to describe that, “estimated times of traversing a leg may be determined for various conditions.” *Id.*, 3:64-67; *id.*, 3:60-4:8. A POSITA would have recognized that this disclosure of Boies indicates that the Knockeart-Feldman-Boies system estimates how much time is predicted to travel through a traffic condition by determining the times required to travel the route legs subject to the traffic condition (such as construction, an accident, inclement weather, etc.).

162. As previously discussed, Knockeart describes that the system “plan[s] a *route* through the road network from a starting to a destination location *using the speed information associated with the road segments*.” GM-1004, [0030]; *see also id.*, [0077], [0089], [0254], [0315]-[0319], [0337]-[0342]. Therefore, a POSITA would have recognized that in the Knockeart-Feldman-Boies system, the estimation of the amount of time predicted to travel through various road conditions is provided to the server system for use in calculating the optimum route. Knockeart further describes “display[ing] characteristics” of available routes, such as “time” to traverse the route, as I discussed in paragraphs 116, 134, above. GM-1004, [0413], *see also* claim 24.

[22] The computer program product of claim 16, wherein the event is a type of road condition.

[23] The computer program product of claim 22, wherein the type of road condition is roadwork.

[24] The computer program product of claim 22, wherein the type of road condition is an accident.

163. Boies demonstrates that the predictable combination of Knockeart with Feldman and Boies provides that the event is a type of road condition and that the type of road condition is roadwork or an accident. Specifically, Boies discloses that the navigation system resulting from the combination of Knockeart with Feldman and Boies collects historical traffic data for a variety of road conditions

affecting travel time, including “accident information” and “construction.” GM-1008, 2:59-66, 3:20-25, 3:60-4:8, 9:28-39, 11:17-20, 12:15-18, 1:22-25, FIG. 7.

164. As I discussed with respect to claims 15 and 16 in Ground 1, above, in the resulting combination, the system compares the event recorded at the time of the historical traffic condition and a currently occurring event to identify exceptional traffic conditions. A POSITA would have understood that this comparison of the historical event and currently occurring event would have included the road condition events of roadwork and accidents in the Knockeart-Feldman-Boies combination. GM-1004, [0331]-[0337]. For example, Feldman provides disclosure similar to that in Boies:

A behavior pattern of a specific oriented road section describes the regular changing of the associated NTT values as a function of time, for example, during minute and hourly progression of a day. Every oriented road section has its own behavior pattern, and different behavior patterns describe the behavior in different circumstances, such as different days of the week, holidays, special events, weather conditions, and so on.

GM-1005, [0092]. Feldman discloses that “while regular situations are handled with these tools, *unexpected vehicular traffic developments* are identified from the current vehicular traffic situation pictures by *comparing them to regular vehicular traffic behavior patterns*.” GM-1005, [0095]. That is, the most “recently calculated NTT values on each oriented road section is compared to the [historical] pattern that describes the behavior of this oriented road section.” *Id.* A “significant

discrepancy from the pattern activates a respective correction of the NTT values” used to calculate fastest routes in the Knockeart-Feldman combination. *Id.*

Feldman goes on to provide details on using such identified discrepancies (based on comparison of current and historic traffic conditions during similar events) to identify “a major event with prolonged influence” to correct NTT values used to identify fastest routes over a correction period. GM-1005, [0095]-[0098].

XIV. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN, BOIES, AND PETERSON WITH RESPECT TO CLAIM 14 (GROUND 5)

A. Overview of Peterson

165. Peterson discloses yet another prior art navigation system that operates to “provide individual vehicles or drivers with desired information in terms of the shortest elapsed time route between a particular origin and destination[.]” GM-1009, 3:19-23. Peterson’s system is “up to the minute, dynamic, constantly keeping track of the current traffic and recalculating the user’s route considering all changes”:

The present invention provides a method and apparatus for supplying traffic information to users and more particularly to such a method and apparatus for assisting the users in selecting shortest elapsed time routes between various origin and destination combinations. In addition, the invention proves useful for vehicle tracking and management. The *routing is up to the minute, dynamic, constantly keeping track of the current traffic and recalculating the user’s route considering all changes* and calls him back if the route can be improved.

GM-1009, 1:13-22. Peterson's navigation system monitors "instantaneous rates of travel" by measuring "changing position data" of probe vehicles, calculates an "estimated elapsed time for each of the highway segments," and then determines "a shortest elapsed time route" for an "origin-destination combination" for a driver.

Id., 3:35-50; 4:35-43; 6:46-49, 1:13-22. Peterson explains how it was known to use current travel time estimates for the beginning of the route and statistical travel time estimates for the end of the route in some scenarios:

he probability of the recommended route providing the shortest elapsed travel time is enhanced when the instantly monitored rates of travel on the different route segments are adjusted by historical data, censored and probe data referred to above and described in greater detail below. Generally, *the most accurate predictor of elapsed time now is the sensed velocities; two hours from now the probability based most accurate velocity is one hundred percent historical patterns.* The central computer calculates the least time route based on giving weight to sensor data in the near horizon and historical in the far horizon.

GM-1009, 9:64-10:8.

166. Peterson goes on to describe that an in-vehicle navigation unit provides "[t]he estimated elapsed time to destination" and "the recommended route" to the driver. GM-1009, 11:25-32, 4:13-16 ("The computer will...provide further directions and the arrival time."). This information can be communicated via audio or visually via a "display terminal." *See id.*, 12:34-49. Peterson's system identifies "change[s] in elapsed travel time as a result of traffic build-up, for different departure times." *Id.*, 6:55-57. The user can "indicate departure time if

the user is not commencing travel immediately” and the navigation unit uses the indicated departure time along with historical traffic data to “provide a more accurate assessment of elapsed travel time[.]” *Id.*, 12:13-25.

B. Combination of Knockeart, Feldman, and Boies with Peterson

167. Multiple reasons would have prompted a POSITA to apply the teachings of Peterson to the combination of Knockeart with Feldman and Boies to communicate the estimated time to travel through a route leg/segment experiencing a traffic condition to the driver and would have had a reasonable expectation of success in making such a modification. Such a modification would have beneficially allowed the driver to determine if they would like to take a different route. Providing the driver with an indication of the estimated time to travel through a traffic condition would have also beneficially allowed the driver to inform friends, colleagues, relatives, or others if they are going to be late to a destination due to the traffic condition while also providing an updated estimated time of arrival based on the amount of time estimated to traverse the traffic condition. Communicating this information to the driver also would have improved the user experience by giving the driver a better overall idea of what to expect along the suggested route.

168. Finally, such a modification would have been merely the application of known techniques to a known system ready for improvement to yield

predictable results. Such a modification would have been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such a modification. Knockeart even contemplates “[o]ther embodiments” not expressly described and a POSITA would have recognized that Peterson’s teachings provide just such an embodiment that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman and Boies).

C. Application of the Combination of Knockeart with Feldman, Boies, and Peterson to Claim 14

Claim [14] The computer program product of claim 1, further comprising providing an estimation of how much time is predicted to travel through the traffic condition.

169. As I discussed above in my analysis of Ground 4, Boies teaches that “the occurrence of certain traffic situations, such as a road being blocked, an accident, road construction, and the like, influence the travel time.” GM-1008, 1:22-25. To ensure that such events that can influence travel time are accurately accounted for, Boies teaches collecting historical traffic data for such conditions:

The historical data may be any type of data that may affect the selection of optimum routes. For example, the historical data may include ***environmental condition information, weather condition information, traffic condition information***, road condition information, criminal activity information, traffic law enforcement information, accident information, and the like.

GM-1008, 2:60-66. Boies goes on to describe that, “estimated times of traversing a leg may be determined for various conditions.” *Id.*, 3:64-67; *id.*, 3:60-4:8. Boies

teaches using this historical event information to “estimate[] times of traversing a leg” of a route under “various conditions” in the course of calculating an “optimum route[.]” *Id.*, 3:60-4:8.

170. Peterson provides the additional teaching that in the predictable combination of Knockeart with Feldman, Boies, and Peterson, the “[t]he estimated elapsed time” and “the recommended route” for traveling through legs/segments experiencing such traffic conditions is communicated to the driver via audio or visually via a “display terminal.” GM-1009, 11:25-32, 12:34-49, 6:46-54 (“estimated elapsed time for each of the highway segments”), 17:20-27 (“estimated time for a given route segment”). Specifically, Peterson gives an example in which the in-vehicle computer uses audio communication to communicate to the driver “[t]he estimated elapsed time” traversing a route segment along with a recommended route. *Id.*, 11:25-32. Peterson goes on to describe that in addition to or in place of audio communication, the in-vehicle system can use a “data display terminal, or even a video screen, similar to a television screen or otherwise” to convey such information. *Id.*, 12:41-45.

XV. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN AND PETERSON WITH RESPECT TO CLAIMS 27-28 (GROUND 6)

A. Combination of Knockeart and Feldman with Peterson

171. Multiple reasons would have prompted a POSITA to apply the teachings of Peterson to the combination of Knockeart with Feldman to present an

estimated time of arrival for the suggested route to the driver and to provide a user interface that allows the driver to enter an intended departure time for the destination to hear/view the effect of departure time on travel time and would have had a reasonable expectation of success in doing so. As a first reason, such modifications would have beneficially given drivers utilizing the resulting system additional information that would improve the overall user experience and allow the drivers to make informed decisions about which routes to travel or whether to switch routes to avoid various traffic conditions identified by the system. Such estimated time of arrival information and information on the effect of intended departure time on total travel time is “particularly important for a user who is disoriented or unfamiliar with the area.” GM-1009, 12:2-6. Therefore, application of such techniques to the system of Knockeart and Feldman would have improved the resulting navigation system.

172. As a second reason, a POSITA would have recognized that presenting an estimated time of arrival to the driver (either through an audio interface, visual interface, or both) would have allowed the driver to inform friends, colleagues, relatives, or others of when they will arrive at a destination so that they can plan accordingly.

173. As a third reason, a POISTA would have recognized that allowing the user to enter/change departure time and view the effects on travel time would have

allowed a user to select a best or most convenient departure time that potentially minimized the total travel time.

174. Finally, such a modification would have been merely the application of known techniques to a known system ready for improvement to yield predictable results. Such a modification would have been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such a modification. Knockeart even contemplates “[o]ther embodiments” not expressly described and a POSITA would have recognized that Peterson’s teachings provide just such an embodiment that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman). GM-1004, [00420].

B. Application of the Combination of Knockeart with Feldman and Peterson to Claims 27-28

Claim [27] The computer program product of claim 1, further comprising presenting an estimated time of arrival at the destination based at least in part on the traffic condition.

175. Peterson demonstrates that the predictable combination of Knockeart with Feldman and Peterson provides presenting an estimated time of arrival at the destination based at least in part on the traffic condition. Specifically, Peterson describes that the in-vehicle navigation unit (implemented as a cellular phone in at least some cases, based on the teachings of Feldman) provides “[t]he estimated elapsed time to destination” via audio or visually via a “display terminal.” GM-

1009, 11:25-32, 12:2-6, 12:34-49, 4:13-16. As I discussed in Ground 1, above, the route to the destination is determined at least in part on the traffic condition and therefore a POSITA would have understood that the estimated time of arrival at the destination communicated by the in-vehicle navigation system (as taught by Peterson) is based at least in part on the traffic condition. GM-1004, [0030], [0077], [0315]-[0319], [0330], [0170]; GM-1009, 3:35-50, 4:35-61, 9:48-10:10.

Claim [28] The computer program product of claim 27, further comprising receiving an intended leave time for the destination, and further comprising presenting a user interface to adjust the intended leave time such that a user can understand an effect of leave time on estimated travel time.

176. Peterson demonstrates that the predictable combination of Knockeart with Feldman and Peterson provides receiving an intended leave time for the destination, and further comprising presenting a user interface to adjust the intended leave time such that a user can understand an effect of leave time on estimated travel time. Specifically, Peterson describes determining “change[s] in elapsed travel time as a result of traffic build-up, for different departure times.” GM-1009, 6:55-57. The predictable combination of Knockeart with Feldman and Peterson provides a user interface that allows the driver to “indicate departure time if the user is not commencing travel immediately” and uses the indicated departure time along with historical traffic data to “provide a more accurate assessment of elapsed travel time[.]” *Id.*, 12:13-25. A POSITA would have recognized that such

a system would have beneficially allowed the driver to change the departure time and receive an updated “elapsed travel time” for the new departure time and thus would have been able to understand an effect of leave time on estimated travel time.

XVI. ANALYSIS OF KNOCKEART IN VIEW OF FELDMAN AND CRAINE WITH RESPECT TO CLAIM 31 (GROUND 7)

A. Overview of Craine

177. Craine is directed toward “[a] personal traffic congestion avoidance system for drivers of motor vehicles traveling on roadways in motor vehicles with GPS-based navigational systems.” GM-1010, Abstract. Craine describes that “[t]he GPS-based navigation system continuously determines the motor vehicle exact physical location in a region that is intermittently or continuously uploaded to a remote computer via the wireless communication network,” where “[t]he remote computer is connected to a traffic monitoring database or service that provides current traffic affecting events in the region thereto.” *Id.* Craine describes an alert system for warning the driver of nearby traffic events, describing that “[w]hen a traffic affecting event is located *in the designated vicinity* of the current location of the motor vehicle, on the current roadway used by the motor vehicle, or on a roadway that may affect the traffic on the current roadway, *an alert warning is generated and delivered to the GPS-based navigational system* and displayed on the visual display.” *Id.* In further examples, Craine describes that “[t]he alert

signal, which contains location information regarding the traffic affecting event, may be displayed on the navigational system visual display or audibly broadcasted to the driver.” *Id.*, 3:1-4; *id.*, 2:64-3:1.

B. Combination of Knockeart and Feldman with Craine

178. Multiple reasons would have prompted a POSITA to apply the teachings of Craine to the combination of Knockeart with Feldman to provide a warning to the driver when a traffic condition is located within the vicinity of the current location of the vehicle to allow the user to decide if an alternative route should be taken. As a first reason, modifying the Knockeart-Feldman system to provide such an alert based on proximity of a travel time affecting traffic event to the current location of the vehicle would have beneficially allowed the driver to “immediately change his or her route to avoid the traffic affecting event” or “request assistance from the GPS-based navigational system route guidance feature to find an alternative route[.]” GM-1010, 3:5-12, 4:19-23.

179. As a second reason, a POSITA would have recognized that presenting such a proximity based alert to the driver when a travel time affecting traffic event is detected within the vicinity of the current location of the vehicle would have improved the system by providing the alert to the driver at a time that is most beneficial for the driver. For example, alerting the driver to a traffic condition occurring 100 miles away would be unnecessary and potentially distracting as it is

likely that the traffic condition will clear by the time the driver reaches that point of the route. Additionally, if the driver is alerted too soon, the driver may forget about the alert by the time they reach the condition, or may be overwhelmed with too many alerts if the driver is alerted to all traffic conditions along the route rather than only traffic conditions within a proximity of the driver.

180. Finally, such a modification would have been merely the application of a known technique to a known system ready for improvement to yield predictable results. Such a modification would have been well within the skill of a POSITA and a POSITA would have had a reasonable expectation of success in making such a modification. Knockeart even contemplates “[o]ther embodiments” not expressly described and a POSITA would have recognized that Craine’s teachings provide just such an embodiment that would have been readily applicable to the system of Knockeart (as predictably modified by Feldman). GM-1004, [0420].

C. Application of the Combination of Knockeart with Feldman and Craine to Claim 31

Claim [31] The computer program product of claim 1, further comprising a warning system adapted to warn a driver traveling on the route of the traffic condition, wherein the warning is based on a proximity of the driver, as determined by the current location, to an adverse traffic condition.

181. Craine demonstrates that the predictable combination of Knockeart with Feldman and Craine provides a warning system adapted to warn a driver traveling on the route of the traffic condition, wherein the warning is based on a

proximity of the driver, as determined by the current location, to an adverse traffic condition.

182. As I previously discussed in my analysis of Ground 1, Knockeart discloses that “[i]f the received traffic data indicates an exceptional traffic condition on the specified path, ***the user is notified of the traffic condition.***” GM-1004, [0042]; *see also* GM-1005, [0099]-[0101]. Craine elaborates on this alert concept by giving additional details on when such an alert or notification is most beneficially provided to the driver. Specifically, Craine reveals that in the Knockeart-Feldman-Craine combination, the system identifies “[w]hen a traffic affecting event occurs” and “determine[s] ***whether the traffic affecting event is in the designated vicinity***, on a roadway currently used by the driver, or on a roadway that may be affected by the traffic affecting event based on the current location of the motor vehicle.” GM-1010, 2:56-64. “If the motor vehicle is in the designated vicinity...***an alert signal*** is created by the remote computer and transmitted via means for wireless communication to the GPS receiver located inside the motor vehicle... [and] ***displayed on the navigational system visual display*** or audibly broadcasted to the driver.” *Id.*, 2:64-3:4.

183. In another example, Craine describes that “[w]hen a traffic affecting event 75 occurs, it is reported by the traffic monitoring service 60 to the remote computer 40” and “[i]f the motor vehicle 10 is in the vicinity or traveling on such a

roadway, then *an alert signal 61 is created* by the remote computer 40 and *transmitted via the wireless communication network 32* to the GPS receiver 12 located inside the motor vehicle 10 to *warn the driver of the traffic affecting event 75.*” GM-1010, 4:4-19. Craine goes on to describe that “[t]he driver may also request the GPS-based navigational system route guidance system find an alternative route” in response to receiving such an alert. *Id.*, 4:21-23. In yet another example, Craine describes that the resulting system “transmit[s] a traffic alert signal 61 from said remote computer 40 to said motor vehicle 10 when said traffic affecting event 75 is *within a preselected distance* of said motor vehicle 10[.]” *Id.*, 7:4-15.

XVII. ADDITIONAL REMARKS

184. I currently hold the opinions expressed in this Declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

185. I hereby declare 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 further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this proceeding.

Dated:

June 1, 2023

By:

A handwritten signature in black ink, reading "Michael S. Braasch", written over a horizontal line.

Dr. Michael S. Braasch, of Guysville, OH

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: Current Developments In Signal Modeling Of The Precision Distance Measuring Equipment.

Ph.D. in E.E., 1992

Ohio University

Title of Thesis: On The Characterization Of
Multipath Errors In Satellite-Based Precision
Approach and Landing Systems.

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

2023 Elevated to IEEE Fellow

Professional Memberships:

Member, Institute of Electrical and Electronics Engineers (Fellow)

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, 2020-2022, Principal Investigator: M. Braasch

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

Supernal, "Supernal Flight Testing," \$223,283, 2022-2023, Co-Principal Investigators: M. Braasch and S. Ugazio.

Publications:

Journal Articles

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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.

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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.

Needham, T. and M. Braasch, "Gravity Modeling in GNSS-Aided Inertial Navigation System Safety Certification," NAVIGATION: Journal of the Institute of Navigation, Vol. 69, No. 2, June 2022.

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.

“Inertial+, the Once and Future Navigation System,” IEEE AESS Distinguished Lecture, IEEE Buenaventura Section / AESS Chapter, Westlake Village, CA, August 18, 2022.

“Gravity-Modeling Considerations in High-Integrity Inertial Systems,” IEEE AESS Virtual Distinguished Lecture, November 30, 2022.

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.

Timothy Needham: “Gravity Modeling in High-Integrity GNSS-Aided Inertial Navigation Systems,” Ph.D., August 2022. [Co-Advisor with C. Bartone]

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 - 2022 (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- 2022

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): Summers 2013-2022

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, 2022-2023.

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.

GPSoft LLC, 1996-present.

This work has involved software development and short-course teaching. The software developed consists of the GPSoft 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; Kecker & 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 and IPR2017-02051

Client: Flir Systems Inc., Flir Maritime US, Inc., Navico, Inc.

General Technology involved: Marine navigation systems

Services provided: Expert declarations and depositions.

Date: December 2016 – March 2018

Type of Matter: USPTO – Inter Partes Review – Case IPR2017-00815, IPR2017-00816, IPR2017-00817 and IPR2017-00818

Client: Google Inc.

General Technology involved: Vehicle route guidance systems

Services provided: Expert declarations and depositions.

Date: 2016 – 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

Type of Matter: USPTO – Inter Partes Review – Case IPR2018-01024

Client: Unified Patents, Inc.

General Technology involved: Vehicle navigation displays

Services provided: Expert declaration.

Date: 2018

Type of Matter: USPTO – Inter Partes Review – Case IPR2018-01490

Client: Flir Systems Inc., Flir Maritime US, Inc.

General Technology involved: Technology for backtracking a route

Services provided: Expert declaration.

Date: 2018

Type of Matter: USPTO – Inter Partes Review – Case IPR2018-00210

Client: Maxell, Ltd.

General Technology involved: Mobile communication devices with navigation functions

Services provided: Expert declaration and deposition.

Date: 2018

Type of Matter: USPTO – Inter Partes Review – Case IPR2021-00502, IPR2021-00503
and IPR2021-00504

Client: Google, Inc.

General Technology involved: Vehicle route guidance systems

Services provided: Expert declarations.

Date: 2020 – 2021

Type of Matter: USPTO – Inter Partes Review – Case IPR2021-01552, IPR2021-01553
and IPR2022-00073

Client: Apple, Inc.

General Technology involved: Navigation functionality in terrestrial communication
networks

Services provided: Expert declarations.

Date: 2021 – 2022

Type of Matter: District Court (E.D. Texas), Case No. 2:21-cv-00315-JRG-RSP

Client: Cellco Partnership dba Verizon Wireless

General Technology involved: Mobile device location determination techniques

Services provided: Expert consulting.

Date: 2021 - 2022

Type of Matter: USPTO – Inter Partes Review

Client: Unified Patents, LLC

General Technology involved: Wireless communication system for locating wireless
devices

Services provided: Expert declaration.

Date: 2022

Type of Matter: District Court (W.D. Texas), Case No. 21-cv-1312-ADA

Client: Google, Inc.

General Technology involved: Mobile device navigation

Services provided: Expert declaration.

Date: 2022 - present